Are you already timing styles successfully?

The implicit style rotation in technical styles

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Style Timing[1]

> 'Researchers have tried to improve on (style) strategies by incorporating various macroeconomic (conditioning) measures, including earnings yield on the S&P 500, the slope of the yield curve, corporate credit spreads and corporate profits. These "style timing" models have produced mixed results'. Asness (2000)

- We break down investment styles into two categories: fundamental and technical. Fundamental styles use company data, such as earnings, cash flow (sometimes scaled by price), to build portfolios. Technical styles use a history of return data to construct portfolios, for example price momentum and low volatility.

- We first show that correlations between fundamental styles scores are remarkably stable over time; whereas the correlations of technical style scores with either other technical or fundamental scores vary over the economic cycle.

- This leads us to ask the following question; how far can the implicit style-timing within technical styles explain their performance? We show that it is possible to replicate the returns to technical styles closely using only fundamental styles by employing the implicit style rotation strategy embedded within the technical style.

- To which should be added that volatility targeting has proved effective, especially with momentum

1. The author would like to thank Professor James Sefton of Imperial College, London for the significant contribution he provided to this material.

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Fundamental and Technical Styles

- Fundamental Styles are styles constructed using fundamental data.
  1. Value: constructed from the firm's book to price ratio.
  2. Quality: constructed from the firm's return on equity (ROE).
  3. Size: using the firm's total market value of equity
  4. Cash Flow Volatility: constructed using minus the standard deviation of the quarterly cash flow from operations to sales ratio over the previous 4 years.
  5. Earnings Momentum: a weighted average of the percentage changes in the 12 months forward EPS forecast relative to 1, 2 and 3 months ago.
- Technical Styles are constructed using past stock return data.
  1. Low volatility: constructed using minus the standard deviation of daily returns over the past 12 months.
  2. Price momentum: constructed from the percentage return to the equity of the past 12 months.
- The style portfolios are constructed by ranking monthly and taking either the top quintile or the top minus the bottom quintile, all equally weighted. The market is the MSCI US.

Outline and Approach

- Look at the data – both cross-sectional styles scores and time-series of style returns
  - Argue that both cross-sectional score correlations and time-series return correlations are more stable within fundamental styles than across fundamental and technical styles.

- Replicate Technical Styles from Fundamental Styles
  - Reproduce the technical style cross-sectional stocks scores by regressing on the fundamental style scores at each rebalance date (month end). Use the best fit as the replication scores.

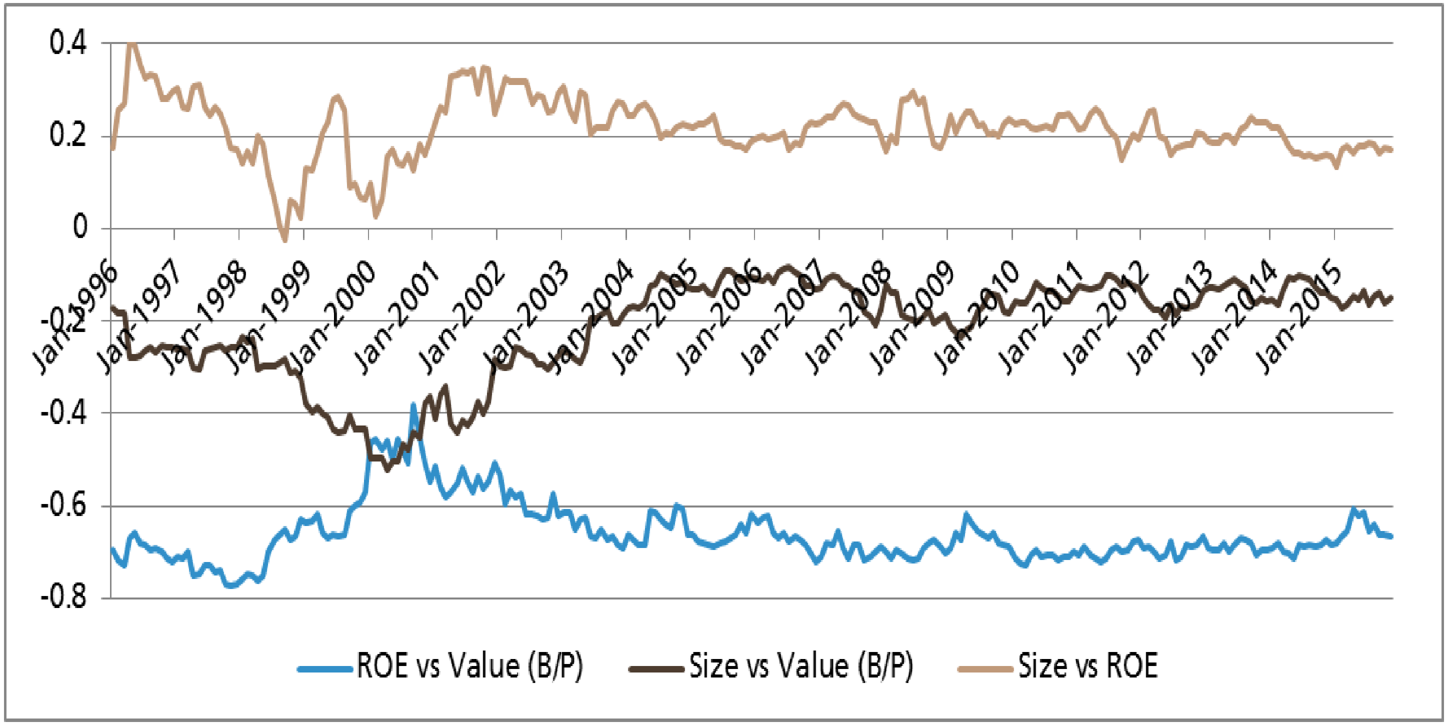
    The best fit will define the implicit style rotation of the fundamental style scores
  - Simulate and compare the returns of the replicated style strategy to the actual technical style.

- Discuss how to adjust for slightly different volatility and beta exposure of the replication strategies.

Cross-Sectional Correlations of Scores

Fundamental Styles

- CS correlations are very stable over time
- Quality is negatively correlated to value and positively to size.
- Value and size are negatively correlated.

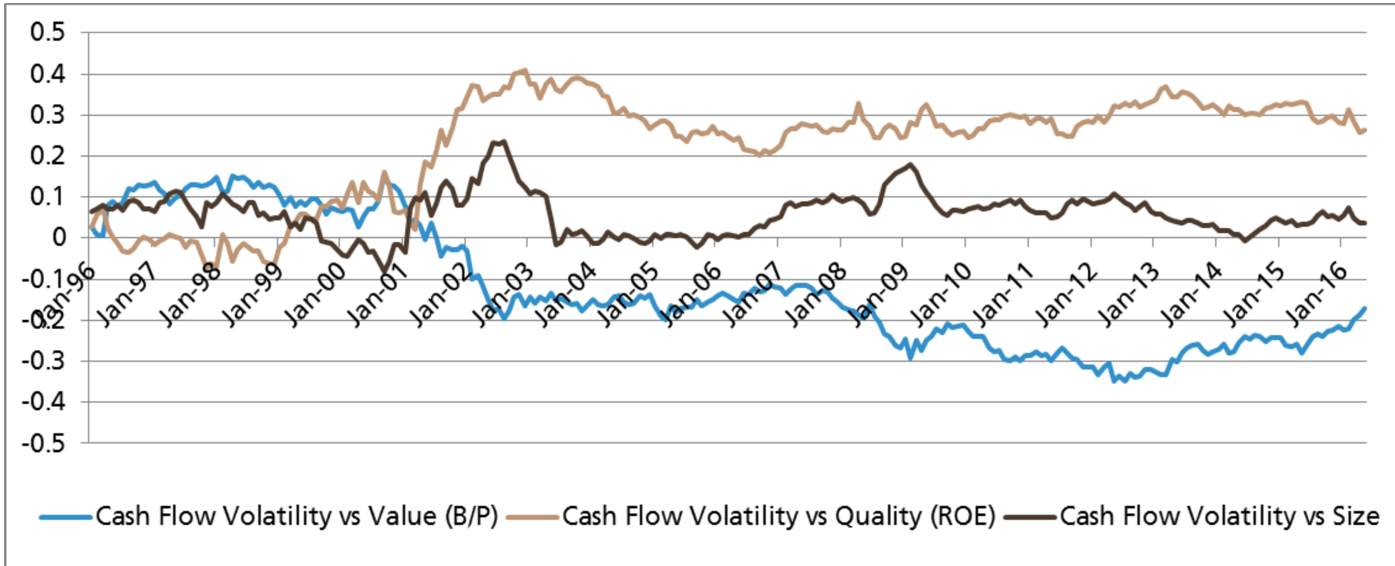


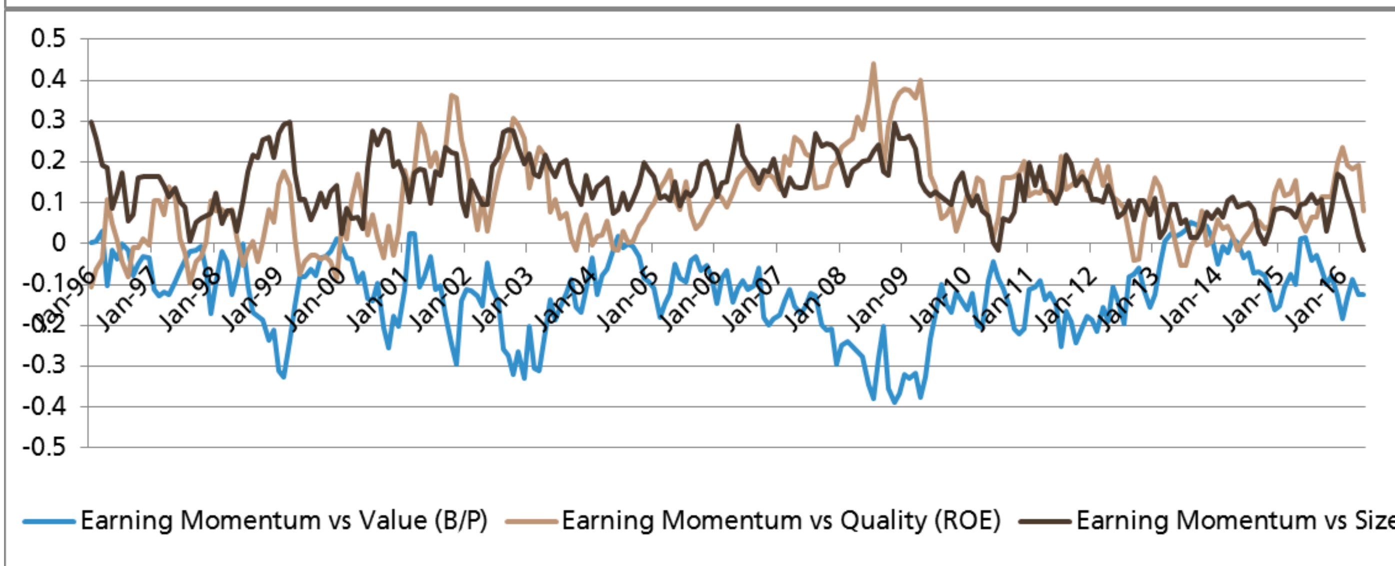
Source: UBS Quantitative Research. The cross-sectional correlation between two styles at the end of every month is the Spearman rank correlation of the two styles scores. The figure plots the value of these correlations over time

Cross-Sectional Correlations of Scores (2)

Fundamental Styles

- The correlations are all intuitive, with quality and size being associated with low cash flow volatility and high earnings momentum, and value with high volatility and low earnings momentum.
- The correlations with cash flow volatility are weaker prior to 2000. .





Source: UBS Quantitative Research. The cross-sectional correlation between two styles at the end of every month is the Spearman rank correlation of the two styles scores. The figure plots the variation in these correlations over time.

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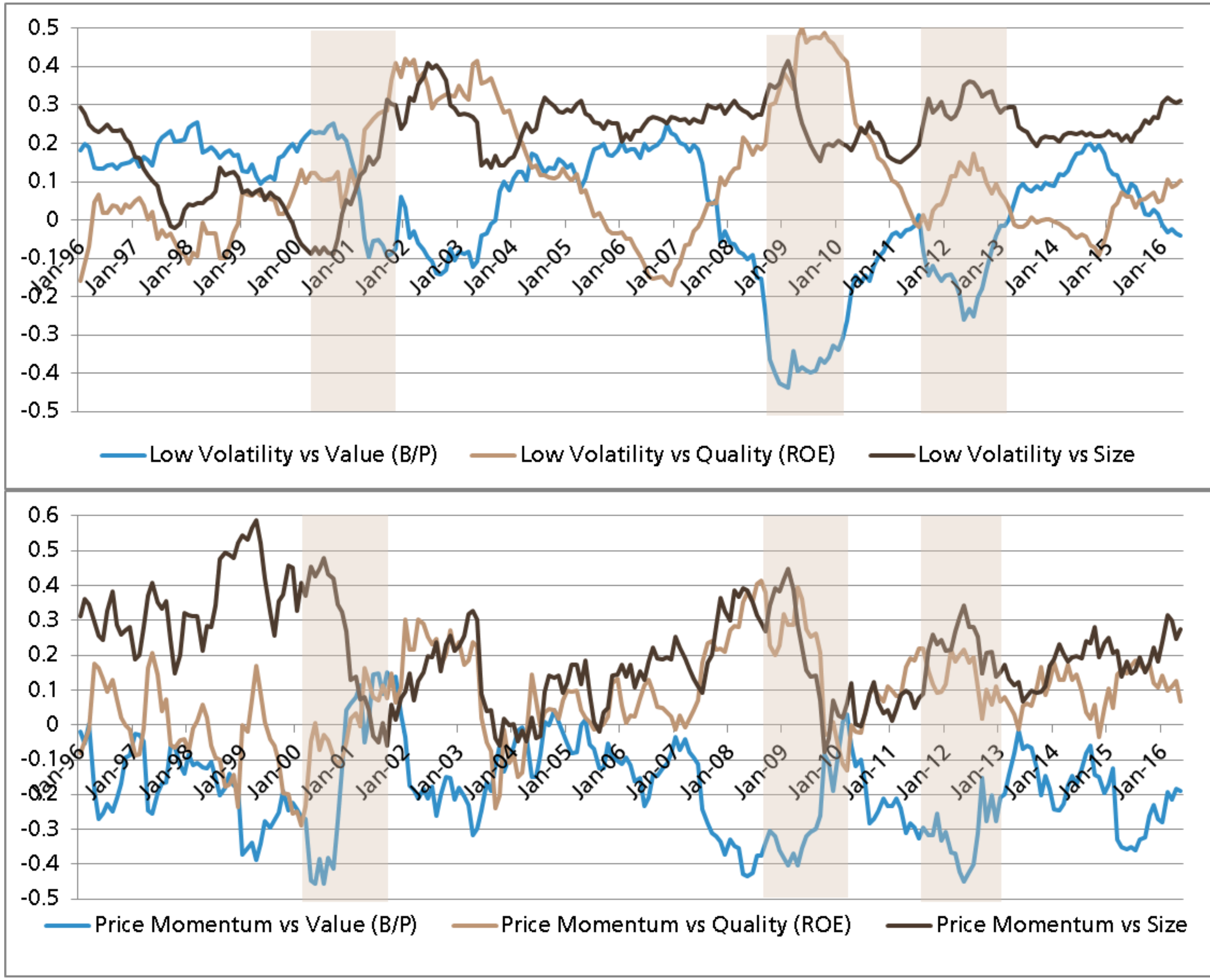
Cross-Sectional Correlations of Scores (3)

- CS correlations are unstable over time.
- Top chart shows correlation with low vol, the bottom with price momentum.
- Correlations are cyclical: ROE +ve in downturns, B/P =ve in recovery



Source: UBS Quantitative Research. The top panel plots the cross-sectional correlation of our 3 core fundamental style scores with the low volatility score at each month end. The bottom panel plots the 6 month rolling correlation of the daily returns to the 3 core fundamental style portfolios with the returns to the low volatility portfolio

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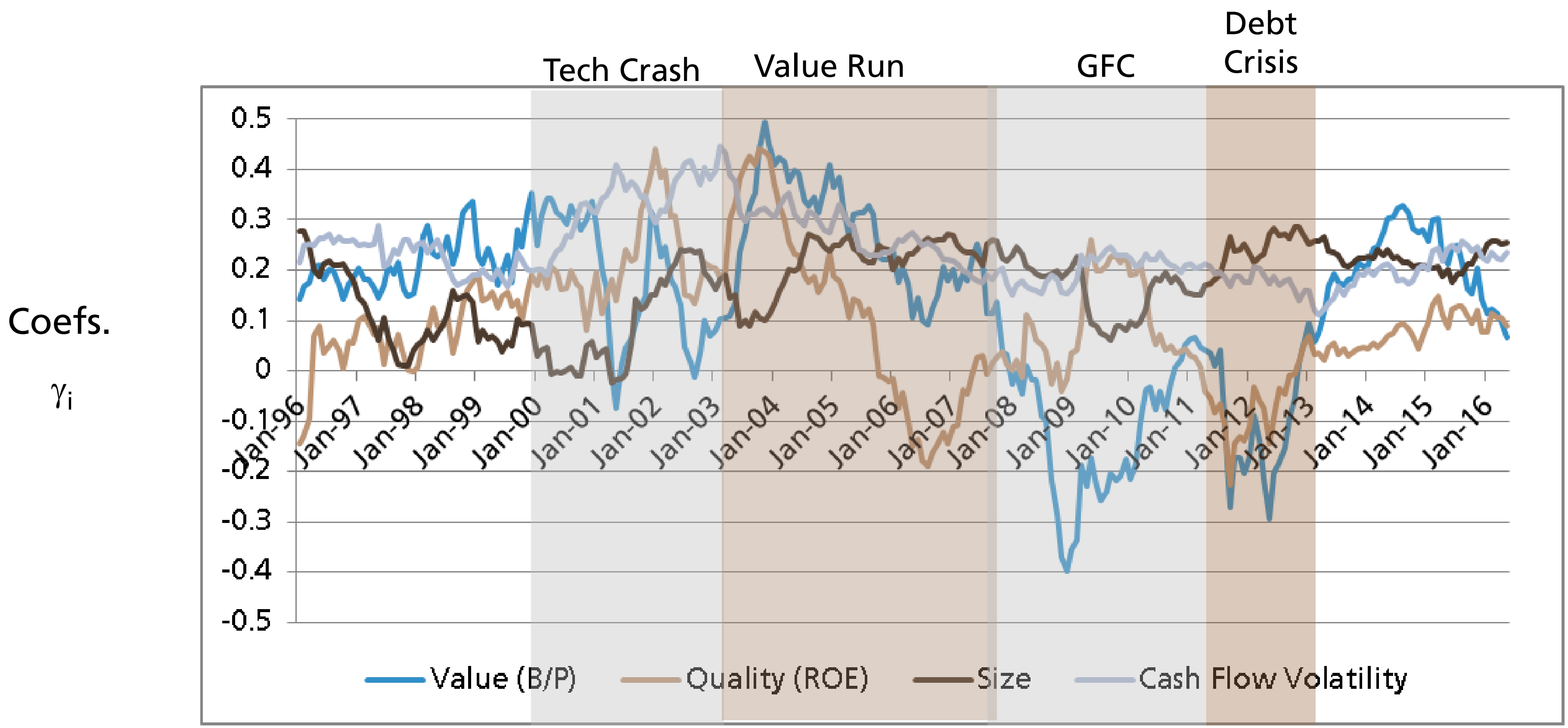
Replication Strategy

- Regress the fundamental scores – Book/Price, ROE, Size and Cash Flow Volatility - onto the low volatility scores (realised volatility over previous 12 month).

$$LV_t = \gamma_1 (B/P)_t + \gamma_2 ROE_t + \gamma_3 Size_t + \gamma_4 CFV_t + \varepsilon_t$$

- Create a replication score from the best fit score, that is $\gamma_1 (B/P)_t + \gamma_2 ROE_t + \gamma_3 Size_t + \gamma_4 CFV_t$



Source: UBS Quants

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Success of Replication

- Compare the returns to the Low Volatility Replication Strategy to the Long-Short Low Volatility Portfolio non sector neutral (R^2 of the returns 0.82)

	Estimate	Estimate	t-value	Estimate	t-value	Estimate	t-value
Low Volatility Replication		1.26	115.33				
Embedded Style Rotation				1.17	95.04		
Cash Flow Volatility						1.23	81.57
MSCI US Index	-0.82	-0.36	-41.99	-0.40	-40.42	-0.51	-49.13
Intercept (*252)	0.082	0.026	2.25	0.023	1.75	0.012	0.84
R^2	0.38	0.82		0.77		0.73	

- And sector neutral (R^2 of 0.71)

	Estimate	t-value	Estimate	t-value	Estimate	t-value
Low Volatility Replication	0.98	75.55				
Embedded Style Rotation			0.93	66.17		
Cash Flow Volatility					0.93	49.85
MSCI US Index	-0.35	-54.32	-0.35	-49.57	-0.44	-60.05
Intercept (*252)	0.023	1.75	0.014	1.45	0.009	0.82
R^2	0.71		0.67		0.59	

Source: UBS Quantitative Research. The returns to various replicating portfolios and the MSCI US Index are regressed on the returns to the low volatility strategy. The table records the regression coefficients and their respective t-statistics as well as the R^2. The intercept term is multiplied by 252 to express it on annualised basis. The first column of the top table records a regression on the market alone; the next 6 columns record the statistics when the portfolios are non-sector neutral. The bottom table records the statistics when the portfolios are sector neutral.

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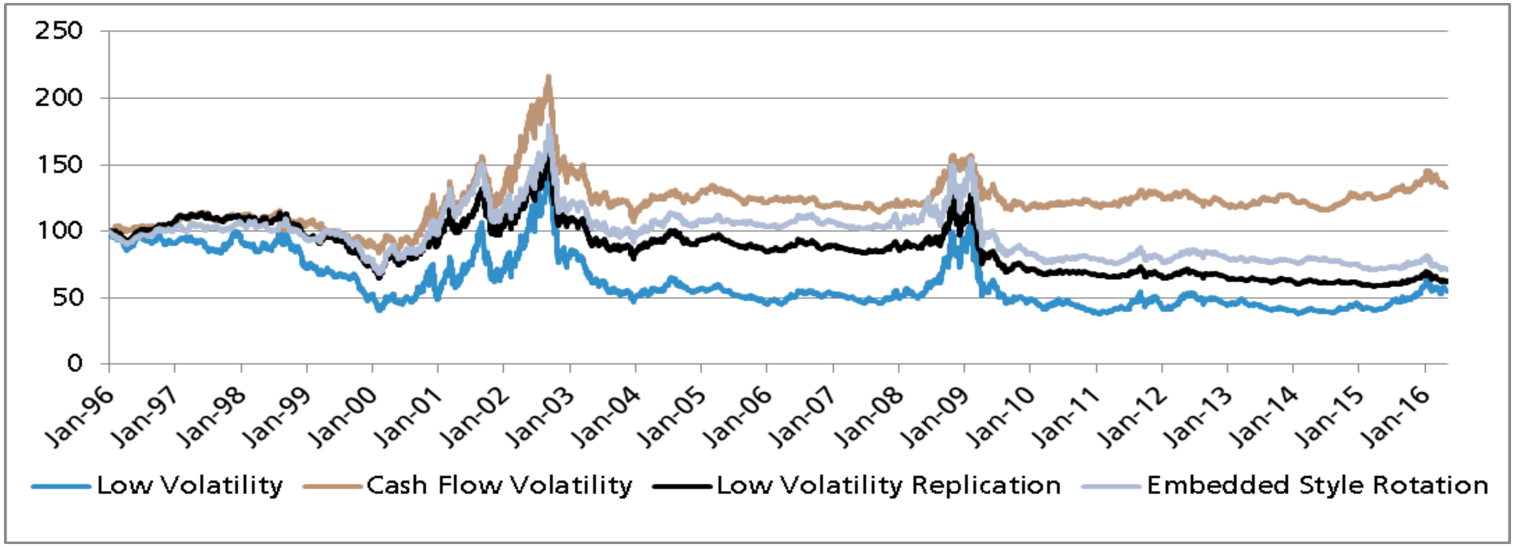
Success of Replication

- Compare performance of LV replication portfolio with LV portfolio:

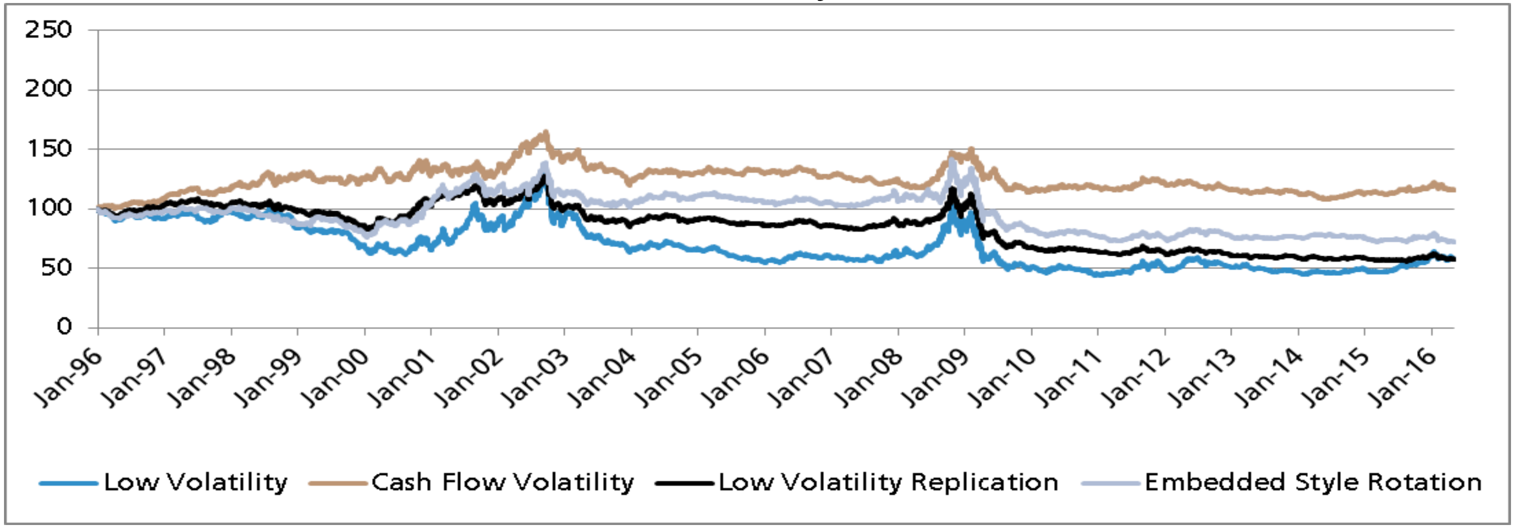
1. High Correlation in returns.
2. But LV portfolio has a lower beta (≈ 0.25)

.

Unbalanced or non-sector neutral styles



Sector neutral Styles



Source: UBS Quantitative Research. The figure plots the performance of the low volatility strategy index against the various replicating strategy indices. The upper panel is non-sector neutral strategies; the lower panel is sector neutral ones.

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Success of Replication (Betting against Beta)

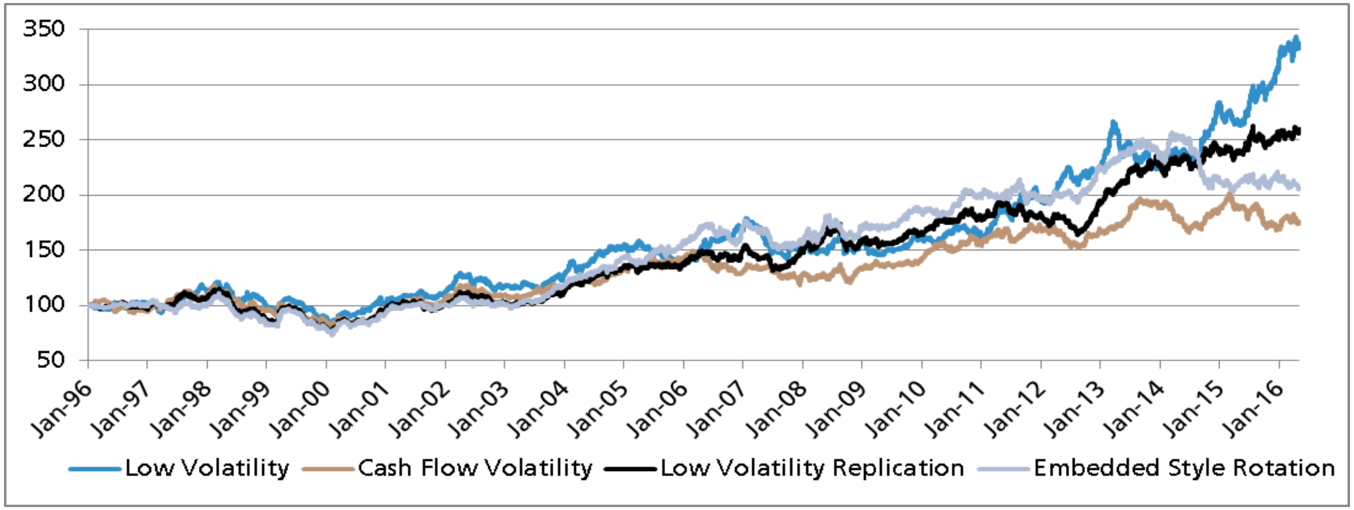
- Alternatively remove Beta exposure (estimate Beta exposure over previous 6M and hedge this exposure over next month)
- Lower Beta exposure of LV portfolio implies slight out-performance over the entire of this portfolio relative to replication portfolio.

Performance statistics of the betting against beta

	Correlation with Low Volatility	Mean Return (annualised)	Std. Dev. (annualised)	Sharpe Ratio
Low Volatility	1.00	6.2%	9.2%	0.67
Low Volatility Replication	0.88	5.0%	8.9%	0.55
Embedded Style Rotation	0.84	3.1%	8.9%	0.43
Cash Flow Volatility	0.78	3.1%	8.9%	0.35
Quality	0.59	2.0%	9.0%	0.22
Value	-0.15	0.3%	9.2%	0.03
Size	0.57	-0.3%	8.8%	-0.04

Source: UBS Quants

Index performance of the low vol betting against beta strategies



Source: UBS Quants

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Price Momentum

- We now repeat analysis for 12 month price momentum
- Chordia, Shivakumar (2006) - data 1972-1999 – and Leippold and Lohre (2012) – data 1990 – 2008 - document the relation between earnings momentum and price momentum.
  - CS find that profits to price momentum 'is subsumed' by earnings momentum in the US
  - LL find a strong relationship too but price momentum 'not always' subsumed by earnings momentum.
- Daniel, Moskowitz (2013) document the time-varying beta exposure of momentum and its ability to explain its performance.
- We explain profits to price momentum in terms of

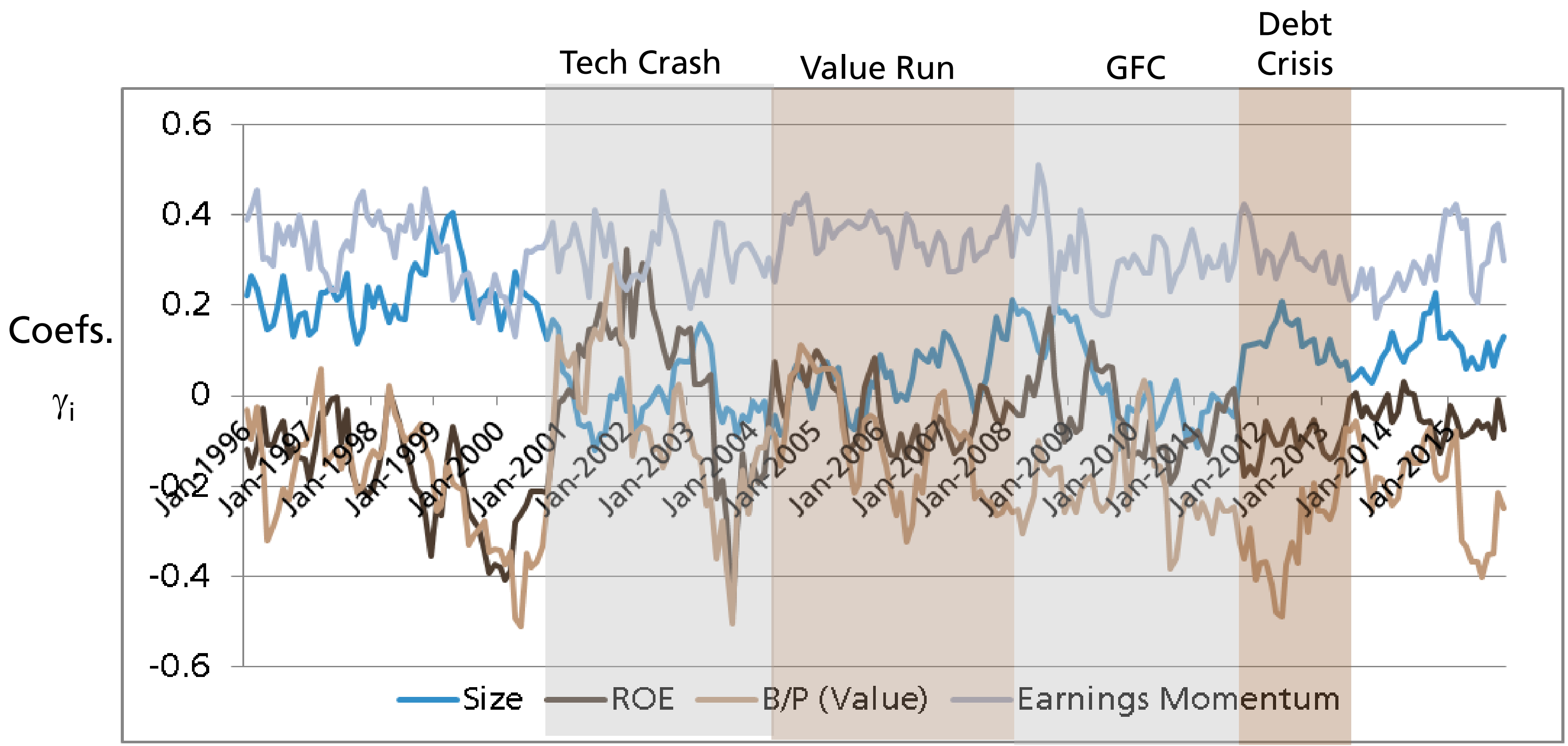
1. B/P, ROE, Size and Earnings Momentum
2. B/P, ROE, Size, Low Volatility and Earnings Momentum

Replication Strategy

- Regress the fundamental scores – Book/Price, ROE and Size - onto the low volatility scores (realised volatility over previous 12 month).

$$(PM)_t = \gamma_1 (B/P)_t + \gamma_2 ROE_t + \gamma_3 Size_t + \gamma_4 (EM)_t + \varepsilon_t$$

- Create a replication score from the best fit score, that is $PM_t^{Rep} = \gamma_1 (B/P)_t + \gamma_2 ROE_t + \gamma_3 Size_t + \gamma_4 (EM)_t$



Source: UBS Quants

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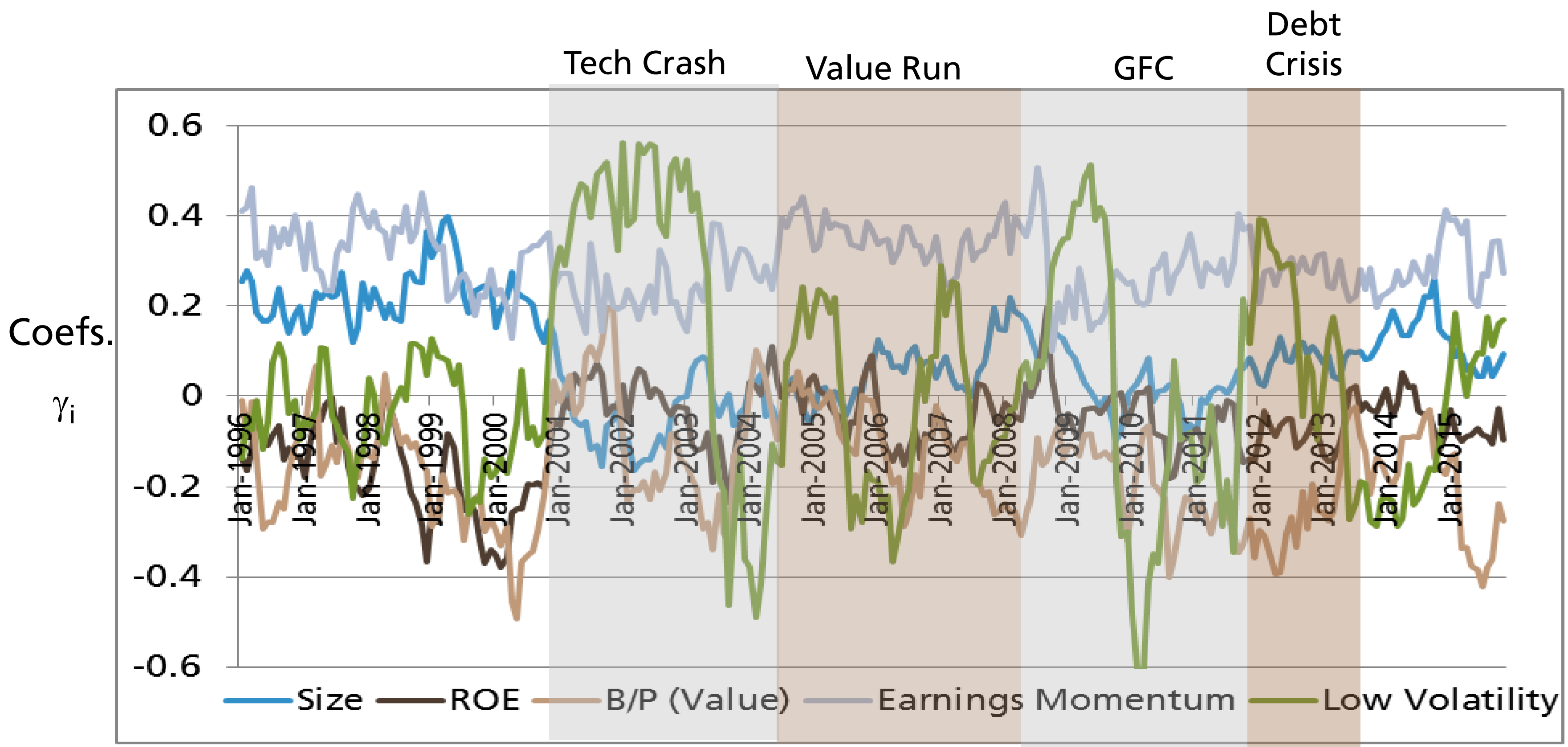
Replication Strategy

- Regress the fundamental scores – Book/Price, ROE and Size - onto the low volatility scores (realised volatility over previous 12 month).

$$(PM)_t = \gamma_1 (B/P)_t + \gamma_2 ROE_t + \gamma_3 Size_t + \gamma_4 \left(EM\right)_t + \gamma_4 \left(LV\right)_t \varepsilon_t$$

- Create a replication score from the best fit score



Source: UBS Quants

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Success of Replication

- Compare the returns of the Unbalanced Long-Short Price Momentum Portfolio to the returns of the Replication Strategy

Non- Sector Neutral Portfolios								
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Momentum Replication Basic	1.12	146.35						
Momentum Replication with Low Vol			0.93	191.97			0.84	94.14
Momentum Earnings					1.16	104.81	0.02	1.13
Net Earnings Upgrades							0.21	12.55
MSCI US Index	-0.02	-3.38	0.04	6.92	-0.02	-2.74	0.03	5.83
Intercept (*252)	0.018	0.86	0.007	0.41	0.018	0.68	0.015	1.06
R^2	0.81		0.88		0.69		0.89	

Source: UBS Quants

- Compare the returns of the Sector Neutral Long-Short Price Momentum Portfolio to the returns of the Replication Strategy

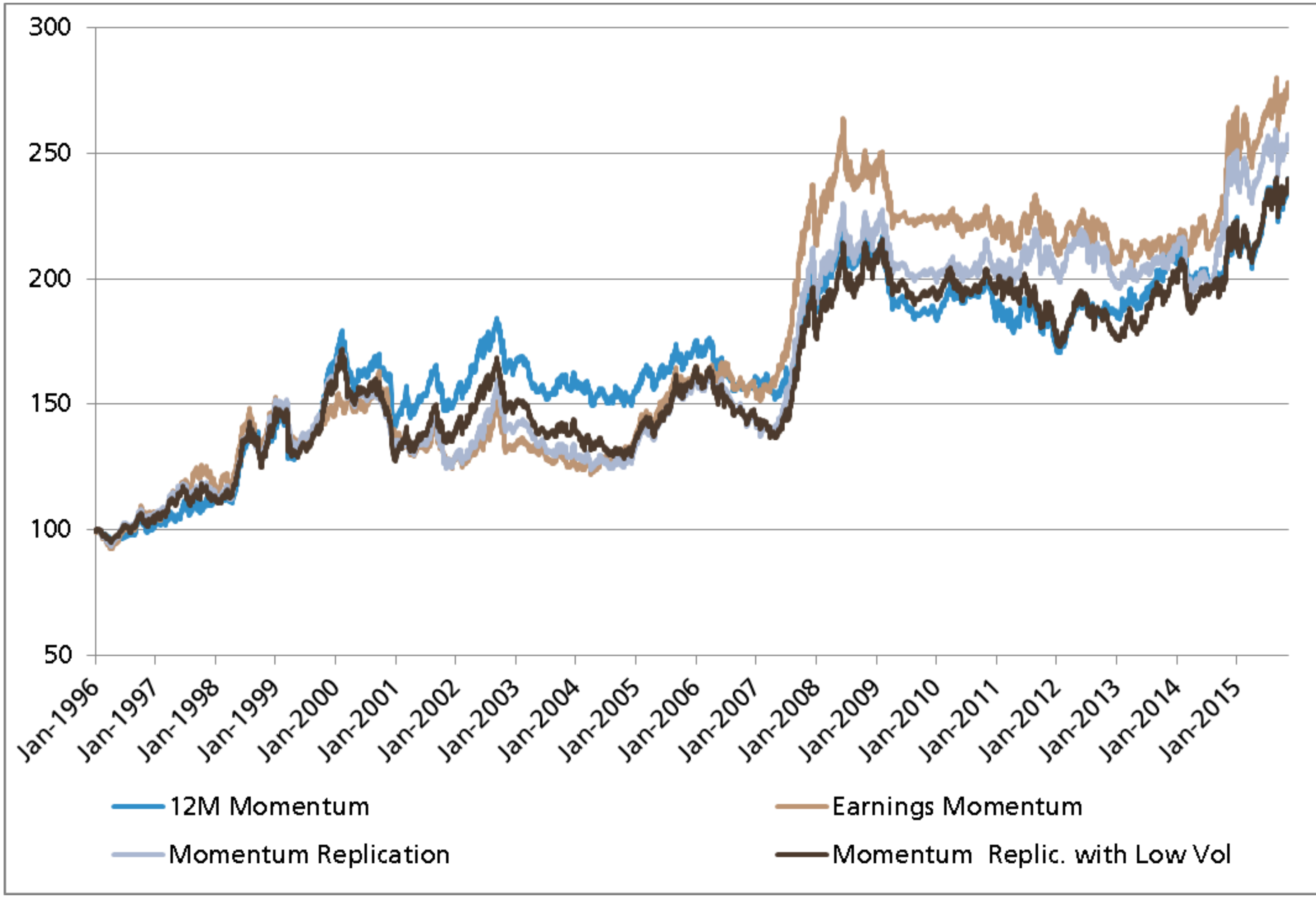
Non- Sector Neutral Portfolios								
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Momentum Replication Basic	1.12	146.35						
Momentum Replication with Low Vol			0.93	191.97			0.84	94.14
Momentum Earnings					1.16	104.81	0.02	1.13
Net Earnings Upgrades							0.21	12.55
MSCI US Index	-0.02	-3.38	0.04	6.92	-0.02	-2.74	0.03	5.83
Intercept (*252)	0.018	0.86	0.007	0.41	0.018	0.68	0.015	1.06
R^2	0.81		0.88		0.69		0.89	

Source: UBS Quants

Success of Replication

- We adjust the returns to the portfolios so as to have same volatility
- The style rotation does little to improve the performance of the strategy.

Unbalanced or non-sector neutral styles



Source: UBS Quants

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Performance Statistics

- Of the three strategies, earnings momentum has the best performance. The style rotation embedded in the momentum replication strategy improves the fit of the strategy but does little for the performance.

	Correlation with Low Volatility	Mean Return (annualised)	Std. Dev. (annualised)	Sharpe Ratio
12 Price Momentum	1.00	4.3%	9.3%	0.47
Earnings Momentum	0.83	5.1%	9.3%	0.54
Momentum Replication	0.90	4.6%	9.3%	0.50
Momentum Replication incl. Low Vol.	0.94	4.3%	9.2%	0.47
Embedded Style Rotation	0.82	1.5%	9.1%	0.16
Embedded Style Rotation incl. Low Vol.	0.89	1.4%	9.1%	0.16
Low Volatility	0.56	0.5%	9.0%	0.06
Value	-0.52	-1.2%	9.0%	-0.13
Quality	0.57	1.6%	9.0%	0.18
Size	0.72	0.0%	9.1%	0.01

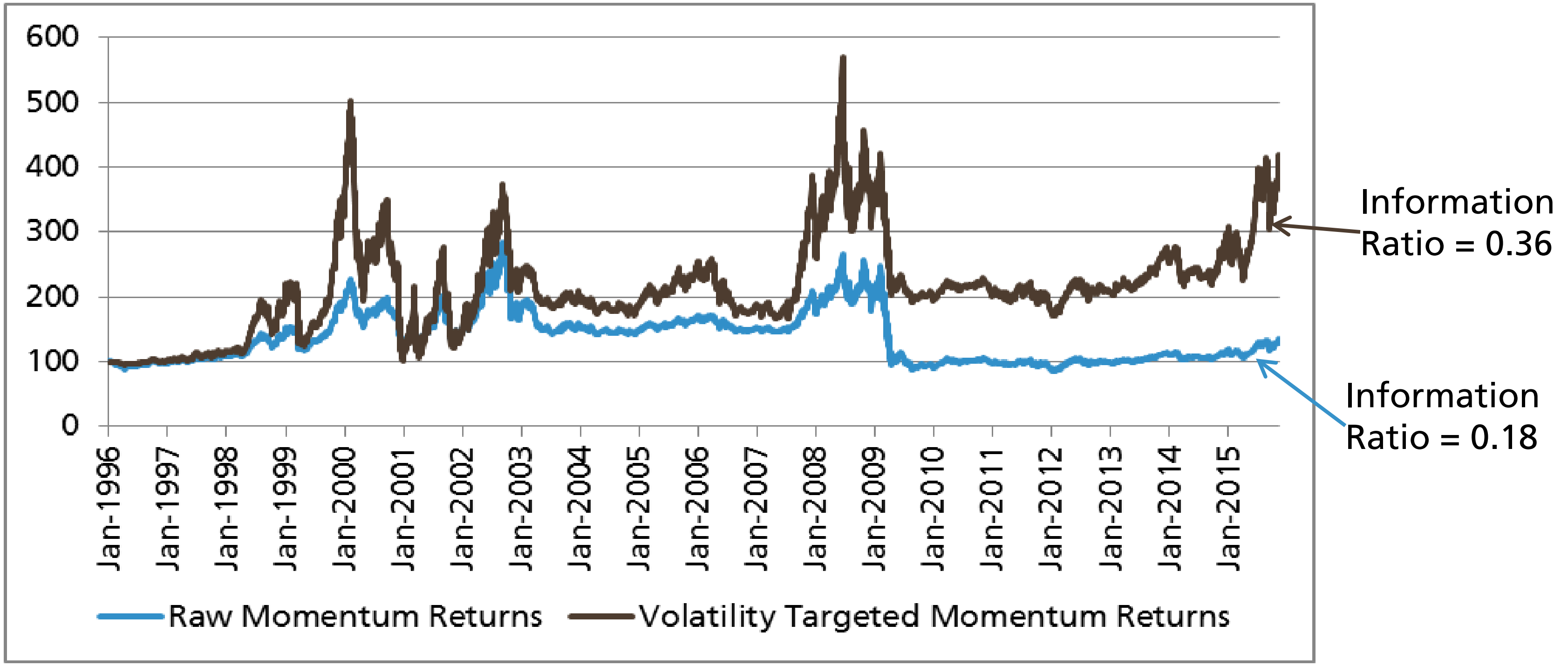
Source: UBS Quantitative Research. The table records the performance statistics for price momentum and associated replication strategies. The leverage of all strategies is rebalanced every month to target 9% volatility. The 'Momentum Replication' Strategy weights earnings momentum, value, quality and size scores to replicate price momentum; 'Momentum Replication incl. Low Vol' includes Low volatility scores as well; 'Embedded Style Rotation' weights Quality, Value and Size scores; 'Embedded Style Rotation incl. Low Vol.' weights Low Volatility as well as Quality, Value and Size scores The statistics are calculated on daily data over the complete sample of January 1996 to end of June 2016.

Section 2

Momentum Volatility Targeting

Momentum has its Moments

- Barosso and Santa Clara (2015) document that volatility targeting momentum doubles its Sharpe Ratio over the period 1930- 2010



Source: UBS Quants

- They note that:

1. Volatility of momentum returns is more persistent (predictable) then market volatility
2. The importance of 'momentum crashes' (Daniel, Moskowitz (2013)) – dramatic falls when volatility is high.

Why does it work?

- Barroso and Santa Clara (2015) suggest that momentum crashes occur contemporaneously with high volatility. Hence volatility targeting reduces the drawdown of momentum crashes.
- Cooper, Gutierrez, and Hameed (2004), Stivers and Sun (2010), Daniel and Moskowitz (2013) suggest momentum returns are forecastable. Low returns to momentum follow low returns to the market (CGH), or high cross-sectional return dispersion (SS) and particularly at market rebounds (DM).
- We estimate a stochastic volatility model of momentum returns that allows for both:
  1. Volatility-in-mean – mean returns to momentum are a function of past volatility
  2. Mean-in- volatility - volatility of momentum returns is a function of past average returns
- and ask whether the model can explain the observed moments to momentum

The Model

- Our Stochastic Volatility Model is based on the model of Brandt and Kang (2004)

$$r_{t+1} = \mu_t + \sigma_t \varepsilon_{t+1}$$

$$where$$

$$\begin{bmatrix} \mu_{t+1} \\ \log(\sigma_{t+1}) \end{bmatrix} = \begin{bmatrix} d_1 \\ d_2 \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \mu_t \\ \log(\sigma_t) \end{bmatrix} + \begin{bmatrix} \eta_{1,t+1} \\ \eta_{2,t+1} \end{bmatrix}$$

$$and$$

$$\begin{bmatrix} \varepsilon_{t+1} \\ \eta_{1,t+1} \\ \eta_{2,t+1} \end{bmatrix} \sim N\left(0, \begin{bmatrix} 1 & \sigma_{\varepsilon 1} & \sigma_{\varepsilon 2} \\ . & \sigma_1^2 & \sigma_{12} \\ . & . & \sigma_2^2 \end{bmatrix} \right)$$

- Except we allow for conditional expected returns to be negative.
- The model has 11 parameters to be estimated on monthly returns to momentum between January 1996 and December 2015

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The Model

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$$r_{t+1} = \mu_t + \sigma_t \varepsilon_{t+1}$$

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$$and$$

$$\begin{bmatrix} \varepsilon_{t+1} \\ \eta_{1,t+1} \\ \eta_{2,t+1} \end{bmatrix} \sim N\left(0, \begin{bmatrix} 1 & \sigma_{\varepsilon 1} & \sigma_{\varepsilon 2} \\ . & \sigma_1^2 & \sigma_{12} \\ . & . & \sigma_2^2 \end{bmatrix} \right)$$

Allows for persistence in conditional expected returns and volatility

- Except we allow for conditional expected returns to be negative.
- The model has 11 parameters to be estimated on monthly returns to momentum between January 1996 and December 2015

The Model

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$$r_{t+1} = \mu_t + \sigma_t \varepsilon_{t+1}$$

where

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and

$$\begin{bmatrix} \varepsilon_{t+1} \\ \eta_{1,t+1} \\ \eta_{2,t+1} \end{bmatrix} \sim N\left(0, \begin{bmatrix} 1 & \sigma_{\varepsilon 1} & \sigma_{\varepsilon 2} \\ . & \sigma_1^2 & \sigma_{12} \\ . & . & \sigma_2^2 \end{bmatrix} \right)$$

Allows for volatility-in-means effect

Allows for mean-in-volatility effect

- Except we allow for conditional expected returns to be negative.
- The model has 11 parameters to be estimated on monthly returns to momentum between January 1996 and December 2015

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The Model

- Our Stochastic Volatility Model is based on the model of Brandt and Kang (2004)

$$r_{t+1} = \mu_t + \sigma_t \varepsilon_{t+1}$$

where

$$\begin{bmatrix} \mu_{t+1} \\ \log(\sigma_{t+1}) \end{bmatrix} = \begin{bmatrix} d_1 \\ d_2 \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \mu_t \\ \log(\sigma_t) \end{bmatrix} + \begin{bmatrix} \eta_{1,t+1} \\ \eta_{2,t+1} \end{bmatrix}$$

and

$$\begin{bmatrix} \varepsilon_{t+1} \\ \eta_{1,t+1} \\ \eta_{2,t+1} \end{bmatrix} \sim N\left(0, \begin{bmatrix} 1 & \sigma_{\varepsilon 1} & \sigma_{\varepsilon 2} \\ . & \sigma_1^2 & \sigma_{12} \\ . & . & \sigma_2^2 \end{bmatrix} \right)$$

Contemporaneous correlation between returns and volatility

Contemporaneous correlation between future expected returns and returns today

- Except we allow for conditional expected returns to be negative.
- The model has 11 parameters to be estimated on monthly returns to momentum between January 1996 and December 2015.

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Estimation Approach – Indirect Inference

- It is best understood as an extension of Simulated Method of Moments

1. Define an auxiliary model – this model is chosen as a close approximation to the 'true' model but easy to estimate.
2. Estimate the parameters, β, of the auxiliary model on the sample data. Also estimate the asymptotic covariance matrix of these parameters Ω (as per GMM).
3. Given a choice of the parameters, θ, of the 'true' model create H simulations. Estimate the auxiliary model parameters, $\hat{\beta}(\theta_i)$, for each of these simulated data histories and average across the simulations

$$\hat{\beta}(\theta) = \tfrac{1}{H}\sum_{i=1}^{H}\hat{\beta}(\theta_i)$$

4. Iterate over 3 so as to minimise

$$\hat{\theta} = \arg\min_{\theta}\left(\beta - \hat{\beta}(\theta)\right)\Omega^{-1}\left(\beta - \hat{\beta}(\theta)\right)$$

5. Standard Errors are calculated by block bootstrap.

Auxiliary Model

- We define the 'statistics', β, of the auxiliary model as

$$\beta = \Big[\sum_t r_t \quad \sum_t r_t^2 \quad \sum_t r_t^3 \quad \sum_t \log r_t^2 \quad \sum_t r_t \log r_t^2 \quad \sum_t r_t\, r_{t-1} \quad \sum_t r_t\, r_{t-2} \quad \sum_t \log r_t^2 \left(\log r_{t-1}^2 + \log r_{t-2}^2\right)$$
$$\sum_t \log r_t^2 \left(\log r_{t-3}^2 + \log r_{t-4}^2\right) \quad \sum_t \log r_t^2 \left(\log r_{t-5}^2 + \log r_{t-6}^2\right) \quad \gamma^a \quad \gamma^b \Big]$$

- where γ^a γ^b are the coefficients from the following regressions

$$r_t = \gamma_1^a + \gamma_2^a r_{t-1} + \gamma_3^a r_{t-2} + \gamma_4^a \left(\log r_{t-1}^2 + \log r_{t-2}^2\right) + \gamma_5^a \left(\log r_{t-3}^2 + \log r_{t-4}^2\right) + \gamma_6^a \left(\log r_{t-5}^2 + \log r_{t-6}^2\right) + \xi_t^a$$

$$\log r_t^2 = \gamma_1^b + \gamma_2^b r_{t-1} + \gamma_3^b r_{t-2} + \gamma_4^b \left(\log r_{t-1}^2 + \log r_{t-2}^2\right) + \gamma_5^b \left(\log r_{t-3}^2 + \log r_{t-4}^2\right) + \gamma_6^b \left(\log r_{t-5}^2 + \log r_{t-6}^2\right) + \xi_t^b$$

Model Estimates (Full Model)

Model A: Full Specification

$$r_{t+1} = \mu_t + \sigma_t \varepsilon_{t+1}$$

where

$$\begin{bmatrix} \mu_{t+1} \\ \log(\sigma_{t+1}) \end{bmatrix} = \begin{bmatrix} 0.0040^{***} \\ 0.0021^{***} \end{bmatrix} + \begin{bmatrix} -0.12^{*} & 0.021^{**} \\ 0.033 & 0.95^{***} \end{bmatrix} \begin{bmatrix} \mu_t \\ \log(\sigma_t) \end{bmatrix} + \begin{bmatrix} \eta_{1,t+1} \\ \eta_{2,t+1} \end{bmatrix}$$

and

$$\begin{bmatrix} \varepsilon_{t+1} \\ \eta_{1,t+1} \\ \eta_{2,t+1} \end{bmatrix} \sim N\left(0, \begin{bmatrix} 1 & 0.0155 & -0.67^{***} \\ . & 0.0039^{**} & -0.315^{**} \\ . & . & 0.135^{***} \end{bmatrix} \right)$$

Diagonal elements are std. dev. and off-diagonal are correlations

** denotes significance at 10% level, ** at 5% and *** at 1%*

- Momentum volatility is very persistent
- A positive shock to volatility is instantaneously correlated with low returns to momentum
- A positive shock to volatility is correlated to a negative shock to returns

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Model Estimates (Stochastic Volatility)

Model B: Stochastic Volatility

$$r_{t+1} = \mu_t + \sigma_t \varepsilon_{t+1}$$

where

$$\begin{bmatrix} \mu_{t+1} \\ \log(\sigma_{t+1}) \end{bmatrix} = \begin{bmatrix} 0.0043^{***} \\ 0.0025^{***} \end{bmatrix} + \begin{bmatrix} 0.0 & 0.0 \\ 0.0 & 0.95^{***} \end{bmatrix} \begin{bmatrix} \mu_t \\ \log(\sigma_t) \end{bmatrix} + \begin{bmatrix} \eta_{1,t+1} \\ \eta_{2,t+1} \end{bmatrix}$$

and

$$\begin{bmatrix} \varepsilon_{t+1} \\ \eta_{1,t+1} \\ \eta_{2,t+1} \end{bmatrix} \sim N\left(0, \begin{bmatrix} 1 & 0.0 & -0.29^{**} \\ . & 0.0 & 0.0^{**} \\ . & . & 0.144^{***} \end{bmatrix} \right)$$

Diagonal elements are std. dev. and off-diagonal are correlations

** denotes significance at 10% level, ** at 5% and *** at 1%*

- With a stochastic volatility model, volatility is as persistent
- However the instantaneous negative correlation to returns is reduced.

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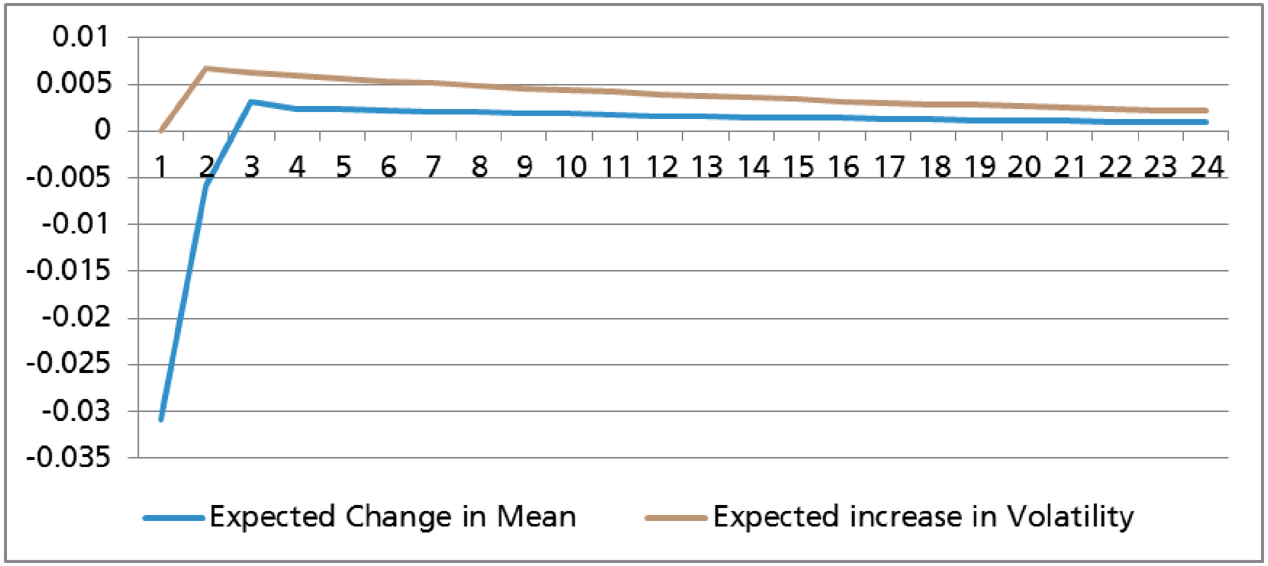
Impulse Response to a shock in underlying volatility

- A shock to Volatility is persistent and still significant after 2 years
- Expected returns to momentum are low both instantaneously and in the next month



Source: UBS Quants

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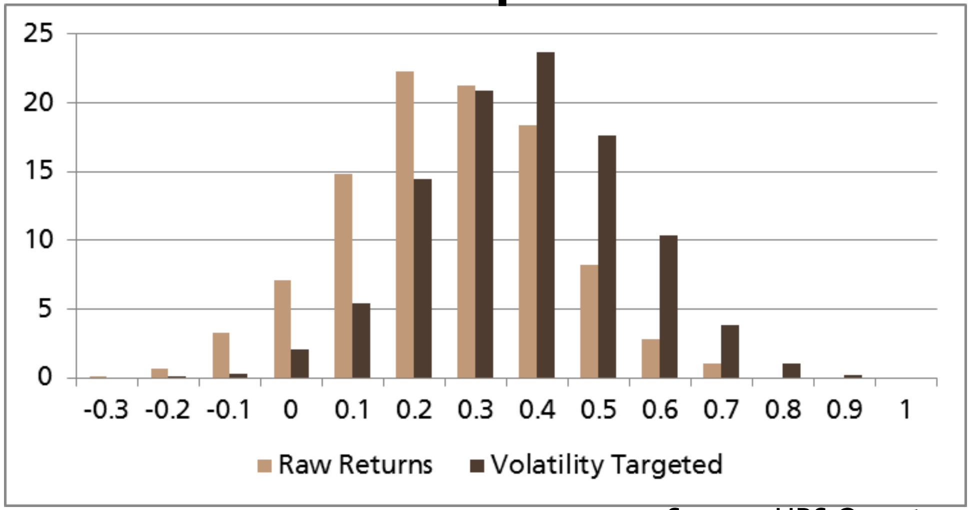
Ability to explain increase in Sharpe Ratios

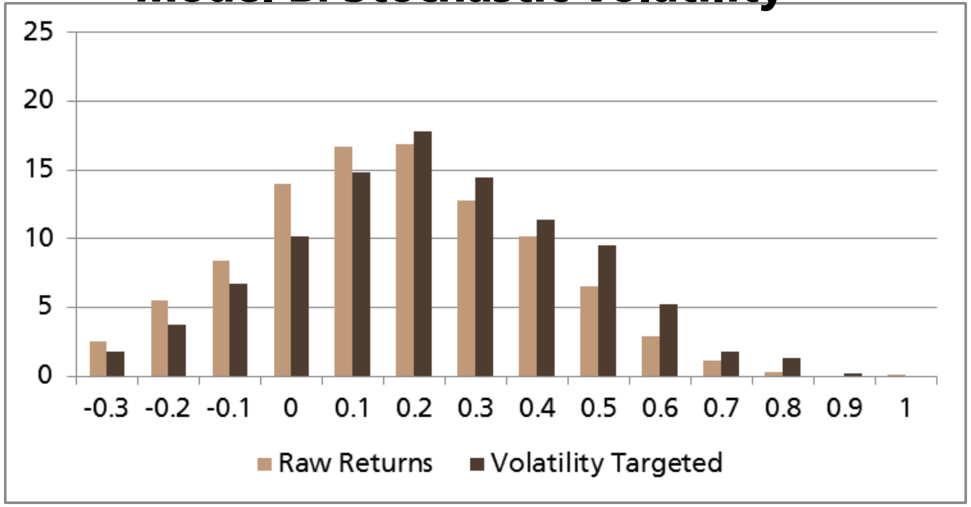
- We run 1000 simulations through each model and observe the distribution of the strategy Information ratio.
- Using the full model the average Information Ratio increases by 50% using volatility Targeting.
- Using the simple stochastic volatility model the Information ration increases by only 14%.

Model A: Full Specification



Source: UBS Quants

Model B: Stochastic Volatility



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Valuation Method and Risk Statement

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Buy	FSR is > 6% above the MRA.	47%	32%
Neutral	FSR is between -6% and 6% of the MRA.	38%	25%
Sell	FSR is > 6% below the MRA.	15%	21%
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 30 June 2016.
1:Percentage of companies under coverage globally within the 12-month rating category.
2:Percentage of companies within the 12-month rating category for which investment banking (IB) services were provided within the past 12 months.
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