UBS

Global Equity Research

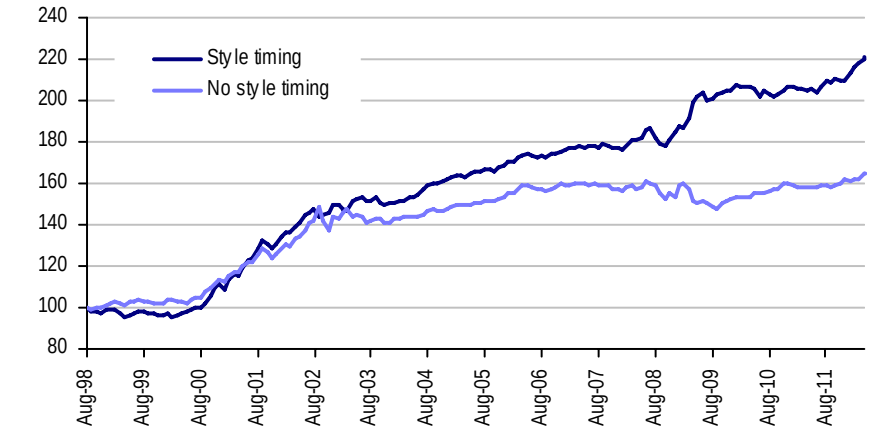
Global

Quantitative

Quantitative

UBS Investment Research

Global Quantitative Research Monographs



Simple style timing

■ Style timing could be very profitable, but is very hard to implement

Many analysts have tried to build a two-stage model, first trying to model the relationship between style returns/co-variances and macro-economic factors, and then building portfolios using this model. This is very complex and errors are introduced at every stage which often compound to make the final style allocation unstable and unintuitive.

■ We illustrate a new, simpler approach to style timing

We do not try to model the underlying relationships between styles and macro-economic factors, but go straight from the factors to our style allocation. This is completely transparent and reduces the possible errors which can compound.

■ We test it in European and US universes

We have tested this approach by using: i) volatility, ii) the value spread, and iii) the slope of the yield curve to allocate between four quantitative styles. Our style-timing approach would have outperformed the traditional approaches to style allocation in both universes, particularly during the period since the financial crisis.

11 June 2012

www.ubs.com/investmentresearch

Claire Jones
Associate Analyst
claire-c.jones@ubs.com
+44-20-7568 1873

Giuliano De Rossi
Analyst
giuliano.de-rossi@ubs.com
+44-20-7568 3072

David Jessop
Analyst
david.jessop@ubs.com
+44-20-7567 9882

James Sefton
Analyst
james.sefton@ubs.com
+44-20-7568 6078

Heran Zhang
Associate Analyst
heran.zhang@ubs.com
+44 20756 83560

Executive Summary

Style timing is critical ...

More than 50 years after the first quantitative investment funds were set up, there is plenty of evidence that quantitative styles do work on average, but, as the summer of 2009 showed, they can also blow-up spectacularly. To use quantitative styles successfully, we need to time our allocation to each style.

As with all investing, past performance is not an indication of future performance, so to time styles we cannot simply look at how they have performed historically. We need to take into account the current macro-economic climate using conditioning factors such as volatility, business cycle indicators and statistics on how expensive different styles are.

... but tricky

Traditionally quant investors have tried to tackle this problem head-on. They have tried to model how the expected returns to styles and the covariance matrix between styles move with macro-economic conditioning factors, and then use this model in order to produce a style allocation. This gets very complicated very fast, and the errors in each level of modelling often compound, making the final model hard to understand and with hopelessly wide margins of error.

We attack the problem empirically with a simple and transparent model

We approach the problem differently; we look at it from a strictly empirical point of view and we go straight from the values of the conditioning factors to the style allocation, side-stepping all the problems involved with trying to model the underlying relationships. Our backtests show this would have been very successful. Tables 1-2 and Charts 1-2 give a summary of how our dynamic model would have performed in Europe and the US and Charts 3-4 show the weights that this model would have suggested holding in each style through time.

Table 1: Performance of our style allocation model in Europe

	Over full history		Since 01-01-2008	
	Return	I.R.	Return	I.R.
1/n style allocation model	3.71%	0.83	1.20%	0.31
Backwards looking style allocation model	3.97%	0.73	2.10%	0.49
Dynamic style allocation	5.93%	1.33	5.10%	1.25

Table 2: Performance of our style allocation model in US

	Over full history		Since 01-01-2008	
	Return	IR	Return	IR
1/n style allocation model	1.58%	0.37	-2.10%	-0.41
Backwards looking style allocation model	2.69%	0.57	1.00%	0.24
Dynamic style allocation	2.49%	0.67	2.30%	0.85

Chart 1: Performance of our style allocation model in Europe

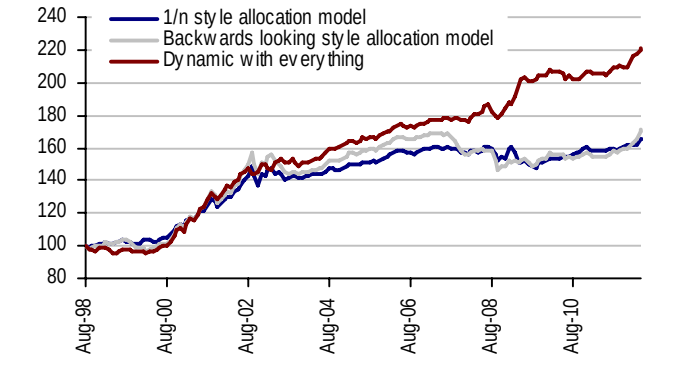
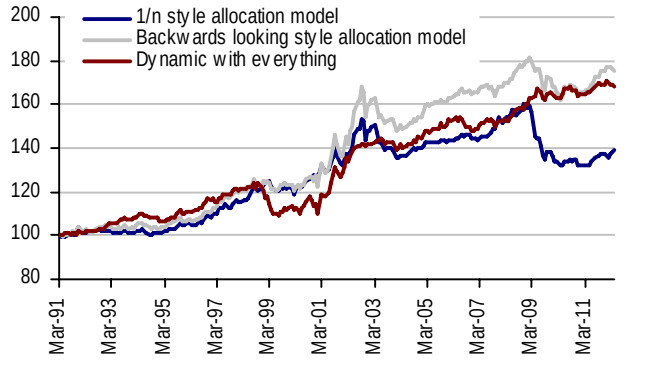


Chart 2: Performance of our style allocation model in US



Source: UBS Quantitative Research

Chart 3: Weights in each style suggested by the dynamic style allocation model in Europe

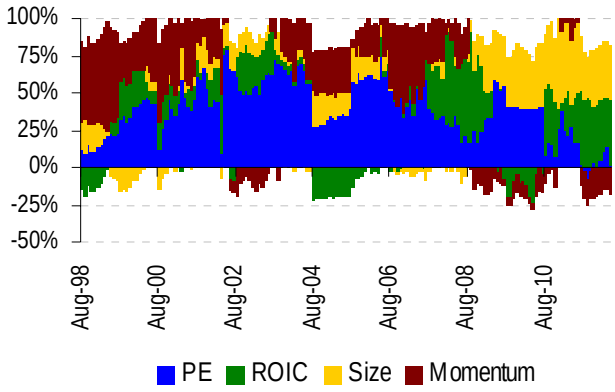
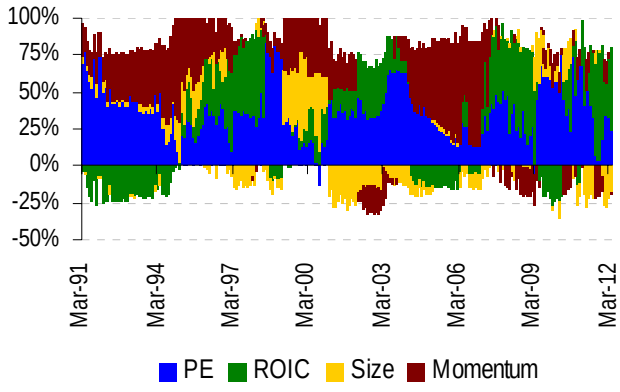


Chart 4: Weights in each style suggested by the dynamic style allocation model in the US



Source: UBS Quantitative Research, Each style portfolio is long-short (100% long, 100% short) and we can take a positive or negative weight in each style, subject to the constraint that the sum of the absolute weights must be 100%.

Currently the European model suggests taking weights of -8% in value, 51% in quality, 24% in size and -18% in momentum, and the US model suggests taking weights of 19% in value, 51% in quality, -22% in size (i.e. the model prefers large-caps over small-caps) and 8% in momentum.

Which factors did we condition on?

Volatility, the value spread and the slope of the yield curve

We use three conditioning factors to time our style allocation in this version of the model: i) volatility, ii) the value spread and iii) the slope of the yield curve. We do not claim these are optimal, but we chose them based on our experience and the existing literature.

Charts 5-7 further motivate this. We use US data here because of the longer time series available. You can see that momentum underperforms significantly in months with very high volatility, value tends to perform better when the value spread is wider, and small-caps tend to underperform large-caps when the yield curve is very steep.

Chart 5: Average monthly return to momentum, conditional on volatility

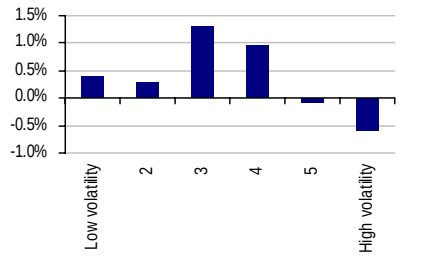


Chart 6: Average monthly return to value, conditional on the value spread

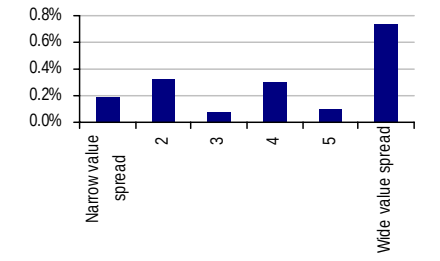
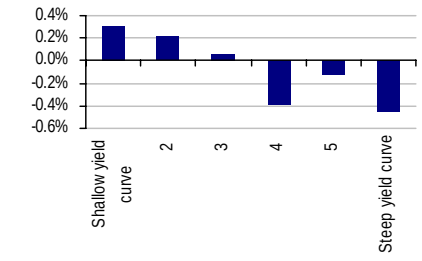


Chart 7: Average monthly return to size, conditional on the yield curve



Source: UBS Quantitative Research, We divide the months from August 1989 to April 2012 into 6 regimes based on either i) the trailing 30-day realised volatility of the S&P500 or ii) the value spread or iii) the slope of the yield curve and compute the average return to the style over the next month for each regime. Value spread is computed as the difference between the median book-to-price of the top third of stocks in each sector by a composite value measure divided by the median book-to-price of the bottom third of stocks in each sector. A high value indicates value stocks appear "very cheap" compared to not-value stocks.

The model

This is the model. Our weight in style i at time t is proportional to the sum of a base weight and the product of the exposure ($\beta_{i,j}$) to each conditioning factor and the value of the conditioning factor at time t.

Equation 1: $$\hat{w}_{i,t} = \text{Base weight}_i + \sum_j \beta_{i,j} \text{ x Conditioning Factor}_{j,t}$$

Advantages of our approach

This very simple model has three advantages:

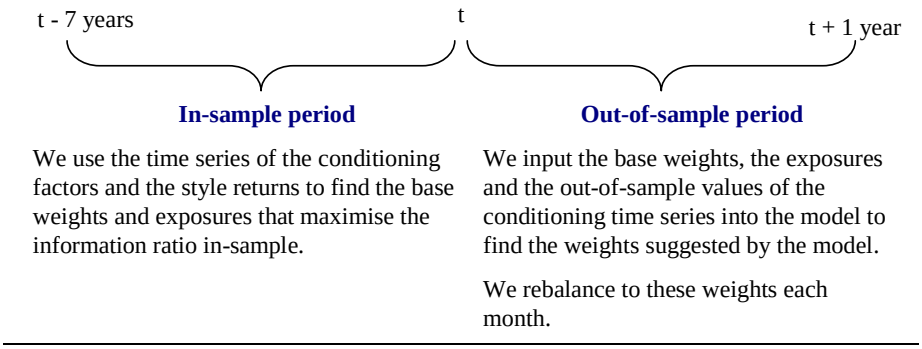
i) it is completely transparent; when the weights suggested by the model change you can see which conditioning factor is driving that,

ii) it is the reduced form for any linear model so doesn't sacrifice modelling power, and

iii) by going directly from conditioning factors to weights and by-passing modelling the returns, risk premiums and covariances of styles, we avoid introducing extra errors that will compound up.

Figure 1 shows how we implement the model; we optimise in-sample using a 7-year window of historic data to find the best base weights and exposures, and then out-of-sample we change our weights according to the model as the conditioning factors change. We create a new model once a year.

Figure 1: Implementation of the dynamic style allocation model



Source: UBS Quantitative research

Data and Technical Details

Data

We focus on just four styles meant to be representative of different families of styles quantitative investors are typically interested in:

1. Trailing PE, a value style
2. ROIC, a quality style
3. Market cap, the size style. Please note we hold a positive weight in small-caps and a negative weight in large-caps (what Fama & French call the SMB portfolio).
4. Price momentum, measured as total return from 7 months ago to 1 month ago, a momentum style

We run backtests for these styles for the period from 31-Aug-1998 to 14-May-2012 in Europe and for the period from 31-Jan-1986 to 14-May-2012 in the US.

The European universe was the largest 500 stocks in Europe in the Dow Jones index and the US universe the largest 1000 stocks in the US. Our portfolio construction method was what we loosely called "top third minus bottom third, sector neutral". That is, at the end of each month we created our portfolios by identifying the top third of stocks in each sector (Dow Jones groups) and taking an equal positive weight in each of them, and similarly, identifying the bottom third of stocks in each sector and taking an equal negative weight in each of them. We rebalanced these portfolios monthly. All simulated returns were total returns and were in Euros (for the European results) or in USD (for the US results).

Conditioning factors' data

Our three conditioning signals were volatility, the value spread and the slope of the yield curve:

i) In Europe volatility was defined as the value of the VIX for the period from 31-Aug-1993 to 01-Jan-1999 and of the VSTOXX subsequently, and in the US it was defined as the trailing 30-day realised volatility of the S&P500.

ii) The value spread was defined as the median book-to-price of stocks in the value basket minus the median book-to-price of stocks in the not-value basket, divided by the median book-to-price overall; a wide spread indicates the value stocks appear comparatively cheap.

iii) The slope of the yield curve was computed using Datastream data as the difference between the German (or US) benchmark 10-year government bond's yield to maturity and the German (or US) benchmark 2-year government bond's yield to maturity.

Technical details of the Approach

Model

As discussed earlier, our model is of the following form:

(1) $\hat{w}_{i,t} = \text{Base weight}_i + \sum_j \beta_{i,j}$ x Conditioning Factor$_{j,t}$

(2) $\text{Weight in style i at time t} = \dfrac{\hat{w}_{i,t}}{\sum_j |\hat{w}_{jt}|}$

We scale the output of our linear model (1) so that the sum of the absolute weights is always 100% (2).

Constraints

We also have four constraints on the values the base weights and exposures can take:

1. $0\% \le \text{Base weight}_i \le 50\%$, for all i
2. $\sum_i \text{Base weight}_i = 100\%$
3. $-50\% \le \beta_{ij} \le 50\%$, for all i,j
4. $\sum_j \beta_{i,j} = 0$, for all i

Normalising the time series of the conditioning factors

We transform the conditioning factors to lie between -1 and +1 by ranking the factor's values compared to its value over the whole in-sample period, and then taking the linear transformation of the rank so that we assign a score of +1 if it is at its maximum and -1 if it is at its minimum. Charts 8-10 illustrate this process for the slope of the yield curve conditioning factor.

Chart 8: Slope of the yield curve

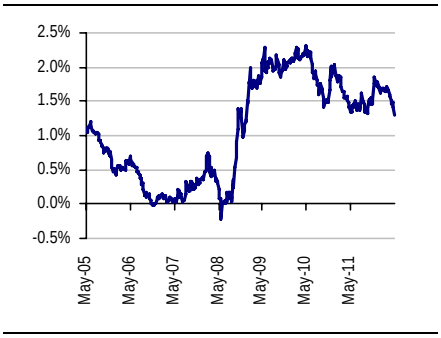
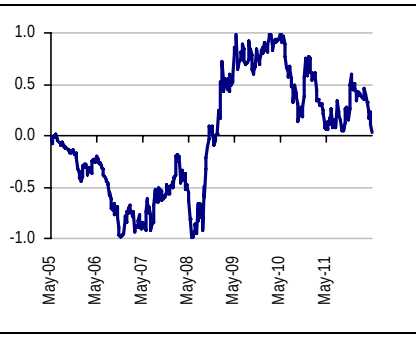


Chart 9: Rank compared to value over the period

Chart 10: Slope of the yield curve score



Source: Datastream, difference between the German benchmark 10-year government interest rates and the German benchmark 2-year interest rates

Implementation

We use a trailing window of 7-years of historic weekly data to run the optimisation to find the base weights and exposures and create the model, and then use the model for 1 year out-of-sample, rebalancing our weights monthly (see Figure 1).

The weights suggested by the optimiser change each month as the value of the conditioning factors change, which allows us to react to changes in the macro-economic climate by changing our style allocation.

Example

If we run the optimisation over the most recent 7 years of European data, using only one conditioning factor (volatility) we find these base weights and exposures maximise the in-sample information ratio:

Table 3:

	Value	Quality	Size	Momentum
Base weight	20%	48%	23%	10%
Exposure to volatility	-0.37	0.50	0.37	-0.50

Source: UBS Quantitative Research

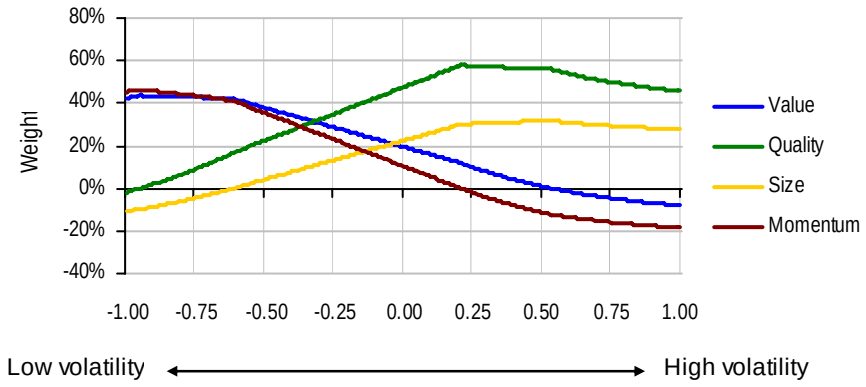
Out of sample, we compare the level of the VSTOXX to the level we saw in-sample. If it is higher than the maximum we observed in-sample, we give the volatility a score of +1, if it is lower than the minimum, we give volatility a score of -1 and if it is exactly the median, we give volatility a score of 0.

Putting these scores into the model, we find the suggested weights. Table 4 and Chart 11 show how those weights change as the volatility does.

Table 4: How suggested weights in each style change if the volatility changes

	Value	Quality	Size	Momentum
Very low volatility, score = -1	42%	-2%	-11%	45%
Normal volatility, score = 0	20%	48%	23%	10%
Very high volatility, score = +1	-8%	46%	28%	-19%

Chart 11: How suggested weights in each style change if the volatility changes



Source: UBS Quantitative Research

Motivation

Brief Review of Existing Literature

Style rotation can be profitable ...

There is a great deal of evidence showing that the rankings of the style returns change considerably from year to year, making style rotation an attractive idea. Ahmed, Lockwood and Nanda (2005) illustrate the considerable potential benefits of style rotation in the US. Levis and Liodakis (1999) show the distribution of gains that a UK investor could expect following a style timing strategy for the value and size styles for a given level of forecasting accuracy.

... but needs more than just style momentum to do

Coggin (1999) found evidence that style returns cannot be predicted using only their time series (and that of the market) alone. Investors wishing to follow a style rotation strategy will need to use other conditioning factors.

A wide variety of economic and technical factors have been suggested as conditioning factors.

Guidolin & Timmermann (2005) create a successful, theoretical four-state model for the joint distribution of returns to the market, to value and to size portfolios in each state using US data, with different optimal style allocations in each. They note that each regime is associated with differing underlying economic conditions, with strong relationships to industrial production and the NBER defined recessions, which gives hope that practitioners can time their style allocation using these economic fundamentals.

Clare, Sapuric and Todorovic (2008), Arshanapalli, Switzer and Panju (2007) and Levis and Liodakis (1999) suggest a wide variety of economic variables to predict which styles will outperform this month. Some of these include: change in consumer confidence indicator, inflation, change in the money supply, change in exchange rates, equity risk premium, level / change in slope of the yield curve, level / change in interest rates and change in industrial production. Asness et al (2000) (motivated by an elegant decomposition of the Gordon growth model) use a combination of the value spread and the earnings growth spread to forecast the future returns to value versus growth.

Why should our Conditioning Factors Work?

Volatility

Market volatility is known to have a strong impact on the returns to styles. Momentum is a trend-following strategy, so, if the trend in the market breaks down i.e. generally at turning points in the market, then the style will tend to under-perform. Turning points in the market are usually accompanied with rising volatility, so it is not unreasonable to expect momentum and volatility to be negatively related.

Value Spread

The value spread is a measure of how cheap the value stocks are in comparison to the not-value stocks. If we assume that the value spread is mean-reverting, that is that the value stocks cannot become cheaper and cheaper indefinitely, then a very wide value spread indicates an opportunity for investors to buy value,

in anticipation that the spread will narrow and value will out-perform. Hence we might anticipate that the value spread will be positively related to the performance of the value style.

Slope of the yield curve

The slope of the yield curve is widely accepted to be a good proxy for the business cycle. A flat or downwards sloping yield curve has historically been associated with poor economic growth or recession in the future. Distressed firms have an increased risk of bankruptcy during these periods and so tend to under-perform. These firms are usually low quality, so on a long-short basis, the quality style is likely to outperform during down-turns. We can expect the quality style to be negatively associated with the slope of the yield curve.

Results

Current Models

We consider four dynamic models. The overall model using all three of our conditioning factors and three models which use only one of the possible conditioning factors each.

Table 5: Current dynamic style allocation model for Europe, using data from 9-Sep-2005 to 14-May-2012

	PE	ROIC	Size	Price Momentum
Base Weight	35%	30%	28%	8%
Exposure to volatility	-0.24	0.50	-0.05	-0.21
Exposure to value spread	-0.42	0.50	0.28	-0.36
Exposure to yield curve slope	0.29	-0.50	0.33	-0.12
Current weights	-8%	51%	24%	-18%

Source: UBS Quantitative Research

Some, but not all, of these exposures aligned with our intuition. In highly volatile markets the model suggests exiting momentum and value and moving into quality. If the yield curve is strongly upwards sloping (associated with a better economic climate) the model suggests reducing your position in quality and increasing your position in value and small-caps. These are very intuitive suggestions. The unexpected output of this model is the negative exposure of value to the value spread. It appears that, at least over this relatively short-term horizon, we don't see mean reversion of the value spread.

How can we judge if our dynamic style allocation is successful?

To judge how effective our dynamic style allocation is we need to have some alternative style allocation approach to compare the performance to – a benchmark. There is no definitive candidate for this, but there are several style allocation approaches we think are reasonable:

1. 1/n style allocation model

This is a simple, heuristic approach to style allocation which takes weights of 25% value, 25% quality, 25% size and 25% momentum.

2. Backwards looking style allocation model

This approach to style allocation tries to choose our weights in each style more intelligently than the 1/n approach. We choose weights such that the overall portfolio would have produced steady, positive returns historically by optimising over the in-sample period (a trailing 7-year window) to find the weights which would give the best in-sample information ratio, subject to two constraints: i) each weight must be between 0% and +50% and ii) the sum of the weights must be 100%.

We use these weights for a year out-of-sample, rebalancing to them every month. At the start of the next year, we re-run our optimisation and find a new set of weights.

3. Short-term style momentum model

Each month this model invests 50% each in the two best performing styles over the previous 6 months[1]. Many practitioners use similar momentum based style rotation models.

Results for benchmark style allocation approaches

Diversification is powerful

Table 6 shows how effective even the most primitive approaches to style allocation can be. Our simplest approach was the 1/n style allocation. Diversifying across multiple styles gives the portfolio a lower risk (as measured by the standard deviation of returns) than any of the individual styles, and that gets us a better risk-adjusted return than any of the styles taken individually.

Table 6: Statistics on the performance of the styles individually and the benchmark style allocation approaches

	Return	SD	Sharpe	Style Turnover
PE	4.49%	9.93%	0.45	-
ROIC	3.21%	6.38%	0.50	-
Size	2.97%	5.84%	0.51	-
Price momentum	2.80%	13.06%	0.21	-
1/n style allocation model	3.71%	4.47%	0.83	2%
Backwards looking style allocation model	3.97%	5.42%	0.73	4%
Short-term style momentum model	2.21%	6.24%	0.36	33%

Source: UBS Quantitative Research, Style turnover is the average monthly sum of the absolute differences in weights in each style, which takes a value between 0% and 200%. The 1/n style allocation model has a positive style turnover despite constant weights because we have to rebalance to those weights each month.

[1] The choice of 6-month momentum was motivated by the success of the 6-month style momentum strategy in Clare et al, "Quantitative or Momentum based Multi-style Rotation? UK Experience" (2008)

The style momentum model has very high volatility compared to the other possible benchmarks and would have had a huge style turnover, so looks much less attractive than the other approaches.

Results for dynamic style allocation approaches

We have considered four dynamic style allocation models; three models that use only one of the possible conditioning factors and the full model that uses all of them. Please see the Appendix to see how the weights suggested by each model change through time (the equivalents of Chart 3)

Table 7: Statistics on the performance of the dynamic style allocation approaches

	Over full history				Since 01-Jan-2008			
	Return	SD	Information Ratio	Style Turnover	Return	SD	Information Ratio	Style Turnover
1/n style allocation model	3.71%	4.47%	0.83	2%	1.20%	4.00%	0.31	2%
Backwards looking style allocation model	3.97%	5.42%	0.73	4%	2.10%	4.20%	0.49	5%
Short-term style momentum model	2.21%	6.24%	0.36	33%	2.60%	5.60%	0.46	28%
Dynamic with volatility	3.33%	4.65%	0.72	18%	2.50%	3.80%	0.66	29%
Dynamic with value spreads	3.99%	4.70%	0.85	11%	3.00%	3.70%	0.80	17%
Dynamic with yield curve slope	4.44%	5.74%	0.77	12%	4.00%	4.30%	0.93	17%
Dynamic with everything	5.93%	4.46%	1.33	24%	5.10%	4.10%	1.25	26%

Source: UBS Quantitative Research, Style turnover is the average of the sum of the absolute differences in weights in each style from month to month, which takes a value between 0% and 200%.

Full model is the most successful

The full dynamic model, using all three conditioning factors, would have obtained a better risk adjusted return than any of our benchmark approaches. The information from all three signals does appear to be adding useful information about future style returns.

We see similar results to the dynamic models both over the full history and just since the crisis started. In contrast, the 1/n style allocation model and the backwards looking style allocation model would have performed significantly worse over recent history.

Chart 12: Long-term performance of the benchmark style allocation approaches

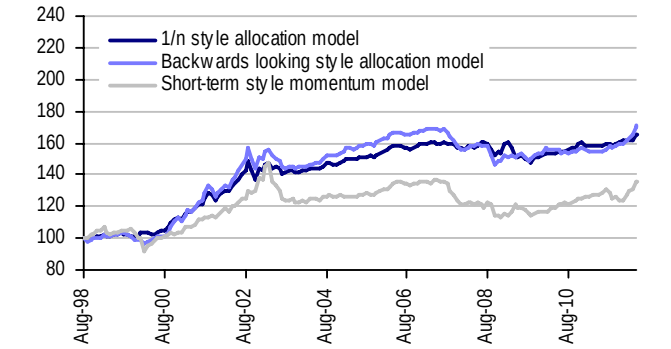


Chart 13: Performance of the benchmark style allocation approaches since 01-Jan-2008

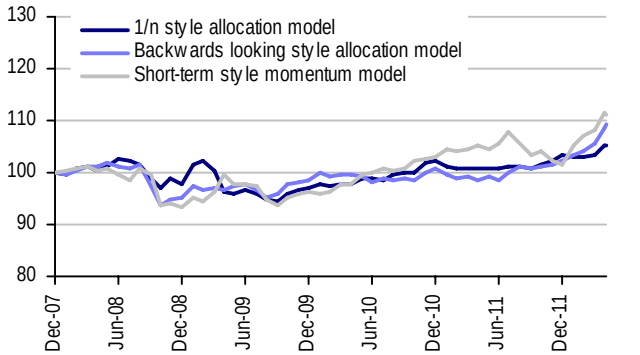


Chart 14: Long-term performance of the dynamic style allocation approaches

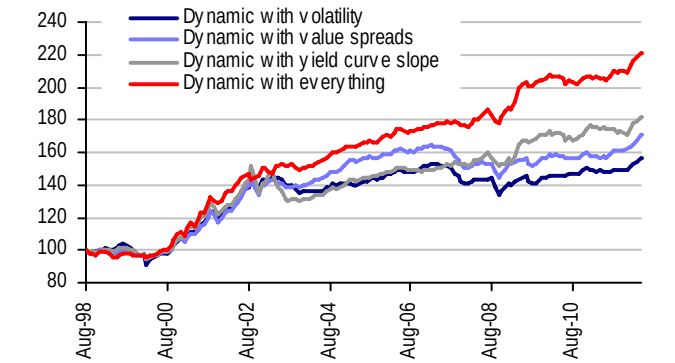
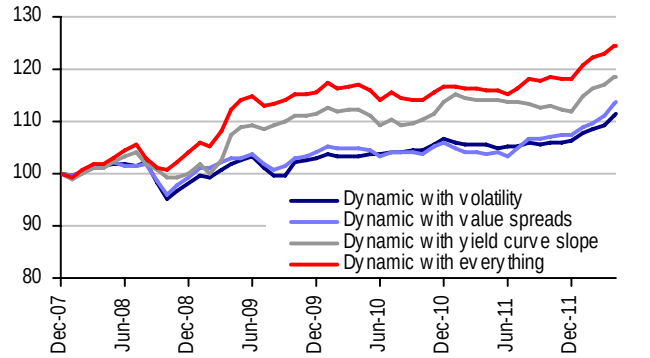


Chart 15: Performance of the dynamic style allocation approaches since 01-Jan-2008



Source: UBS Quantitative Research

US Results

We have also re-run this analysis in a US universe to see how consistent our results are. Table 8 and Charts 15-18 below illustrate how the success of the approach.

The most successful model over the full history would have been the full dynamic model, with an information ratio of 0.67. Over the period since the crisis, it would have been by far the best performing model, with an information ratio of 0.85 compared to 0.24 for the backwards looking style allocation model.

Table 8: Statistics on the performance of the dynamic style allocation approaches, US results

	Over full history				Since 01-Jan-2008			
	Return	SD	Information Ratio	Style Turnover	Return	SD	Information Ratio	Style Turnover
1/n style allocation model	1.58%	4.31%	0.37	1%	-2.10%	5.10%	-0.41	1%
Backwards looking style allocation model	2.69%	4.74%	0.57	2%	1.00%	4.20%	0.24	2%
Short-term style momentum model	-0.17%	5.89%	-0.03	39%	-2.20%	6.60%	-0.33	43%
Dynamic with volatility	2.71%	4.22%	0.64	24%	1.80%	3.60%	0.49	40%
Dynamic with value spreads	2.36%	4.40%	0.54	11%	1.50%	3.50%	0.43	18%
Dynamic with yield curve slope	1.98%	4.11%	0.48	10%	-0.20%	4.00%	-0.04	15%
Dynamic with everything	2.49%	3.73%	0.67	2%	2.30%	2.70%	0.85	40%

Source: UBS Quantitative Research

Chart 16: Performance of the benchmark style allocation approaches – US results, full history

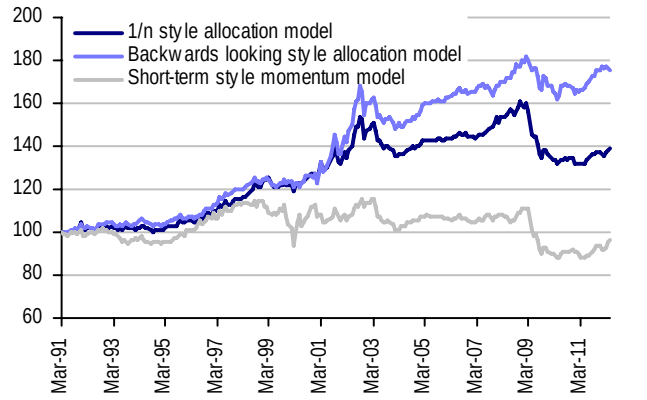


Chart 17: Performance of the benchmark style allocation approaches – US results, since 01-Jan-2008

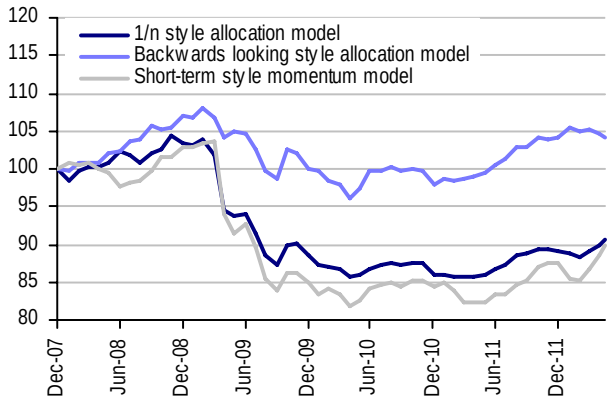


Chart 18: Performance of the dynamic style allocation approaches – US results, full history

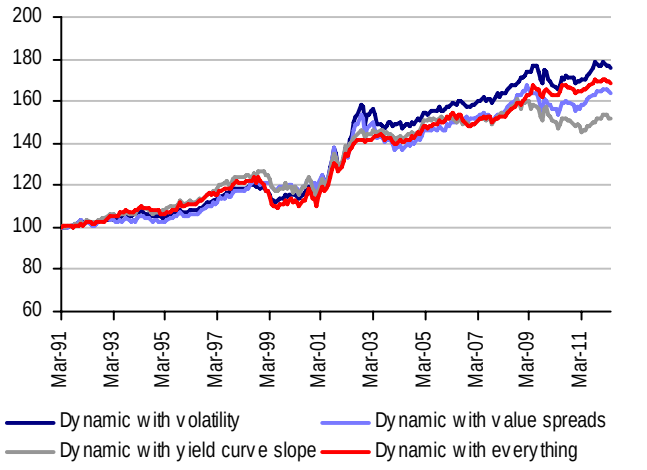
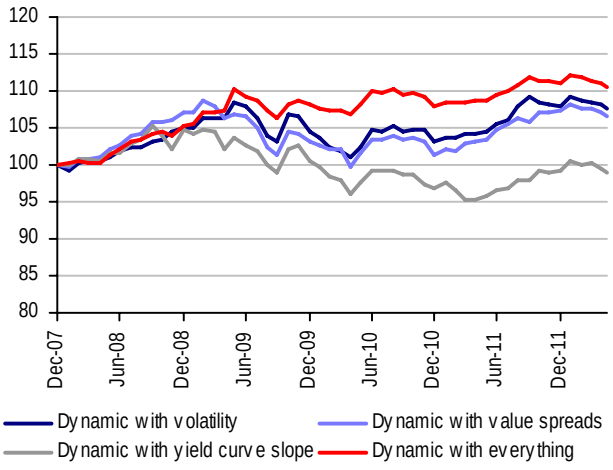


Chart 19: Performance of the dynamic style allocation approaches – US results, since 01-Jan-2008



Source: UBS Quantitative Research

Variations & Future Research

The results we have discussed here are particular examples of a general approach, but there are many variations and further generalisations it could be useful to consider.

We can use the same approach, but allocate between different styles, or even between different asset classes, or using different conditioning factors. With some slight changes to the constraints of our optimisation we could find optimal allocations in the long-only case or in the situation where we can allocate to cash as well as to style portfolios.

There is also great potential for further research (and hopefully improvement) in our method of transforming these signals from the raw data into a time series bounded between -1 and +1. We could also consider making the functional form of the weight equation non-linear. For example, a quadratic equation might be able to capture the relationship between volatility and momentum better.

We will re-visit this approach and attempt to improve it in future publications.

Conclusions

Historical style returns alone are not adequate to predict future style returns. To choose a style allocation we need an approach that takes into account the current macro-economic climate.

One approach is to attack the problem directly, by modelling the relationship between style returns and co-variances and the conditioning factors, and then producing weights from these with some portfolio construction method (e.g. mean-variance optimisation). However, each stage will introduce errors and those errors can compound up, resulting in very unstable models which don't reflect the true underlying relationships.

The approach we have discussed here ducks the main difficulties of the problem, and goes straight from the data to the weights. Fewer steps mean fewer opportunities for errors to be introduced. Our model is also more transparent; if the model suggests changing weights it is instantly clear what is driving that. The weights suggested by our model are stable in normal times, but if the macro-environment changes rapidly our model can keep up.

Our results show that our simpler, clearer approach does work, particularly over recent history. The dynamic style timing model with three conditioning factors would have seen stable out-performance in both Europe and the US.

References

Ahmed, P., Lockwood, L.J., Nanda, S., "Multistyle Rotation Strategies", *Journal of Portfolio Management*, Spring 2002, vol. 28, no. 3

Arshanapalli, B., Switzer, L., Panju, K., "Equity Style Timing: A Multi-Style Rotation Model for the Russell Large-cap and Small-cap Growth and Value Style Indexes", *Journal of Asset Management*, Vol.8, 1, p9-23

Asness, C., Friedman, J, Krail, R. and Liew, J., "Style Timing: Value versus Growth", *Journal of Portfolio Management*, Spring 2000, vol. 26, no. 3

Clare, A., Sapuric, S., Todorovic, N., "Quantitative or Momentum based Multi-style Rotation? UK Experience", working paper, 2010

Coggin, T., "Long Term Memory in Equity Style Indexes", *Journal of Portfolio Management*, Winter 1998, vol. 24, no. 2

Guidolin & Timmermann, "Size and Value Anomalies under Regime Shifts", January 2005, Federal Reserve Bank of St. Louis

Levis, M., Liodakis, M., "The Profitability of Style Rotation Strategies in the United Kingdom", *Journal of Portfolo Management*, Fall 1999

Lucas, A.m Van Dijk, R. and Kleok, T., "Stock Selection, Style Rotation and Risk", 2002, Tinbergen Institute Discussion Paper

Appendix

Weights through time: Europe

These are the weights that each of our four European dynamic style allocation models suggest taking in each style through time.

Chart 20: Suggested weight in each style using the dynamic style model with just VOLATILITY

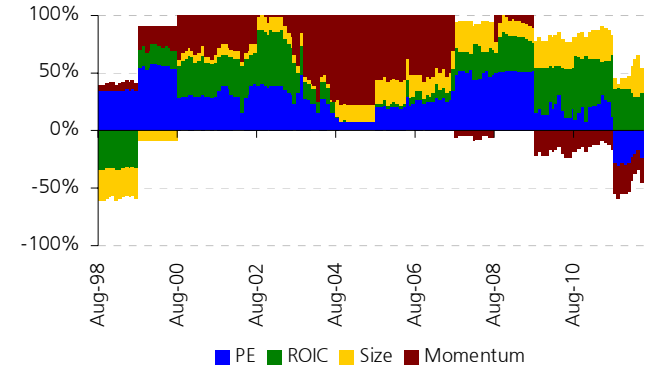


Chart 21: Suggested weight in each style using the dynamic style model with just the VALUE SPREAD

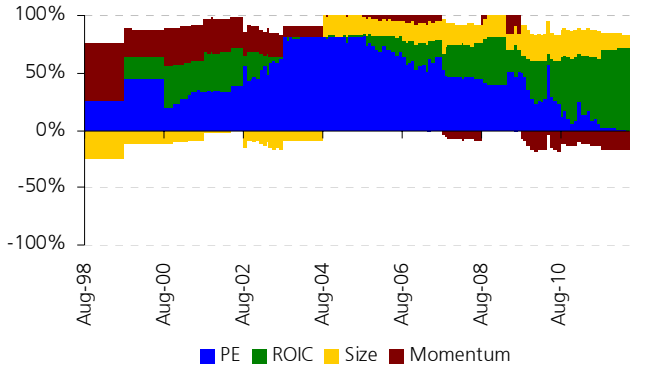


Chart 22: Suggested weight in each style using the dynamic style model with just the SLOPE OF THE YIELD CURVE

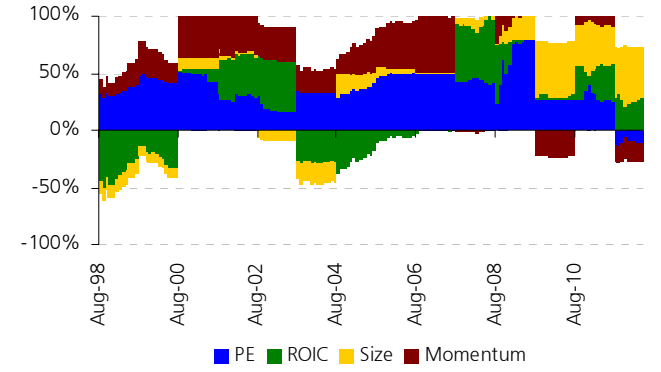
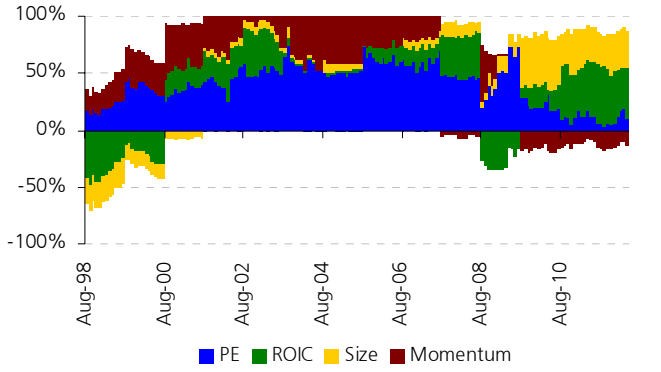


Chart 23: Suggested weight in each style using the FULL DYNAMIC MODEL



Source: UBS Quantitative Research

Weights through time: US

These are the weights that each of our four US dynamic style allocation models suggest taking in each style through time.

Chart 24: Suggested weight in each style using the dynamic style model with just VOLATILITY

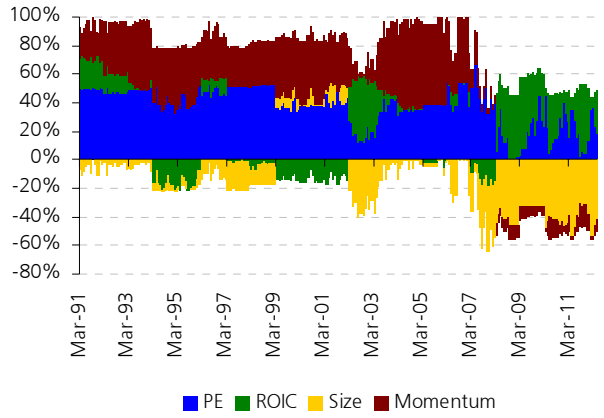


Chart 25: Suggested weight in each style using the dynamic style model with just the VALUE SPREAD

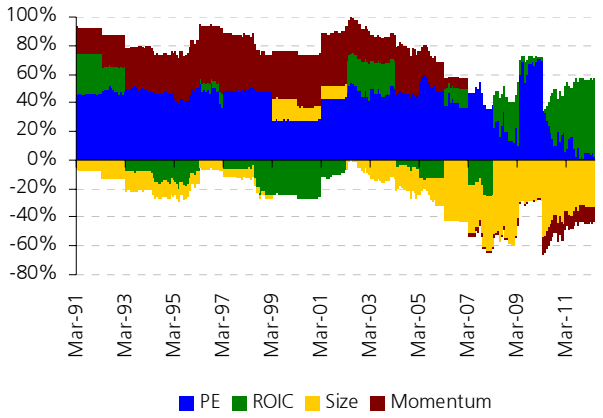


Chart 26: Suggested weight in each style using the dynamic style model with just the SLOPE OF THE YIELD CURVE

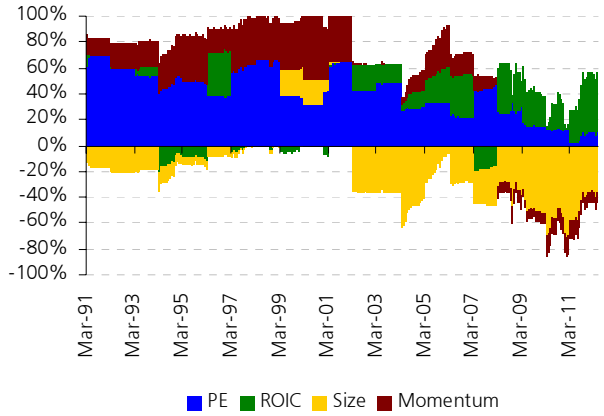
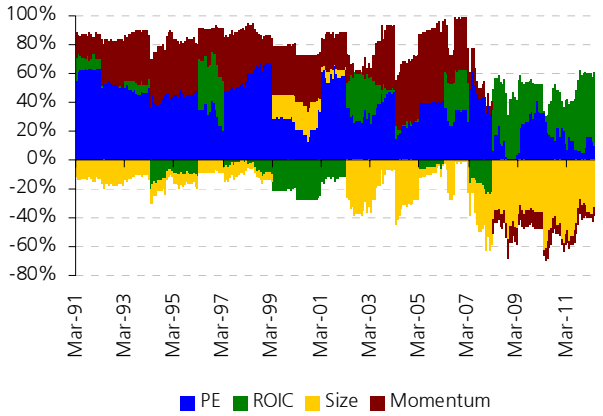


Chart 27: Suggested weight in each style using the FULL DYNAMIC MODEL



Source: UBS Quantitative Research

Analyst Certification

Each research analyst primarily responsible for the content of this research report, in whole or in part, certifies that with respect to each security or issuer that the analyst covered in this report: (1) all of the views expressed accurately reflect his or her personal views about those securities or issuers and were prepared in an independent manner, including with respect to UBS, and (2) no part of his or her compensation was, is, or will be, directly or indirectly, related to the specific recommendations or views expressed by that research analyst in the research report.

Required Disclosures

This report has been prepared by UBS Limited, an affiliate of UBS AG. UBS AG, its subsidiaries, branches and affiliates are referred to herein as UBS.

For information on the ways in which UBS manages conflicts and maintains independence of its research product; historical performance information; and certain additional disclosures concerning UBS research recommendations, please visit www.ubs.com/disclosures. The figures contained in performance charts refer to the past; past performance is not a reliable indicator of future results. Additional information will be made available upon request. UBS Securities Co. Limited is licensed to conduct securities investment consultancy businesses by the China Securities Regulatory Commission.

UBS Investment Research: Global Equity Rating Allocations

UBS 12-Month Rating	Rating Category	Coverage[1]	IB Services[2]
Buy	**Buy**	51%	34%
Neutral	**Hold/Neutral**	40%	35%
Sell	**Sell**	9%	15%
UBS Short-Term Rating	**Rating Category**	**Coverage[3]**	**IB Services[4]**
Buy	**Buy**	less than 1%	25%
Sell	**Sell**	less than 1%	17%

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.
3:Percentage of companies under coverage globally within the Short-Term rating category.
4:Percentage of companies within the Short-Term rating category for which investment banking (IB) services were provided within the past 12 months.

Source: UBS. Rating allocations are as of 31 March 2012.

UBS Investment Research: Global Equity Rating Definitions

UBS 12-Month Rating	Definition
Buy	FSR is > 6% above the MRA.
Neutral	FSR is between -6% and 6% of the MRA.
Sell	FSR is > 6% below the MRA.
UBS Short-Term Rating	**Definition**
Buy	Buy: Stock price expected to rise within three months from the time the rating was assigned because of a specific catalyst or event.
Sell	Sell: Stock price expected to fall within three months from the time the rating was assigned because of a specific catalyst or event.

KEY DEFINITIONS

Forecast Stock Return (FSR) is defined as expected percentage price appreciation plus gross dividend yield over the next 12 months.

Market Return Assumption (MRA) is defined as the one-year local market interest rate plus 5% (a proxy for, and not a forecast of, the equity risk premium).

Under Review (UR) Stocks may be flagged as UR by the analyst, indicating that the stock's price target and/or rating are subject to possible change in the near term, usually in response to an event that may affect the investment case or valuation.

Short-Term Ratings reflect the expected near-term (up to three months) performance of the stock and do not reflect any change in the fundamental view or investment case.

Equity Price Targets have an investment horizon of 12 months.

EXCEPTIONS AND SPECIAL CASES

UK and European Investment Fund ratings and definitions are: Buy: Positive on factors such as structure, management, performance record, discount; Neutral: Neutral on factors such as structure, management, performance record, discount; Sell: Negative on factors such as structure, management, performance record, discount.

Core Banding Exceptions (CBE): Exceptions to the standard +/-6% bands may be granted by the Investment Review Committee (IRC). Factors considered by the IRC include the stock's volatility and the credit spread of the respective company's debt. As a result, stocks deemed to be very high or low risk may be subject to higher or lower bands as they relate to the rating. When such exceptions apply, they will be identified in the Company Disclosures table in the relevant research piece.

Research analysts contributing to this report who are employed by any non-US affiliate of UBS Securities LLC are not registered/qualified as research analysts with the NASD and NYSE and therefore are not subject to the restrictions contained in the NASD and NYSE rules on communications with a subject company, public appearances, and trading securities held by a research analyst account. The name of each affiliate and analyst employed by that affiliate contributing to this report, if any, follows.

UBS Limited: Claire Jones; Giuliano De Rossi; David Jessop; James Sefton; Heran Zhang.

Unless otherwise indicated, please refer to the Valuation and Risk sections within the body of this report.

Global Disclaimer

This document has been prepared by UBS Limited, an affiliate of UBS AG. UBS AG, its subsidiaries, branches and affiliates are referred to herein as UBS.

This document is for distribution only as may be permitted by law. It is not directed to, or intended for distribution to or use by, any person or entity who is a citizen or resident of or located in any locality, state, country or other jurisdiction where such distribution, publication, availability or use would be contrary to law or regulation or would subject UBS to any registration or licensing requirement within such jurisdiction. It is published solely for information purposes; it is not an advertisement nor is it a solicitation or an offer to buy or sell any financial instruments or to participate in any particular trading strategy. No representation or warranty, either express or implied, is provided in relation to the accuracy, completeness or reliability of the information contained in this document ('the Information'), except with respect to Information concerning UBS. The Information is not intended to be a complete statement or summary of the securities, markets or developments referred to in the document. UBS does not undertake to update or keep current the Information. Any opinions expressed in this document may change without notice and may differ or be contrary to opinions expressed by other business areas or groups of UBS.

Nothing in this document constitutes a representation that any investment strategy or recommendation is suitable or appropriate to an investor's individual circumstances or otherwise constitutes a personal recommendation. Investments involve risks, and investors should exercise prudence and their own judgement in making their investment decisions. The financial instruments described in the document may not be eligible for sale in all jurisdictions or to certain categories of investors. Options, derivative products and futures are not suitable for all investors, and trading in these instruments is considered risky. Mortgage and asset-backed securities may involve a high degree of risk and may be highly volatile in response to fluctuations in interest rates or other market conditions. Foreign currency rates of exchange may adversely affect the value, price or income of any security or related instrument referred to in the document. For investment advice, trade execution or other enquiries, clients should contact their local sales representative.

The value of any investment or income may go down as well as up, and investors may not get back the full amount invested. Past performance is not necessarily a guide to future performance. Neither UBS nor any of its directors, employees or agents accepts any liability for any loss (including investment loss) or damage arising out of the use of all or any of the Information.

Any prices stated in this document are for information purposes only and do not represent valuations for individual securities or other financial instruments. There is no representation that any transaction can or could have been effected at those prices, and any prices do not necessarily reflect UBS's internal books and records or theoretical model-based valuations and may be based on certain assumptions. Different assumptions by UBS or any other source may yield substantially different results.

Research will initiate, update and cease coverage solely at the discretion of UBS Investment Bank Research Management. The analysis contained in this document is based on numerous assumptions. Different assumptions could result in materially different results. The analyst(s) responsible for the preparation of this document may interact with trading desk personnel, sales personnel and other parties for the purpose of gathering, applying and interpreting market information. UBS relies on information barriers to control the flow of information contained in one or more areas within UBS into other areas, units, groups or affiliates of UBS. The compensation of the analyst who prepared this document is determined exclusively by research management and senior management (not including investment banking). Analyst compensation is not based on investment banking revenues; however, compensation may relate to the revenues of UBS Investment Bank as a whole, of which investment banking, sales and trading are a part.

For financial instruments admitted to trading on an EU regulated market: UBS AG, its affiliates or subsidiaries (excluding UBS Securities LLC) acts as a market maker or liquidity provider (in accordance with the interpretation of these terms in the UK) in the financial instruments of the issuer save that where the activity of liquidity provider is carried out in accordance with the definition given to it by the laws and regulations of any other EU jurisdictions, such information is separately disclosed in this document. For financial instruments admitted to trading on a non-EU regulated market: UBS may act as a market maker save that where this activity is carried out in the US in accordance with the definition given to it by the relevant laws and regulations, such activity will be specifically disclosed in this document. UBS may have issued a warrant the value of which is based on one or more of the financial instruments referred to in the document. UBS and its affiliates and employees may have long or short positions, trade as principal and buy and sell in instruments or derivatives identified herein; such transactions or positions may be inconsistent with the opinions expressed in this document.

United Kingdom and the rest of Europe: Except as otherwise specified herein, this material is distributed by UBS Limited to persons who are eligible counterparties or professional clients. UBS Limited is authorised and regulated by the Financial Services Authority (FSA). **France:** Prepared by UBS Limited and distributed by UBS Limited and UBS Securities France S.A. UBS Securities France S.A. is regulated by the Autorité des Marchés Financiers (AMF). Where an analyst of UBS Securities France S.A. has contributed to this document, the document is also deemed to have been prepared by UBS Securities France S.A. **Germany:** Prepared by UBS Limited and distributed by UBS Limited and UBS Deutschland AG. UBS Deutschland AG is regulated by the Bundesanstalt fur Finanzdienstleistungsaufsicht (BaFin). **Spain:** Prepared by UBS Limited and distributed by UBS Limited and UBS Securities España SV, SA. UBS Securities España SV, SA is regulated by the Comisión Nacional del Mercado de Valores (CNMV). **Turkey:** Prepared by UBS Menkul Degerler AS on behalf of and distributed by UBS Limited. No information in this document is provided for the purpose of offering, marketing and sale by any means of any capital market instruments and services in the Republic of Turkey. Therefore, this document may not be considered as an offer made or to be made to residents of the Republic of Turkey. UBS AG is not licensed by the Turkish Capital Market Board under the provisions of the Capital Market Law (Law No. 2499). Accordingly, neither this document nor any other offering material related to the instruments/services may be utilized in connection with providing any capital market services to persons within the Republic of Turkey without the prior approval of the Capital Market Board. However, according to article 15 (d) (ii) of the Decree No. 32, there is no restriction on the purchase or sale of the securities abroad by residents of the Republic of Turkey. **Poland:** Distributed by UBS Limited (spolka z ograniczona odpowiedzialnoscia) Oddzial w Polsce. **Russia:** Prepared and distributed by UBS Securities CJSC. **Switzerland:** Distributed by UBS AG to persons who are institutional investors only. **Italy:** Prepared by UBS Limited and distributed by UBS Limited and UBS Italia Sim S.p.A. UBS Italia Sim S.p.A. is regulated by the Bank of Italy and by the Commissione Nazionale per le Società e la Borsa (CONSOB). Where an analyst of UBS Italia Sim S.p.A. has contributed to this document, the document is also deemed to have been prepared by UBS Italia Sim S.p.A. **South Africa:** Distributed by UBS South Africa (Pty) Limited, an authorised user of the JSE and an authorised Financial Services Provider. **Israel:** UBS Limited and its affiliates incorporated outside Israel are not licensed under the Investment Advice Law. This material is being issued only to and/or is directed only at persons who are Sophisticated Investors within the meaning of the Israeli Securities Law, and this material must not be relied or acted upon by any other persons. Whilst UBS Limited holds insurance for its activities, it does not hold the same insurance that would be required for an investment advisor or investment marketer under the relevant Investment Advice Law Regulations. **Saudi Arabia:** This document has been issued by UBS AG (and/or any of its subsidiaries, branches or affiliates), a public company limited by shares, incorporated in Switzerland with its registered offices at Aeschenvorstadt 1, CH-4051 Basel and Bahnhofstrasse 45, CH-8001 Zurich. This publication has been approved by UBS Saudi Arabia (a subsidiary of UBS AG), a foreign closed joint stock company incorporated in the Kingdom of Saudi Arabia under commercial register number 1010257812 having its registered office at Tatweer Towers, P.O. Box 75724, Riyadh 11588, Kingdom of Saudi Arabia. UBS Saudi Arabia is authorized and regulated by the Capital Market Authority to conduct securities business under license number 08113-37. **United States:** Distributed to US persons by either UBS Securities LLC or by UBS Financial Services Inc., subsidiaries of UBS AG; or by a group, subsidiary or affiliate of UBS AG that is not registered as a US broker-dealer (a **'non-US affiliate'**) to major US institutional investors only. UBS Securities LLC or UBS Financial Services Inc. accepts responsibility for the content of a document prepared by another non-US affiliate when distributed to US persons by UBS Securities LLC or UBS Financial Services Inc. All transactions by a US person in the securities mentioned in this document must be effected through UBS Securities LLC or UBS Financial Services Inc., and not through a non-US affiliate. **Canada:** Distributed by UBS Securities Canada Inc., a registered investment dealer in Canada and a Member-Canadian Investor Protection Fund, or by another affiliate of UBS AG that is registered to conduct business in Canada or is otherwise exempt from registration. **Hong Kong:** Distributed by UBS Securities Asia Limited. **Singapore:** Distributed by UBS Securities Pte. Ltd. [mica (p) 016/11/2011 and Co. Reg. No.: 198500648C] or UBS AG, Singapore Branch. Please contact UBS Securities Pte. Ltd., an exempt financial adviser under the Singapore Financial Advisers Act (Cap. 110); or UBS AG, Singapore Branch, an exempt financial adviser under the Singapore Financial Advisers Act (Cap. 110) and a wholesale bank licensed under the Singapore Banking Act (Cap. 19) regulated by the Monetary Authority of Singapore, in respect of any matters arising from, or in connection with, the analysis or document. The recipients of this document represent and warrant that they are accredited and institutional investors as defined in the Securities and Futures Act (Cap. 289). **Japan:** Distributed by UBS Securities Japan Co., Ltd. to institutional investors only. Where this document has been prepared by UBS Securities Japan Co., Ltd., UBS Securities Japan Co., Ltd. is the author, publisher and distributor of the document. **Australia:** Distributed by UBS AG (Holder of Australian Financial Services License No. 231087) and/or UBS Securities Australia Ltd (Holder of Australian Financial Services License No. 231098). The Information in this document has been prepared without taking into account any investor's objectives, financial situation or needs, and investors should, before acting on the Information, consider the appropriateness of the Information, having regard to their objectives, financial situation and needs. If the Information contained in this document relates to the acquisition, or potential acquisition of a particular financial product by a 'Retail' client as defined by section 761G of the Corporations Act 2001 where a Product Disclosure Statement would be required, the retail client should obtain and consider the Product Disclosure Statement relating to the product before making any decision about whether to acquire the product. **New Zealand:** Distributed by UBS New Zealand Ltd. The information and recommendations in this publication are provided for general information purposes only. To the extent that any such information or recommendations constitute financial advice, they do not take into account any person's particular financial situation or goals. We recommend that recipients seek advice specific to their circumstances from their financial advisor. **Dubai:** The research prepared and distributed by UBS AG Dubai Branch is intended for Professional Clients only and is not for further distribution within the United Arab Emirates. **Korea:** Distributed in Korea by UBS Securities Pte. Ltd., Seoul Branch. This document may have been edited or contributed to from time to time by affiliates of UBS Securities Pte. Ltd., Seoul Branch. **Malaysia:** This material is authorized to be distributed in Malaysia by UBS Securities Malaysia Sdn. Bhd (253825-x). **India:** Prepared by UBS Securities India Private Ltd. 2/F, 2 North Avenue, Maker Maxity, Bandra Kurla Complex, Bandra (East), Mumbai (India) 400051. Phone: +912261556000 SEBI Registration Numbers: NSE (Capital Market Segment): INB230951431, NSE (F&O Segment) INF230951431, BSE (Capital Market Segment) INB010951437.

The disclosures contained in research documents produced by UBS Limited shall be governed by and construed in accordance with English law.