Academic Research Monitor

Factor Investing: Allocation and Implementation

Equities

Global

Quantitative

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What firm characteristics matter jointly from a portfolio perspective?

In other words, given a large number of portfolios formed on firms' characteristics, how should we choose which ones to allocate to? The first paper that we review proposes a novel methodology to shed light on this question. In an in-sample analysis and in the absence of transaction costs only six characteristics appear significant, while this number increases to 15 when trading costs are considered. More importantly, it is possible to identify combinations of characteristics ex-ante that result in significant improvement in out-of-sample performance. We apply the proposed methodology to the UK market and find qualitatively similar results.

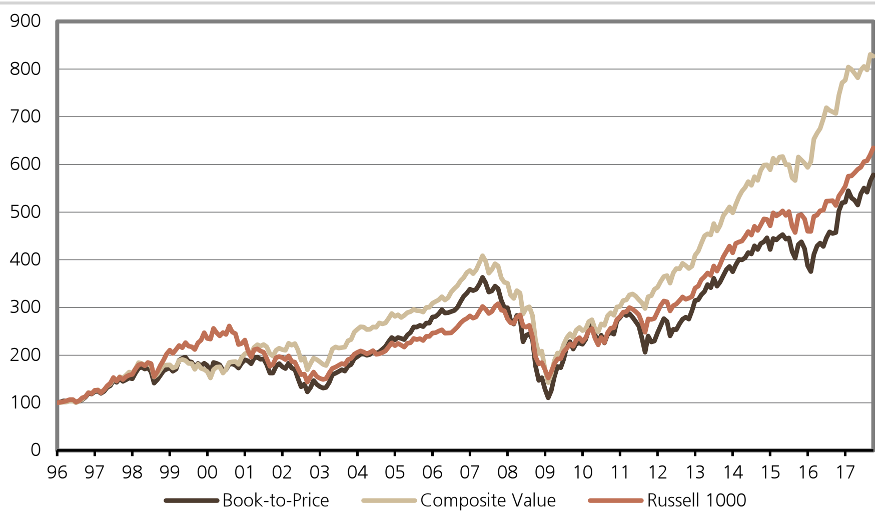
HXZ versus FF5 from an investment perspective

Most of the academic literature has focused on comparing asset-pricing models in terms of their pricing ability. The second paper compares two new models – the Hou, Xue, and Zhang four-factor model (HXZ) and the Fama and French five-factor model (FF5) from an asset allocation point of view. It shows that a Bayesian investor, who believes in a model with a certain degree of confidence, can improve his certainty-equivalent returns by choosing HXZ over FF5 both in- and out-of-sample.

Craftmanship Alpha: skilful implementation counts!

The process of transforming a view on which styles drive returns into a successful investment strategy requires making a number of design decisions. A recent paper by AQR summarises the choices a style investor faces and offers the authors' insights into the best approaches to forming these decisions. Taking everything into consideration, the authors assert that successful implementation, in itself, can generate what they term as craftsmanship alpha.

Figure 1: Russell 1000 Value: Composite vs. Single Measure



Source: UBS Quantitative Research: The chart shows cumulative returns for high value stocks using a single measure (book-to-price) or a composite. Stocks are considered high value if their value score lies in the top quintile and are weighted according to their market cap. The period of analysis covers Jan 1996 – Oct 2017. Composite Value is an average of the z-scores of book-to-price, dividend yield, earnings yield, EBIT/EV, and free cash flow yield.

Introduction

In this issue of our Academic Research Monitor, we consider three recent papers that touch on the topic of portfolio allocation and implementation from various angles (Figure 2).

The first paper proposes a novel approach to select characteristics that matter jointly from a portfolio perspective by combining the parametric portfolio approach of Brandt et al (2009) with a Lasso constraint to prevent overfitting. For a mean-variance investor, only six characteristics appear to be significant in the absence of transaction costs. When trading costs are taken into account, however, this number goes up to 15. The reason for the increase is the fact that by combining characteristics the turnover of the individual strategies are reduced significantly due to netting-off. Along with the review of the paper we apply a slightly modified version of the methodology to the UK market to find qualitatively similar results.

The second paper compares two of the new competing asset pricing models: a four-factor model first introduced by Hou, Xue, and Zhang (2015) and the five-factor model of Fama and French (2015). While prior literature focused on these models have compared them on the basis of their pricing abilities, this paper shows that the former model outperforms from an investment perspective due to its ability to better estimate the average returns.

The third paper provides a valuable summary of the decisions an investor is required to make when constructing a style-based investment strategy. From transforming a signal into a weighting scheme to managing risk and trading costs, Israel, Jiang and Ross (2017) posit that alpha opportunities exist from skilfully combining these portfolio ingredients.

Figure 2: Papers on Implementation

"A Portfolio Perspective on the Multitude of Firm Characteristics" *Victor DeMiguel, Alberto Martin-Utrera, Francisco J. Nogales & Raman Uppal*	*SSRN working paper, Feb 2017*
"What Difference Do New Factor Models Make in Portfolio Allocation?" *Frank J. Fabozzi, Dashan Huang and Jiexun Wang*	*SSRN working paper, Sep 2016*
"Craftmanship Alpha: An Application to Style Investing" *Ronan Israel, Sarah Jiang and Adrienne Ross*	*Journal of Portfolio Management, forthcoming* *SSRN working paper, Sep 2017*

Source: UBS.

"A Portfolio Perspective on the Multitude of Firm Characteristics"

Victor DeMiguel, Alberto Martin-Utrera, Francisco Nogales and Raman Uppal

How do we know which characteristics[1] are important for forecasting stock returns? This paper proposes a novel approach to discover which characteristics are important "jointly from a portfolio perspective". In other words, which characteristics are significant when we look to combine them together to create a portfolio?

The authors say they are attempting to answer three questions:

- Which characteristics are jointly significant, and why?
- How does this change when one incorporates transaction costs?
- Can one identify ex-ante combinations of factors which will perform well out-of-sample?

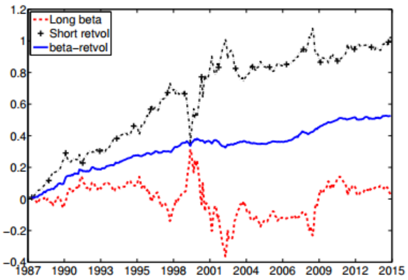
The authors consider a *parametric portfolio* ((of Brandt et al (2009)) which holds the benchmark plus, for each characteristic, a holding in a long-short portfolio with weight θ_k. They optimise to find the weight vector which maximise the mean-variance utility of the overall portfolio. They incorporate transaction costs, and also a *lasso constraint* to help to avoid overfitting. They then examine which of these weights are significant.

Creating long / short portfolios

The authors begin their analysis with 51 characteristics based, as always, on CRSP, Compustat and IBES, with the data going from January 1980 to December 2014. They remove stocks below the 20th percentile of market cap but this still leaves on average 3,071 firms per month. For each characteristic they winsorise the data[2] and then standardise it to have a cross-sectional mean of zero and standard deviation of one. This becomes a long-short portfolio: long stocks where the characteristic value is above the mean and short where it is below.

Looking ahead to the results they find that both volatility and beta are significant. The parametric portfolio is long beta and short volatility, i.e. it goes long *high* beta / short low beta and long *low* volatility / short high volatility. The argument given by the authors is the low volatility portfolio has a positive return whereas the beta portfolio returns close to zero but is a hedge to the volatility position, and so the pairing produces an attractive source of returns, as shows in Figure 3.

Figure 3: Low volatility, high beta and the blended portfolio



Source: *A Portfolio Perspective on the Multitude of Firm Characteristics*, DeMiguel et al. Used with permission. A reproduction of Figure 2 from the paper.

Each of these portfolios is created with equal weights on the long and short side which to us is slightly surprising. A common algorithm to creating portfolios based on risk based measures is the "betting against beta" (Frazzini et al, 2014) approach where the high risk side of the portfolio is "geared down" to have the same forecast beta as the low risk side – so creating a portfolio with an expected beta of zero. We investigate this in our replications below.

[1] One could use the term "factors" here but this, although in common usage, is technically incorrect.
[2] They winsorise at the third quartile plus three times the interquartile range on the high end and the symmetrical value at the low.

Parametric portfolios

If we write the vector of benchmark portfolio weights as $w_{b,t}$ and the weights of our long-short characteristic portfolios as $w_{i,t}$ then the *parametric portfolio* can be written as

$$w_t(\theta) = w_{b,t} + (\theta_1 w_{1,t} + \theta_2 w_{2,t} + \cdots + \theta_K w_{K,t})/N_t = w_{b,t} + W_t\theta/N_t$$

where N_t is the number of stocks at time t, W_t is a matrix whose *k*th column is $w_{i,t}$, θ_k are the weights of each characteristic in the portfolio which make up the vector θ. We note that the weights are constant over time i.e. at each rebalance of the portfolio we return to the same weights.

The authors write the problem as

$$\min_{\theta}\left(\frac{\gamma}{2}\theta^T\hat{\Sigma}_c\theta + \gamma\theta^T\hat{\sigma}_{bc} - \theta^T\hat{\mu}_c\right)$$

where $\hat{\mu}_c$ is the sample mean of the characteristic returns, $\hat{\Sigma}_c$ is the sample covariance matrix and $\hat{\sigma}_{bc}$ is the sample vector of covariances between the benchmark portfolio return and the characteristic returns. This term obviously vanishes if we consider the excess return problem.

The authors go on to extend this formulation in two ways; firstly they add in transaction costs and then add in the lasso constraint.

Adding transaction costs

The authors use a simple transaction cost function where the transaction cost for a particular stock at time t is

$$\kappa_{i,t} = y_t(0.006 - 0.0025 \times me_{i,t})$$

where $me_{i,t}$ is the market cap of the firm at time t which is normalised cross-sectionally to lie between zero and one and y_t is a scaling factor which starts at 3.3 and falls to 1 by Jan 2002 and then remains at this level[3]. Using this the authors extend the above optimisation to

$$\min_{\theta}\left(\frac{\gamma}{2}\theta^T\hat{\Sigma}_c\theta + \gamma\theta^T\hat{\sigma}_{bc} - \theta^T\hat{\mu}_c + TC(\theta)\right)$$

where $TC(\theta)$ is the average of the transaction costs over the optimisation period. Taking the derivative of this with respect to the weights allows one to identify why a particular characteristic is important. Does it contribute to the increasing the mean, decreasing the costs or decreasing the variance?

Adding a lasso constraint

The final extension to this problem is the addition of a lasso constraint on the weight vector. This is simply a constraint on the sum of the absolute weights. This reduces overfitting by creating solutions where only a few of the characteristics have a non-zero weight. The authors refer to this approach as a *big-data parametric portfolio*. The optimisation problems becomes

$$\min_{\theta}\left(\frac{\gamma}{2}\theta^T\hat{\Sigma}_c\theta + \gamma\theta^T\hat{\sigma}_{bc} - \theta^T\hat{\mu}_c + TC(\theta)\right)$$
$$s.t. \|\theta\|_1 = \sum_{k=1}^{K}|\theta_k| \le \delta$$

[3] The idea being that costs were around 3 times higher than today in 1980 but have remained relatively constant since 2002. See *Is it easier to be a quant in small-caps?* (Aug 2016) for more discussion on this topic.

The methodology for picking the value of δ is based on a jackknife approach which optimises an out-of-sample mean-variance utility.

Which characteristics are significant?

The final step in this process is to identify which of the characteristic weights are actually significantly non-zero. There are technical issues with doing this in the presence of a lasso constraint so the authors use a two stage approach. Firstly they drop any characteristics where the weights are zero. They then run a second bootstrap based stage without the lasso constraint to select the significant characteristics. For details see the paper. The most important point to stress is this approach considers all the characteristics simultaneously.

Which characteristics matter?

Six characteristics are significant

In the absence of transaction costs the authors find 10 characteristics survive the first lasso based stage[4]. They then add back the three Cahart factors (size, book to market and momentum) and find six characteristics are significant (with the sign of the weight in brackets remembering the portfolios are all long the high values of the characteristic): unexpected quarterly earnings (+), return volatility (-), asset growth (-), one month momentum (-), gross profitability (+) and beta (+).

What is interesting is the first five of these are selected to increase the portfolio's return (and generally reduce its risk) whereas the last one, beta, is only selected because it reduces risk (and is only significant at the 10% level). As we noted above, the volatility and beta portfolios are created with equal weights on the long and short sides.

Adding transaction costs increases the number of significant characteristics

Adding in transaction costs has an interesting, and initially unintuitive, consequence, which is the number of characteristics significant at the 5% level *increases* from 5 to 15. Why? The answer is that by combining the characteristics the turnover of the individual strategies are reduced significantly. The biggest example of this is one month reversals where the marginal contribution to transaction costs falls by 75% when it is considered in a portfolio against being considered on its own.

More portfolios lead to lower average stock turnover

The authors go on to show that if the average stock trade within an individual characteristic is normally distributed then the average cost of trading the same stock in an equally weighted portfolio of K characteristics is $1/\sqrt{K}$ of the cost within a single characteristic portfolio.

Identifying the characteristics ex-ante

The final step in the authors' analysis is to attempt to identify significant characteristics using a rolling window approach. In detail the authors have a data set which contains 419 monthly observations. They use the first 100 to calculate an initial value of the vector, θ. They then use this weight vector to create a portfolio to hold in month 101. They roll this calculation forward one month at a time and calculate an out of sample performance of the big-data portfolio and contrast this with other simpler approaches[5]. We show their results in Figure 4.

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[4] The reported results are for risk-aversion parameter $\gamma = 5$.
[5] We contrast this approach with that taken in *Simple style timing* (June 2012) where we allow the characteristic weights to vary as a function of macroeconomic variables.

Figure 4: Out-of-sample performance of various parametric portfolios

Policy	Turnover	Mean	SD	SR	
Panel A: Portfolios with no characteristics					
VW	0.05	0.085	0.15	0.567	***
1/N	0.134	0.085	0.177	0.482	***
Panel B: Portfolios with characteristics					
Size / val / mom	0.754	0.145	0.215	0.675	***
Size / val / inv / prof	0.963	0.236	0.22	1.072	**
Fifteen significant characteristics	1.065	0.223	0.166	1.343	
Big-data	0.979	0.241	0.178	1.356	

Source: *A Portfolio Perspective on the Multitude of Firm Characteristics*, DeMiguel et al. Used with permission. A reproduction of Table 6 from the paper. The asterisks show whether the difference in Sharpe ratios from the big-data portfolio are significant at the 1%/5%/10% level.

As can be seen the out-of-sample *big-data* portfolio outperforms all of the other portfolios including that of the in-sample *Fifteen significant characteristics*. The *big-data* portfolio has a higher mean than the in-sample portfolio but does have a slightly higher risk.

We use smaller universe fewer characteristics and consider the excess return problem

This final result we found interesting enough to reproduce. We select the UK part of the Dow Jones World Index as our universe for the sample period from January 1997 through September 2017 with an average of 295 firms per month. We consider a set of 22 characteristics, described in the Appendix, which is also substantially smaller than that considered in the paper. The last methodological difference is that we look at the excess return problem by excluding the benchmark portfolio from the analysis.

A direct consequence from the fact that we use fewer characteristics portfolios is that our estimate for the tuning parameter in the Lasso constraint, δ, is lower. Based on the leave-one-out cross validation procedure (described in footnote 14 of the paper) we set $\delta = 7$.

Five characteristics matter jointly without transaction costs

In the absence of transaction costs, we find that 17 out the 22 characteristics have non-zero weights after applying the Lasso constraint. However, only 5 appear jointly significant at the 5% level: *Capex-to-depreciation* (-), *Dividend Yield* (+), *Dividend cover* (+), *12m price momentum* (+) and *6m price momentum* (-). This is consistent with one of the main findings in the paper, namely that only a small number of characteristics matter jointly from a portfolio perspective without transaction costs.

It is reassuring to see that the result of the optimisation has some economic rationale (although none was imposed). We choose to go long two quality styles – Capex/depreciation[6] and Dividend cover; we are also long value in the form of Dividend yield; finally we observe an apparent "hedge trade" between long-term and medium-term price momentum.

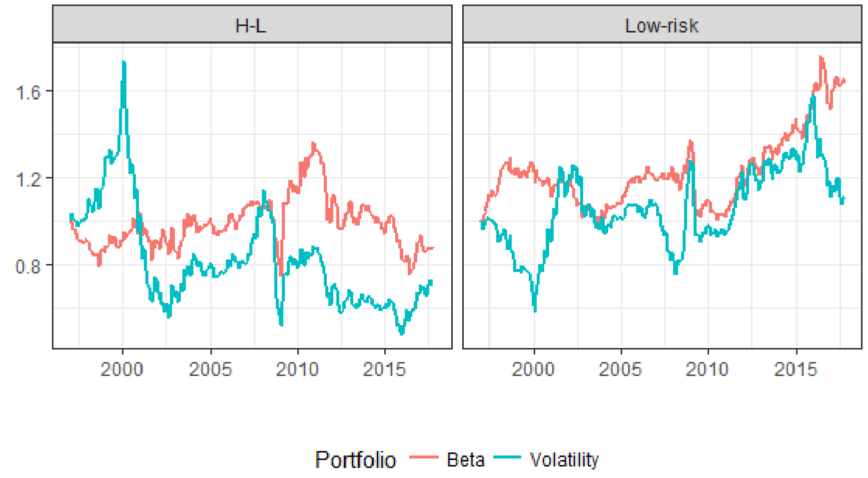
[6] Remember that characteristic portfolios are constructed as High-Low meaning that the Capex/depreciation portfolio is long "low-quality", i.e. the parametric portfolio is effectively long "high-quality".

Our replication reveals that, in their naïve implementation, Beta and Volatility are not significant in the parametric portfolio, so another interesting question we explore is whether or not the results change if the two characteristics are implemented as Betting-against-beta (BAB) and Low-volatility respectively. To this end we re-run the analysis by redefining the two portfolios as the returns to the low basket minus the returns to the high, deleveraged to have a beta equal to that of the low. Figure 5 shows the performance of the portfolios using the original implementation and the low-risk strategy. In this setting we find that BAB has a statistically strong positive weight in the parametric portfolio.

Redefining Beta and Volatility as BAB and low-vol

BAB is significant at the 5% level

Figure 5: Cumulative returns of the two implementations of Beta and Volatility



Source: UBS Quantitative Research. The chart on the left shows the cumulative performance of Beta and Volatility, implemented as the returns to the high minus the returns to the low baskets. The chart on the right shows the performance of Betting-against-beta (BAB) and Low-volatility.

We next consider transaction costs in a similar framework to that in the paper although we assume the transaction costs vary with firm size only, i.e. we set $y_t = 1$ for all [7]. The transaction costs associated with the implementation of the parametric portfolio can be expressed as follows:

$$TC(\theta) = \frac{1}{T-1}\sum_{t=1}^{T-1}\left|\left|\Lambda_t[w_{t+1}\cdot\theta\cdot(1+r_{t+1}^{p}) - w_t^{+}\cdot\theta]\right|\right|_1, \quad (1)$$

where $r_{t+1}^p = R_{t+1}^T \cdot \theta$, is the return to the parametric portfolio at time $t+1$ and R_{t+1} are the returns to the characteristic portfolios; $w_t^+ = w_t \cdot (1 + r_{t+1})$ and r_{t+1} is the vector of stock level returns. The difference with the cost function proposed in the paper is that we scale the weights at $t+1$ by the total return to the parametric portfolio at that time. To understand why this might be a reasonable thing to do, let's assume that all stocks double in value and nothing else changes. We therefore have $r_{t+1} = \mathbf{1}$ (a vector of ones). The new weights at time $t+1$ are the same as at time t: $w_{t+1} = w_t$, while $w_t^+ = 2 \cdot w_t$. The absolute difference $|w_{t+1} - w_t^+| = \mathbf{1}$ means that, unless we scale w_{t+1} as described above, we would appear to incur significant transaction costs, while in practice no trading is required.

[7] y_t is constant at 1 from January 2002; since the sample period we consider starts much later than that in the paper, the parameter does not play an important role in our analysis

Using the transaction cost function in Equation (1) and based on 100 bootstrap samples we find that the number of significant characteristics does not increase. summarises the results for the UK market with and without transaction costs and reveals that there is only one disagreement in selected characteristics: 6m price momentum, which had a strong negative weight in the parametric portfolio in the absence of transaction costs has been substituted with long ROIC.

Figure 6: Significant characteristics

Without transaction costs	With transaction costs
Dividend Yield (+)	Dividend Yield (+)
Capex/depreciation (–)	Capex/depreciation (–)
Dividend cover (+)	Dividend cover (+)
6m momentum (–)	ROIC (+)
12m momentum (+)	12m momentum (+)

Source: UBS Quantitative Research.

"What Difference Do New Factor Models Make in Portfolio Allocation?"

by Frank J. Fabozzi, Dashan Huang and Jiexun Wang

How does HXZ differ from FF5 from an investment perspective?

Several competing models exist for explaining the cross-section of returns, two of the most well-known being the Fama and French (2015) five-factor model[8], henceforth FF5, and the four-factor model by Hou, Xue, and Zhang (2015), henceforth HXZ. The HXZ model has been shown to be able to explain more of the anomalies generally considered in the academic literature[9], suggesting that it outperforms FF5 from a *pricing perspective* (Barillas & Shanken, 2015, 2016). In their recent paper, Fabozzi, Huang and Wang consider a more practical setting and compare the two models for the *purpose of investing*.

The factors that enter the two models are summarised in Figure 7, which also shows the key differences between them: firstly, HXZ does not include the value factor and secondly, the two models adapt different definitions of profitability. Hou, Xue and Zhang (2017) provide a more detailed comparison of the models.

Figure 7: Summary of factors in FF5 and HXZ, highlighting the differences

Factor	FF5	HXZ
Market	Market excess return (**MKT**)	Market excess return (**MKT**)
Value	Book-to-Price: High minus Low (**HML**)	Not included
Size	Market Equity: Small minus Big (**SMB**)	Market equity (**ME**)
Profitability	Operating profitability: Robust minus Weak (**RMW**)	Return on equity (**ROE**)
Investment	Asset growth: Conservative minus Aggressive (**CMA**)	Asset growth (**I/A**)

Source: UBS Quant. In FF5, size, value, profitability and investment are constructed using a quadruple sort ($2 \times 2 \times 2 \times 2$); In HXZ, size profitability and investment are constructed using a triple sort ($2 \times 3 \times 3$)

"… investing provides an economic criterion for model comparison…"

The analysis carried out in this paper is centred on a mean-variance portfolio allocation problem. The set-up starts with a Bayesian investor who imposes a factor model on the asset returns. In this framework, the investor has a *prior confidence* on a model and computes the optimal portfolio allocation using their *posterior belief*, which is updated with the data.

The analysis is performed on two subgroups of anomalies

The available risky assets include long-short portfolios of 15 anomalies from Novy-Marx and Velikov (2016) for the sample period Jul 1973 – Dec 2013. The authors divide this universe into two groups that are considered separately when comparing the models. The first group consists of 5 anomalies which can be explained by the HXZ model but not FF5; the second one contains 10 anomalies which cannot be explained by either HXZ or FF5. The rationale behind the split is the fact that one model may outperform another due to its better ability to capture the mean, the covariance matrix, or both. Since prior literature has shown that HXZ is better at pricing anomalies than FF5 (i.e. better ability to capture the mean), distinguishing between these two groups yields a more objective comparison.

[8] We have reviewed the paper in our February 2014 ARM.
[9] Throughout the paper a factor model is said to be able to "explain an anomaly" if the regression alpha is not significant.

The pricing ability of the two models

As preliminary comparison between HXZ and FF5, the authors test the pricing power of the models in a linear regression setting by assessing the value of the intercept term. Consistent with prior literature, the average alpha for HXZ achieved for the first set of factors (those that can be explained by HXZ) is 0.13% ($t = 0.63$), while that for FF5 is 0.67% ($t = 3.45$). For the second group of anomaly portfolios the average alphas achieved by HXZ and FF5 are very similar (0.72% and 0.75% respectively).

Methodology for comparing the models from an investment perspective

To assess the performance of the two models for asset allocation, the authors divide the universe of n risky assets into m non-benchmark assets with returns $\boldsymbol{r}_1$ and $n - m$ benchmark assets with returns $\boldsymbol{r}_2$. The return vector to all assets at time t is then written as:

$$\boldsymbol{r}_t = [\boldsymbol{r}_{1t}^T, \boldsymbol{r}_{2t}^T]^T$$

When the benchmark model is HXZ, the set of benchmark assets consists of the four anomaly portfolios used to define the model; put differently, the return vector $\boldsymbol{r}_2$ consists of the returns to the market, ME, ROE and I/A portfolios. Benchmark assets and returns are defined analogously when FF5 is the benchmark model.

Assuming independent and normally distributed returns over time, we can express $\boldsymbol{r}_{1t}$ as a function of the benchmark asset returns, $\boldsymbol{r}_{2t}$, in the following regression model:

$$\boldsymbol{r}_{1t} = \boldsymbol{\alpha} + B\boldsymbol{r}_{2t} + \boldsymbol{u}_t \text{ with } \boldsymbol{u} \sim N(\boldsymbol{0}, \Sigma).$$

This means that we can write the mean returns of the assets as

$$\mu = \begin{bmatrix} \alpha + B\mu_2 \\ \mu_2 \end{bmatrix}$$

where μ_2 is the sample mean of the benchmark assets.

100% belief in a model is equivalent to $\boldsymbol{\alpha} = \boldsymbol{0}_{m\times 1}$

An asset pricing model is true if and only if the alpha is a vector of zeros. Letting $\omega \in [0, 1]$ denote the confidence in a model, an investor who wholly believes in a particular asset pricing model will set $\omega = 1$ and will estimate the mean and covariance matrix by setting $\alpha = 0_{m\times 1}$. This implies that the mean of the non-benchmark assets is simply $B\mu_2$. At the other extreme, when $\omega = 0$ the investor does not believe in the asset pricing model and will estimate the mean and covariance without imposing any restrictions on α, so would use the sample means of all the assets. Throughout the paper the authors consider four confidence levels: $\omega \in \{0, 0.5, 0.75, 1\}$.

Large differences in predictive means and standard deviations would imply difference in allocation

Before examining the asset allocation decisions implied by the two models, the authors look at their predictive means and standard deviations[10]; if both models give rise to very similar estimates, then one would also expect to see very similar allocations. For estimates of the predictive means this is certainly not the case – by varying the confidence level ω the authors find substantial differences between the two models. In contrast, the posterior estimates of standard deviations are much the same across confidence levels and asset pricing models.

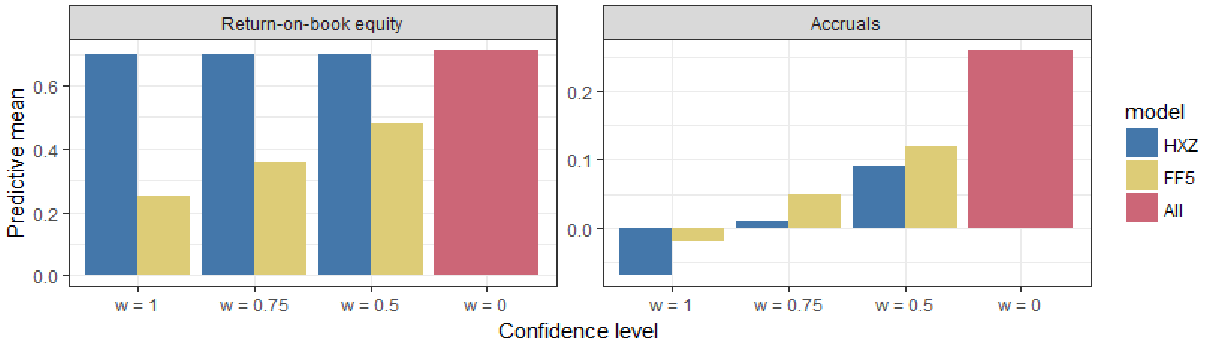
As an illustrative example we include the results for two portfolios in Figure 8: return on book equity which can be explained by HXZ but not FF5, and accruals,

[10] "Predictive mean" and "predictive standard deviation" refers to the mean and standard deviation of the posterior (predictive) distribution.

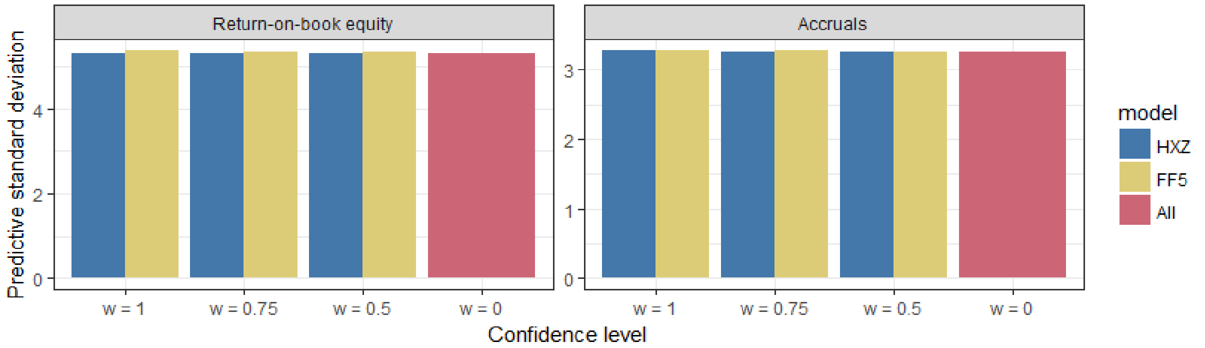
which cannot be explained by either model[11]. If an investor wholly believes in an asset pricing model ($\omega = 1$), his estimated means for return-on-book equity would be 0.70% for HXZ and 0.25% for FF5 (Panel A). Instead, an investor who is agnostic about asset pricing models ($\omega = 0$) would have an unbiased estimate of the anomaly return, namely the sample mean of 0.71%. Decreasing the confidence level forces the predictive mean to converge to this sample average. In particular, since FF5 cannot explain the anomaly under consideration, the predictive mean increases as the level of confidence goes down, while those estimated by HXZ remain essentially the same.

Figure 8: Predictive means and standard deviations for a subset of portfolios

Panel A: Predictive means



Panel B: Predictive standard deviations



Source: "What Difference Do New Factor Models Make in Portfolio Allocation?" by F. Fabozzi, D. Huang and J. Wang, reproduced with permission. Panel A in the figure shows the predictive means implied by HXZ and FF5 for different levels of confidence in the models and for two anomaly portfolios: Return-on-equity (Table 4, Panel A in the paper) and Accruals (Table 4, Panel B in the paper). Panel B shows the predictive standard deviations for the same portfolios (Table 4, Panel C and D in the paper).

Predictive standard deviations are very similar

On the other hand, as Panel B of Figure 8 illustrates, there is hardly any discrepancy between the predictive and unbiased estimates of standard deviations, even for anomaly portfolios that cannot be explained by either model. The implication of these observations, which the authors show more rigorously later in their paper, is that if a model is better for investment purposes, then that will be due to its ability to better describe the mean returns.

Implied optimal allocations differ substantially despite tight margin constraint

Figure 9, which shows the results for the subset of anomalies that cannot be explained by either model, indeed demonstrates that the optimal allocation according to the two models varies substantially when the level of confidence is high ($\omega \geq 0.75$) despite the tight margin requirement constraint of 50%. The authors report even higher discrepancies when this constraint is relaxed, which is what one would expect.

[11] Further details in the paper.

To decide which model is better from an allocation perspective, the authors compare them on the basis of the certainty-equivalent return (CER)[12] and Sharpe ratio. As the last two rows in Figure 9 illustrate, for all levels of confidence HXZ achieves higher CER as well as Sharpe ratios than FF5. The performance improvement for choosing HXZ model instead of FF5 is more pronounced for higher level of confidence, for example, for $\omega = 0.5$, CER increases by 13%, while for $\omega = 1$ the corresponding increase is 25%.

HXZ outperforms FF5 in-sample as it achieves higher CER and Sharpe ratios

Figure 9: Optimal mean-variance allocations with 50% margin requirement, in-sample

	ω = 1		ω = 0.75		ω = 0.5		ω = 0
	HXZ	FF5	HXZ	FF5	HXZ	FF5	All
Accruals	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net issuance	0.00	26.60	0.00	34.30	0.00	0.00	0.00
Investment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross margins	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Value, momentum, prof.	33.10	3.60	54.80	30.60	51.70	42.30	33.70
Industry Momentum	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry relative reversals	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High-frequency combo	0.00	0.00	4.30	3.10	30.70	37.50	66.30
Seasonality	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry low-volatility	0.00	0.00	0.00	0.00	0.00	0.40	0.00
HML	0.00	25.60	0.00	1.20	0.00	0.00	0.00
CMA	0.00	11.30	0.00	0.00	0.00	0.00	0.00
RMW	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE	39.40	0.00	13.80	0.00	0.00	0.00	0.00
SMB	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MKT	55.00	65.80	54.30	61.60	35.30	39.70	0.00
Certainty equivalent return	7.40	5.90	8.40	6.80	10.30	9.10	15.60
Sharpe ratio	0.88	0.75	0.89	0.80	1.10	0.99	1.62

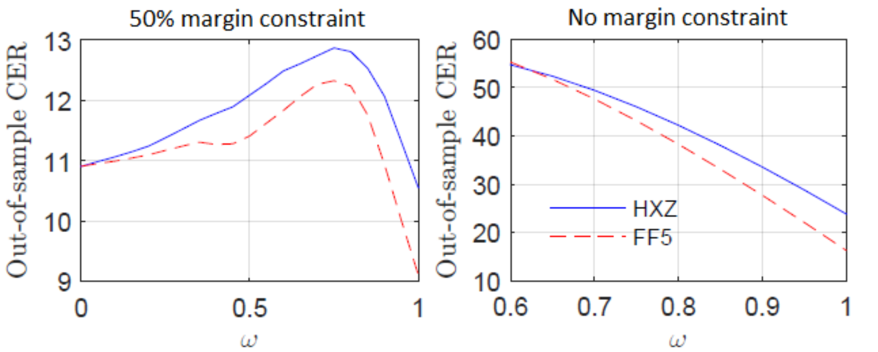
Source: "What Difference Do New Factor Models Make in Portfolio Allocation?" by F. Fabozzi, D. Huang and J. Wang, reproduced with permission. The table shows the optimal allocation of $100 for investing in anomalies that cannot be explained by HXZ or FF5 (Table 6 in the paper).

Results also hold out-of-sample

Using a rolling window of 120 months, the authors find that the results also hold true on an out-of-sample basis. The out-of-sample CER achieved by the two models as a function of the confidence level are shown in Figure 10.

[12] CER is defined as: $CER(\tilde{x},\tilde{\mu},\tilde{V}) = \tilde{x}'\tilde{\mu} - \frac{\gamma}{2}\tilde{x}'\tilde{V}\tilde{x}$, where $\gamma = 3$, $\tilde{x}$ refers to the optimal portfolio under the predictive mean, $\tilde{\mu}$, and covariance, $\tilde{V}$.

Figure 10: Out-of-sample certainty-equivalent returns (CER)



Source: "What Difference Do New Factor Models Make in Portfolio Allocation?" by F. Fabozzi, D. Huang and J. Wang, reproduced with permission. The figures show the out-of-sample certainty equivalence returns for different levels of confidence in HXZ and FF5 and subject to 50% margin constraint (left) or no margin constraint (right).

"Craftmanship Alpha: An Application to Style Investing"

Ronan Israel, Sarah Jiang and Adrienne Ross (2017)

The task of setting up a framework for style investing requires making a number of decisions, all of which play their part in determining how successful the associated strategy is. Assuming we have a well-researched, economic rationale for why a particular style should be profitable, how should we define that style? In situations where we wish to have exposure to multiple styles, how do we go about combining them? Furthermore how do we combine those styles without inheriting unintended exposures? Which weighting scheme should we use and how frequently should we rebalance? Equally important, how can we manage trading costs and risk? These are the choices an investor typically faces when constructing a strategy. Israel, Jiang and Ross (2017) discuss these choices in the context of style investing and posit that alpha opportunities exist from skilfully combining these portfolio ingredients.

Alpha can be generated just from skilfully implementing a style-based strategy.

> "*…the skilful targeting and capturing of style premia may constitute a form of alpha on its own – one we refer to as 'craftsmanship alpha'*"

We summarise the authors' points of view associated with each choice one by one below.

Which styles should we invest in?

Academic literature on style investing is vast. Collectively, hundreds of factors exist, all of which are claimed to drive returns in one context or another. In fact, there are so many to choose from, they are often referred to as the "zoo of factors"[13]. How should an investor, therefore, narrow down this list?

There is still no consensus on which styles drive returns.

The most common styles include value, momentum, defensive and carry. The process does not become any easier, either, once the style(s) have been chosen; the decision on whether to gain exposure to said style(s) in a long-only framework or "purify" the exposure in a long-short framework still needs to be made.

The authors believe style investing will continue to be profitable in the long-run, provided they are implemented efficiently.

How to define your style?

For a given style, defining the characteristic associated with that style presents another challenge. Taking value as an example, Israel, Jiang & Ross remark on the variation in inputs used to quantify value: which market price to use, which fundamental to use in the numerator and at what point in time do you take those values. The standard HML factor a la Fama & French (1992) uses contemporaneous prices with the book value which could be lagged by up to 18 months. Asness and Frazzini (2013), however, use current market prices instead in their "HML Devil" factor therefore using information available at the time of investing and avoiding any incidental bet on both value and momentum. A company may be categorised as expensive according to Fama & French's HML factor but cheap according to the latter "HML Devil" factor.

For any given style, multiple measures have been used to quantify them.

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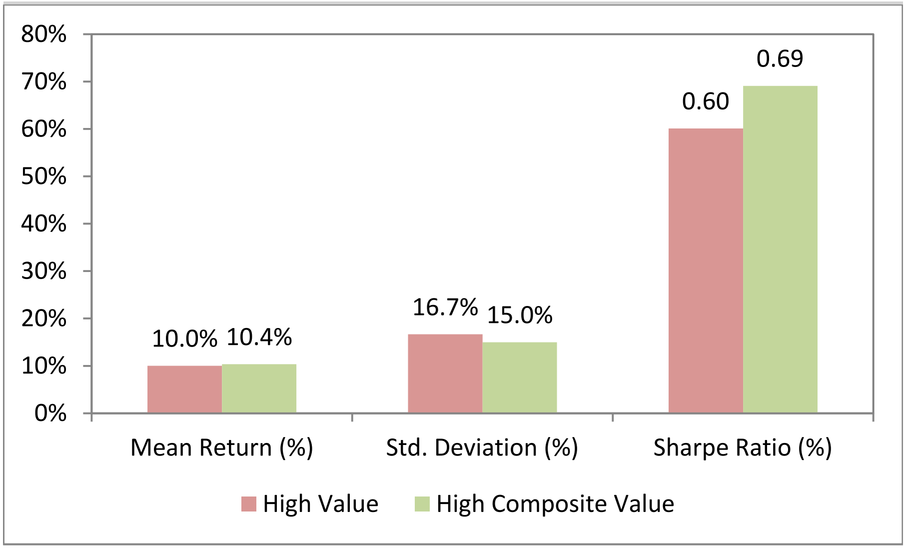
13 https://www.researchaffiliates.com/en_us/publications/articles/223_finding_smart_beta_in_the_factor_zoo.html

To add to the above, Israel et al. point out that other measures exist for defining value and forming a composite of measures results in a more robust quantification by reducing measurement noise. Due to the lack of clarity on which single measure should be used for each factor, we have also supported the use of composite measures, for example for value and quality. As Figure 11: High US Value vs. High US Composite Value shows, if we run a simple backtest of high (top 50%) value stocks from Russell 1000 when either using a single value measure (book-to-price in this case) or a composite of value measures, the composite version leads to a lower standard deviation of returns and a higher Sharpe ratio. The difference can be greater for high quintile stocks (see the chart of cumulative returns in Figure 1 for a visual illustration of the difference in this case).

Figure 11: High US Value vs. High US Composite Value



Source: UBS Quantitative Research: The bar chart shows the difference between annualised return, annualised standard deviation and Sharpe ratio for high value and high composite values stocks from Russell 1000 Index. Stocks are market cap weighted and the period of analysis covers January 1996 – October 2017. Composite Value is an average of the z-scores of book-to-price, dividend yield, earnings yield, EBIT/EV, and free cashflow yield.

Stock selection and weighting schemes

How to transform style signals into portfolio weights?

The criteria used for selecting stocks and the method used for allocating weights to eligible constituents are key drivers of the ensuing exposures and performance. The exposure to any factor can be determined by either investing in a subset of an underlying basket of stocks or investing in all of the constituents of that basket but adjust the weights according to a function of the factor or factors of interest. On the former, stocks are typically weighted in relation to their market capitalisations. Equally weighting stocks within that subset is also popular but should only be done in the knowledge that exposure to small, potentially more risky and less liquid companies will be increased. The latter approach of maintaining the constituent composition of an underlying basket but overweighting (underweighting) stocks with higher (lower) factor values accounts for their relative strength. In the context of value, again this approach tends to overweight smaller and less liquid stocks.

The point here, is that multiple techniques for weighting stocks exist but, as the authors claim, a weighting scheme which incorporates market capitalisations and signal strength may offer a balanced tradeoff between liquidity and expected gross return.

Risk Management

Naïve implementation of style investing can lead to exposures to unintended risks. These include, but are not limited to, market risk, industry risk, country risk as well as other styles. Several solutions do exist for managing these unwanted risks; for example, ranking stocks based on a particular style within industries rather than across the entire cross-section avoids industry bets and compares companies fairly to their industry peers. However, as Israel et al. rightly state, there are trade-offs to making these adjustments. For value, industry neutralisation typically results in higher Sharpe ratios (a good thing) but higher turnover (not such a good thing)!

Separating and managing risks separately allows for better risk control.

In light of the above, whilst it is generally considered to be desirable to achieve pure exposure to a particular style, it might be the case that an investor is comfortable with certain indirect risk exposures. In which case, the authors advocate building style portfolios by separating and managing these risks independently. Accordingly, this approach makes it easier to allocate and control the sources of risk.

Continuing on the same topic, a technique mentioned for managing risk in a strategic asset allocation framework is volatility targeting. Practitioners often use this technique in order to create more stable portfolios with improved diversification; it is commonly used as an overlay in a momentum strategy. Israel et al. (2017) also note that volatility should not always be considered in a negative light. When higher volatility is associated with higher Sharpe ratios, taking a consistent level of risk can prove beneficial.

Israel, Jiang & Ross advocate the use of a systematic plan for times of crisis.

As a final note on this section, investors should also be mindful of other risks including leverage, illiquidity, solvency, left tail risk and correlation risk. The authors support the idea of having a systematic plan, such as mechanical drawdown rules, in place in times of crisis. This not only serves as an effective risk management tool, but may avoid the need to abandon an investment during economically tough times.

Combining Styles

Multiple style investing is typically achieved via a mixed or integrated approach.

Exposure to multiple styles is often achieved via one of two main approaches to combining the respective factor values:

Mixed Approach (Blended Portfolio) – this entails a straightforward combination of the top n-tiles of N standalone single factor portfolios. In the case of two factors, F_1 and F_2, the returns of the mixed portfolio are equal to the weighted sum of the factor returns:

$$Mixed\ Portfolio = w_{F_1} \cdot Portfolio_{F_1} + (1 - w_{F_1}) \cdot Portfolio_{F_1}$$

Integrated Approach (Blended Score) – this requires forming a composite score as a weighted average of the standalone factor scores. The resulting portfolio is then formed by selecting the top n-tile stocks according to this composite score.

$$Integrated\ Composite\ Score = w_{F_1} \cdot Score_{F_1} + (1 - w_{F_1}) \cdot Score_{F_2}$$

The merits of each method should be considered when deciding which one to use. Portfolio compositions stemmed from employing these two approaches can end up being very different when the incorporated styles are lowly correlated. One can advocate the mixed approach on the grounds that it is much easier to quantify the level to which each style is driving the performance. The integrated approach, on the other hand, can be advantageous since it avoids selecting stocks which rank very highly on one dimension but average on another dimension. We refer the reader to our related Academic Research Monitor for further analysis on the mixed and integrated style combination techniques.

Implementation

Of all the choices mentioned thus far, skilful implementation is a key determinant to a successful style strategy. Ultimately, the objective is to achieve positive (often high) excess returns net of transaction costs.

Tactical or Strategic Allocation?

Several decisions need to be made relating to implementation. Firstly, is it worth trying to tactically time styles and invest accordingly or are we better off maintaining a strategic allocation? On the former, the debate as to whether style timing can actually be achieved continues to be a source of research. This fact, in itself, highlights the difficulty investors face when carrying it out in practise. As we showed in "Are you already timing styles successfully?" (Sep 2016), price-based styles effectively time fundamental factors. What this means, is that particular styles can be mimicked by price-driven factors which also relate to the economic cycle.

Style timing is a function of skill; greater skill merits greater tilts.

In general, successful style timing is skill-driven. As Israel et al. (2017) show, with an initially equal-weighted value-momentum portfolio, timing skills need to be better than a 0.1 Sharpe ratio to justify any level of tilting.

There is a tradeoff between persistent exposure and implementation costs.

Another important input into the implementation stage is how frequently the strategy should be rebalanced and, consequently, how we should go about managing transaction costs and turnover[14]. Theoretically speaking, continuously rebalancing the portfolio maintains the desired exposure but is costly. An investor needs to strike a balance between preserving exposures to preferred styles and reducing transaction costs. Once the investor has decided on the rebalancing frequency and set the desired turnover, techniques do exist for minimising transaction costs. In particular, Israel et al. (2017) mention the staggered rebalancing approach used, for example, in the RAFI Index series[15].

Taking everything into account, "many details matter"! Israel, Jiang and Ross (2017) have nicely summarised the numerous choices involved in implementing style investing, whilst pinpointing where greater skill in making these choices can result in a successful investment, i.e. craftsmanship alpha.

[14] See our latest note on various approaches to lowering turnover.
[15] https://www.researchaffiliates.com/content/dam/ra/documents/strategy/RAFI-Index-Series-Rulebook.pdf

Appendix

We currently maintain data for styles based on the following factors. Additional style factors are regularly assessed for future inclusion.

Style Factor	Data definition, sources and notes
Book / Price	The universe is ranked by the inverse of the P/BV multiple. Values are returned from the source cascade: HOUSE (12 months trailing time-weighted) then WLDSCOPE (latest actual). We 'cascade' through the sources until a style factor value is found then use that value.
Beta	Beta value of the stock calculated over 60 monthly returns. Null values are filled with country-sector or country returns. All values are adjusted for risk free rates.
Capex / Depreciation	The universe is ranked by the ratio Capital Expenditure to Depreciation. Values are obtained from the cascade: HOUSE (12 months forward time-weighted then 12 months trailing time-weighted) then WLDSCOPE (latest actual).
Debt /EV	The universe (excluding financials) is ranked by the ratio (core) Net Debt to EV (see below). Values are obtained from the cascade: HOUSE (12 months forward time-weighted then 12 months trailing time-weighted) then WLDSCOPE (latest actual).
Dividend Cover	The universe is ranked by the ratio EPS/DPS. Values are obtained from the cascade: HOUSE (12 months forward time-weighted), IBES (12 months forward time-weighted) WIRE (12 months trailing time-weighted), IBES (12 months trailing time-weighted) and finally WLDSCOPE (latest actual). Further test that DPS is non-zero.
Dividend Growth	The universe is ranked by the percentage change of the 12 months forward (time-weighted) DPS over the 12 months trailing (time-weighted) DPS. Values are obtained from the cascade: HOUSE then IBES. Test that the 12 months trailing (time-weighted) DPS is neither 'null' nor 0
Dividend Yield	The universe is ranked by the 12 months trailing dividend yield. Values are obtained from the cascade: HOUSE (12 months trailing time-weighted), IBES (12 months trailing time-weighted) then WLDSCOPE (latest actual).
EBIT Yield	The universe (excluding financials) is ranked by the ratio (core) EBIT to EV (see below). Values are obtained from the cascade: HOUSE (12 months forward time-weighted then 12 months trailing time-weighted) then WLDSCOPE (latest actual).
Historical EPS Growth	The universe is ranked by the ratio: (EPS (0-12 months trailing,) – EPS (60-72 months trailing)) / SUM (absolute(EPS) for 2 – 5 years trailing). Values are obtained from the cascade: HOUSE, IBES, WLDSCOPE, COMPUSTAT (for US) and EDS (for JP). Notes: 1) This method allows for any change of EPS sign between the two periods and distinguishes between patterns of growth between the end points. 2) The time-weighting process may result in very small values especially where the underlying data changes sign, potentially leading to extreme values of the ratio.
Forecast EPS Growth	The universe is ranked by the (absolute) percentage change of the 12 months forward (time-weighted) EPS over the 12 months trailing (time-weighted) EPS. Values are obtained from the cascade: HOUSE, then IBES. Notes: see Historical EPS Growth.

Earnings Momentum	The universe is ranked by the weighted average of the percentage changes in the 12 months forward forecast (time weighted) EPS as at the ‘latest’ month-end compared with the forecasts for the same period as available 1, 2 and 3 months ago. The revisions are weighted at 60%, 30% and 10% for 1, 2 and 3 months ago respectively. Values are obtained from IBES.
Earnings Yield	The universe is ranked by the inverse of the P/E multiple. Values are obtained from the cascade: HOUSE (12 months forward time-weighted) then IBES (12 months forward time-weighted).
Free Cash-flow Yield	The universe is ranked by the ratio free cash-flow / market capitalisation. Free cash-flow = trading profit + depreciation + net interest – tax charge - (abs) capex. Values are obtained from the cascade: HOUSE (12 months forward time-weighted then 12 months trailing time-weighted) then WLDSCOPE (latest actual). Additionally at each cascade level we test that each component has a value before accepting the resultant FCF.
Growth - Value Composite	The universe is ranked by a composite of rank scores of the Book / Price, Dividend Yield, EBIT Yield and Earnings Yield factors, plus supplementary tests on Sales Yield, for extreme values and to ‘interpret’ the factor values.
Market Capitalisation	These baskets are split up according to the market capitalisation thresholds used for each style product. The thresholds are generally adjusted monthly in line with market movements. Our South Africa and US style products preserve a number of stocks in the size baskets. The Asia ex Japan style product maintains stocks to a weight threshold in the size baskets.
PEG	The universe is ranked by 1/PEG = Earnings Yield * Forecast EPS Growth (see above). There is also a check that where both components of the PEG are less than zero then a low value (-9999) is set.
RoE	The universe is ranked by Return on Equity, RoE = Earnings Yield / (Book / Price) (see above). There is also a check that where both components of the RoE are less than zero a low value (-9999) is set.
ROIC	The universe is ranked by Return on Invested Capital (RoIC) = EBIT/ invested capital (non-financials) or PBT/ shareholders' funds (financials). Values are obtained from the cascade: HOUSE (12 months forward time-weighted then 12 months trailing time-weighted) then WLDSCOPE (latest actual). There is also a check that both components of the ratio are positive.
12 Month Price Momentum	The universe is ranked by the –12 months to –1 month (adjusted – local currency) price return, for the ‘current’ month end.
Medium-Term Price Momentum	The universe is ranked by the –7 months to –1 month (adjusted – local currency) price return, for the ‘current’ month end.
Short-Term Price Momentum	The universe is ranked on the monthly (adjusted – local currency) price return, for the ‘current’ month end.
Sales Yield	The universe (excluding financials) is ranked by the ratio (core) Sales to EV (see below). Values are obtained from the cascade: House (12 months forward time-weighted then 12 months trailing time-weighted) then WLDSCOPE (latest actual).

Volatility	Volatility is based on the sum of the squares of the daily (net) total returns in US$ of the stock over the preceding 12 months. If a stock doesn't have 12 months of daily returns history it will be in the medium basket.
Enterprise Value	House: Market Cap + (Core) Net Debt + Pensions Provisions + Minority Buy-outs - Peripheral Assets (UBS House), or WLDSCOPE: Market Cap + Short-term Debt + Long-term Debt Excluding Leases - Cash & Short Term Investments + Minority Interest. Additionally we test that the EV is greater than 10% of the Market Cap before accepting results at any level of the cascade.

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12-Month Rating	**Definition**	**Coverage**[1]	**IB Services**[2]
Buy	FSR is > 6% above the MRA.	45%	26%
Neutral	FSR is between -6% and 6% of the MRA.	39%	23%
Sell	FSR is > 6% below the MRA.	16%	11%
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 September 2017.
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.

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