Academic Research Monitor
Combining Smart Beta Factors

Equities

Global
Quantitative

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How to combine equity factors?

If the documentation of equity premia has been one important task for smart beta investing over the recent decades, then the combination of these premia in a portfolio is certainly of equal, if not greater, importance. Should one combine single-factor portfolios or instead use composite scores? Should one perform an independent double sort based on two factors or a dependent, i.e. sequential, one? These questions have been recently addressed by three academic papers, which we review in this note.

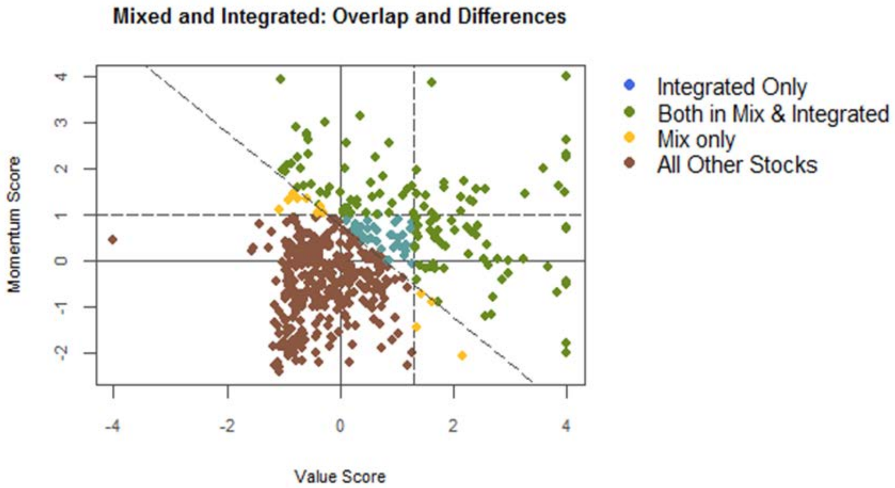
Mixing factor portfolios versus integrating factor scores

In blending factors, one can either combine single-factor portfolios ("mix") or alternatively build a multi-factor portfolio using composite factor scores ("integration"); see Figure 1. The first paper that we review explores the dynamics of the two approaches when combining value and momentum, and highlights the benefits of the integrated approach in terms of performance as well as turnover reduction. We extend the analysis by looking across global regions and find qualitatively similar results.

Independent (a la Fama & French) versus dependent sorting

Given that factors are generally correlated, how should one sort stocks in order to neutralise exposure to unintended factor tilts? The other two papers that we review compare Fama and French's (1993) independent sorting methodology to a sequential (i.e. dependent) one. The main finding is that the sequential sorting methodology can more accurately neutralise unintended factor tilts and therefore isolate the premium of interest. The papers provide illustrative results for the value and size equity factors.

Figure 1: Portfolio constituent selection in the mixed and integrated portfolios



Source: UBS Quantitative Research.

Introduction[1]

In the world of smart beta/factor investing, the first important task is to define the underlying universe of factors.[2] The next important task is really how to combine these factors in a multi-factor investing process in order to improve the profitability or to neutralise exposure to unintended factor tilts and therefore extract a "cleaner" form of the factor premium.

In this issue of our Academic Research Monitor we look at recent academic papers that investigate several methodologies in blending together different factor premia and try to offer insight in the above issues; see Figure 2.

Portfolio of single factors versus using composite score

The first paper that we review asks whether one should simply combine two single-factor portfolios or instead construct a portfolio by ranking stocks using a composite score of the different factors under consideration. Along with our review, we present supportive evidence of the findings by replicating the methodologies across various global regions.

Independent versus dependent sorting

The other two papers that we review investigate the multi-factor sorting methodology and compare its dependent and independent variants. The focus is primarily on which of the two alternatives is more efficient in neutralising the exposure to one (or some) factor(s) in order to isolate the premium of interest.

Figure 2: Papers on factor combination

"Long-Only Style Investing: Don't Just Mix, Integrate" *Shaun Fitzgibbons, Jacques Friedman, Lukasz Pomorski and Laura Serban*	SSRN working paper, June 2016
"Size and Value Matter, But Not the Way You Thought" *Marie Lambert, Boris Fays and Georges Hubner*	SSRN working paper, July 2016
"Size Matters, Book Value Does Not! The Fama-French Empirical CAPM Revisited" *Marie Lambert and Georges Hubner*	SSRN working paper, November 2015

Source: UBS.

[1] We would like to thank **Alisa Raykhman** for her contribution to this report during her rotation in the UBS Equity research department.
[2] Our Academic Research Monitor has extensively covered the smart beta universe in past issues:
- On Momentum (Jan. 2015)
- On Quality and Size (May 2015)
- On Value (Dec. 2015)
- On Low Risk (Feb. 2106)

"Long-Only Style Investing: Don't Just Mix, Integrate"

by Shaun Fitzgibbons, Jacques Friedman, Lukasz Pomorski and Laura Serban

How should one combine factors? Shaun Fitzgibbons, Jacques Friedman, Lukasz Pomorski and Laura Serban shed light on the different methodologies that are available to us in order to construct a multi-factor long-only portfolio.

Option 1: mixing factor portfolios

The first method of constructing a "mixed" portfolio entails a straightforward combination of the top n-tiles of N standalone single factor portfolios. In the case of two factors, $F1$ and $F2$, the returns of the mixed portfolio are equal to the weighted sum of the factor returns:

$$Mixed\ Portfolio = w_{F1} \cdot Portfolio_{F1} + (1 - w_{F1}) \cdot Portfolio_{F2}$$

Option 2: using a composite score

On the other hand, for the method of integration a composite score is first defined as a weighted average of the standalone factor scores with the final "integrated portfolio" comprising the top n-tile of the composite score rank:

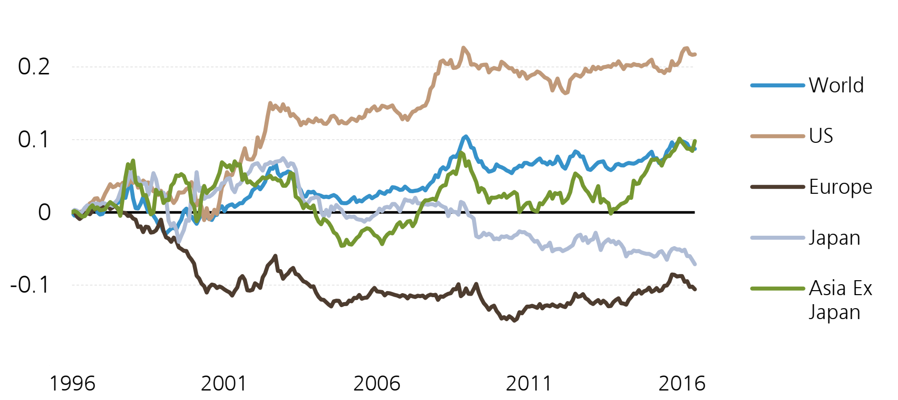
$$Intergated\ Composite\ Score = w_{F1} \cdot Score_{F1} + (1 - w_{F1}) \cdot Score_{F2}$$

The authors examine the performance of both portfolios in both a simulated and historical environment[3] and find that the integrated Value-Momentum portfolio outperforms the mixed portfolio on both an absolute and risk-adjusted basis.

Our replication of the analysis across main global regions

Figure 3 depicts the outperformance of the integrated portfolio over the mixed portfolio based on our replication of the methodologies across main global regions and Figure 4 presents the respective statistics. Our regional multi-style portfolios combine Value and Momentum factors between January 1996 and June 2016, and comprise of the 500 most liquid large-cap stocks in their respective universes.

Figure 3: Relative outperformance of integrated vs. mixed long-only portfolios



Source: UBS Quantitative Research. The figure presents the cumulative monthly returns of equally weighted mixed and integrated portfolios of value and momentum across global regions. Sample: Jan. 1996 – Jun. 2016.

The two-factor integrated portfolio outperforms the mixed in World, US and Asia ex Japan

Our analysis shows that the integration benefits are largest in the US and Asia Ex Japan, where the integrated portfolio achieves a 91% and 47% improvement in Information Ratio (henceforth IR) over the sample period. Our result is broadly in line with the improvement demonstrated by the authors, who find a 40% increase

[3] The authors build portfolios from large stocks in developed countries "*roughly comprising*" the MSCI World index from February 1993 to December 2015, combining momentum (based on 12-month return excl. the most recent month) and value (based on book-to-price).

in IR in their global universe ("*approximately*" MSCI World). They, however, use a market-cap weighted approach while we equally weight portfolio constituents.

Figure 4: Performance of combined factor portfolios across regions

	World		US		Europe		Japan		Asia Ex Japan	
	Mixed	Integrated	Mixed	Integrated	Mixed	Integrated	Mixed	Integrated	Mixed	Integrated
Geometric Ann. Return	9.8%	10.4%	10.6%	11.9%	12.0%	11.5%	5.1%	4.9%	10.4%	11.4%
Active Return	2.3%	2.9%	1.4%	2.7%	3.5%	2.9%	2.4%	2.2%	3.6%	4.6%
Tracking Error	4.4%	4.4%	6.2%	6.4%	4.4%	4.3%	5.6%	6.0%	8.1%	6.9%
Information Ratio	0.52	0.63	0.22	0.42	0.78	0.68	0.43	0.37	0.45	0.66
Calmar Ratio	0.16	0.18	0.18	0.20	0.19	0.18	0.11	0.11	0.15	0.16
Sharpe Ratio	0.63	0.68	0.66	0.74	0.66	0.64	0.35	0.35	0.49	0.52

Source: UBS Quantitative Research. World portfolios are built on 1500 largest equities within MSCI World, broadly in line with the methodology of Fitzgibbons, Friedman, Pomorski and Serban (2016). Regional portfolios are built on a sample of 500 largest stocks by market capitalisation in their respective region. The mixed and integrated portfolios across all geographies are designed to contain approximately equal number of constituents at every rebalancing date (monthly rebalancing), constituents are equally weighted and the portfolios are constructed without sector neutrality. Sample period: January 1996 to June 2016.

Where does the outperformance of integration stem from?

The paper finds that superior performance of the integration method stems from:

- Avoidance of constituents with offsetting factor scores, whilst including stocks with good all-round scores on both factors,
- Higher style exposure than the mixed portfolio,
- Stocks unique to the integrated portfolio having a higher alpha than stocks that are only present in the mixed portfolio,
- Minimisation of information handicap in the decision making process arising from external risk exposure, and
- Turnover reduction via netting off.

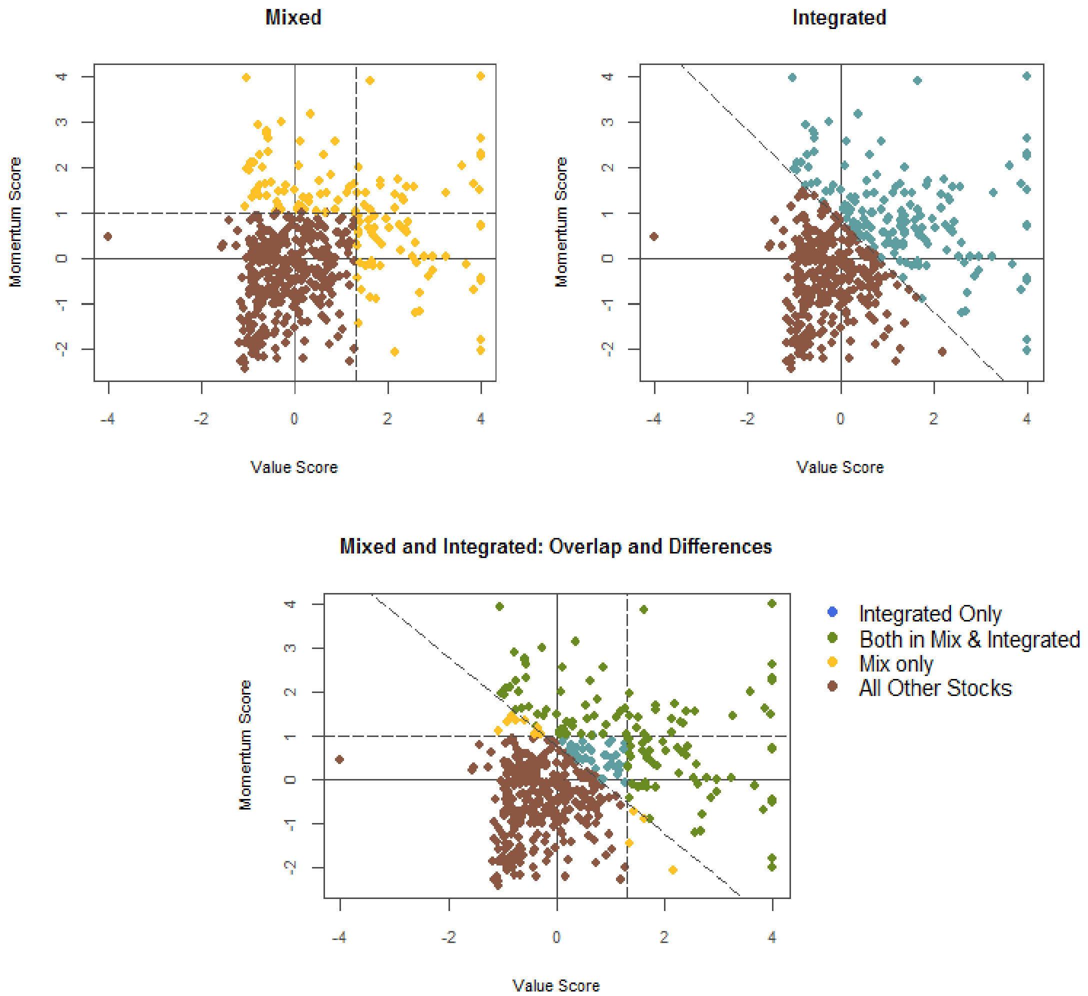
1. The integrated portfolio avoids stocks with "style disagreement"

The key reason for the difference in performance is the selection of constituents for the end n-factor portfolios. The mixed portfolio combines stocks with the highest momentum scores from the standalone momentum portfolio and stocks with the highest value scores from the standalone value portfolio. The mixed portfolio is thus a simple combination of the top n-tiles of standalone factors. It does not, however, account for the relationship between the two factors. In effect, this means that the mixed portfolio ignores any "style disagreement" and can include stocks with offsetting factor exposures. The integrated portfolio, instead, only includes stocks that are attractive on both factors whilst excluding those that may be highly attractive on one factor but unappealing on the other. This seemingly minor difference results in a different portfolio composition. Figure 5 depicts the differences in stock selection across the two methods.

2. Stocks unique to the integrated portfolio exhibit a high, positive alpha while alpha is negative for stocks unique to the mixed portfolio

Furthermore, the authors argue that the process of building any standalone factor portfolio implies ignoring information on any other factors which may be relevant to portfolio performance. The mixed portfolio thus exhibits this "information handicap" twice in the case of a two-factor portfolio. The method of integration, however, curtails this "information handicap" as it employs information regarding both factors simultaneously in the decision-making process. This effect is well illustrated by the stocks unique to the integrated portfolio (highlighted in blue in Figure 5, based on our constructed portfolios), which demonstrate a high positive alpha in comparison to constituents unique to the mixed portfolio, which exhibit a negative alpha altogether; see Figure 6. These stocks generate a 2.8% active return versus -1.4% for the mixed portfolio, without sacrificing tracking error which is identical for both sets of unique stocks at 5.6%. The authors also find that in market-cap weighted portfolios, the method of integration allocates a higher-than-average weight to these unique-to-integration positive alpha stocks.

Figure 5: Portfolio constituent selection in the mixed and integrated portfolio: US



Source: UBS Quantitative Research. Data as of 30/03/2001: Constituents of mixed portfolio, integrated portfolio and overlap of mixed and integrated. Portfolios are built on a sample of 500 largest US stocks and are designed to contain approximately equal number of constituents at every rebalancing date. Constituents are equally weighted and the portfolios are constructed without sector neutrality.

Figure 6: Stocks unique to integrated and mixed portfolio: MSCI World

	Unique to Mixed	Unique to Integrated
Average number of total constituents	451	476
Average number of unique constituents	88	113
Annualized Alpha	-1.3%	3.6%
Tracking Error	5.6%	5.6%
Active Premium	-1.4%	2.8%
Information Ratio	-0.24	0.50

Source: UBS Quantitative Research. Performance statistics for the stocks within MSCI World that are unique to the mixed or the integrated portfolios. Universe: MSCI World - benchmark portfolio contains an average of 1428 stocks. Sample period: January 1996 to June 2016.

3. The integrated portfolio can outperform the best performing standalone style

Since the mixed portfolio is the combination of the highest scoring n-tiles of two factors (in the case of a two-factor approach), the mixed portfolio returns are a weighted average of returns of the constituent factors. Effectively this means that the mixed portfolio return has to lie somewhere in between the returns of the two standalone style portfolios, unable to beat the average returns of the best-performing factor. The authors find that the integrated portfolio, however, can outperform standalone styles due to a higher factor exposure, an effect also found by Frazzini, Israel, Moskowitz and Novy-Marx (2013).

Avoiding stocks with offsetting style exposures also allows the integrated portfolio to benefit from the effect of netting off. An additional advantage of the method of integration, albeit small in comparison to pure performance benefits, is the reduction in turnover which, in turn, reduces transaction costs. Figure 7 presents the annual turnover savings regionally for the period between January 1996 and June 2016 for a value-momentum portfolio. The evidence is rather convincing.

4. Turnover reduction is a welcome additional advantage

Figure 7: Integration leads to turnover savings: Turnover per annum

	Mix	Integrated	Turnover Savings
World	41.8%	39.9%	-4.6%
US	43.1%	41.7%	-3.3%
Europe	42.4%	40.8%	-3.8%
Japan	42.6%	42.4%	-0.5%
Asia Ex Japan	41.1%	40.6%	-1.2%

Source: UBS Quantitative Research. Annual turnover for the mixed and integrated value and momentum portfolios. Sample period: January 1996 to June 2016

What affects the magnitude of outperformance?

The authors argue that the degree of outperformance of the integration method depends on a number of factors, including:

- The number of styles; for multi-factor portfolios, the benefits increase with the number of styles incorporated in a portfolio (see Figures 8 and 9).
- The level of correlation between chosen styles; high negative correlation leads to superior performance, while high positive correlation makes the difference between the two methods negligible.
- The level of targeted tracking error (TE) has a positive relationship with outperformance. Higher TE leads to an increase of benefits from integration.

1. Number of Styles

Example: a three-factor portfolio, Value – Momentum – Quality

The outperformance of the integrated portfolio becomes more prominent as the number of combined styles increases, as purely by construction it avoids more constituents with offsetting exposures. As an example, Figure 8 demonstrates that the active return for a three-factor integrated portfolio of value, momentum and quality (using ROE) using the stocks of MSCI World increases nearly 1.5x versus the mixed, while its two-factor value-momentum counterpart sees only a 14% improvement. This relative outperformance of the three-factor portfolio against the two-factor portfolio does not come at a higher turnover, even though the turnover benefit between the integrated and the mixed portfolio becomes almost obsolete for the three-factor portfolio. Figure 9 presents the results for the remaining global regions; interestingly, the three-factor integrated portfolio outperforms in terms of active return in Europe, which was not the case for the two-factor integrated portfolio (compare the results from Figures 4 and 9).

Figure 8: Integration benefit increase with the number of styles: MSCI World

	Two-factor portfolio			Three-factor portfolio		
	Mixed	Integrated	Difference	Mixed	Integrated	Difference
Active Return	2.3%	2.9%	26%	1.4%	3.4%	143%
Active Risk	4.4%	4.4%	0%	2.4%	4.6%	92%
Information Ratio	0.52	0.63	21%	0.57	0.75	32%
Sharpe Ratio	0.63	0.68	8%	0.59	0.72	22%
Calmar Ratio	0.16	0.18	13%	0.15	0.19	27%

Source: UBS Quantitative Research. Portfolios are built on 1,500 largest stocks by market capitalisation from MSCI World and constituents are equally weighted. The two-factor portfolio incorporates value and momentum. The three-factor portfolio incorporates value, momentum and quality. Sample period: Jan. 1996 – Jun. 2016.

Figure 9: Regional performance of mixed and integrated three-factor portfolios

	US		Europe		Japan		Asia Ex Japan	
	Mix	Integrated	Mix	Integrated	Mix	Integrated	Mix	Integrated
Annualised Return	11.2%	12.5%	12.5%	13.0%	5.2%	4.5%	9.9%	12.4%
Active Return	3.6%	4.9%	4.9%	5.4%	-2.3%	-3.1%	2.3%	4.8%
Active Risk	11.2%	10.0%	9.6%	9.2%	16.3%	15.6%	19.1%	17.6%
Information Ratio	0.32	0.49	0.51	0.59	-0.14	-0.20	0.12	0.28
Sharpe Ratio	0.65	0.76	0.68	0.73	0.36	0.33	0.48	0.57
Calmar Ratio	0.19	0.23	0.20	0.21	0.10	0.09	0.14	0.19

Source: UBS Quantitative Research. All portfolios are built on 500 largest stocks by market capitalisation and constituents are equally weighted. The three-factor portfolio incorporates value, momentum and quality. Sample period: January 1996 – June 2016.

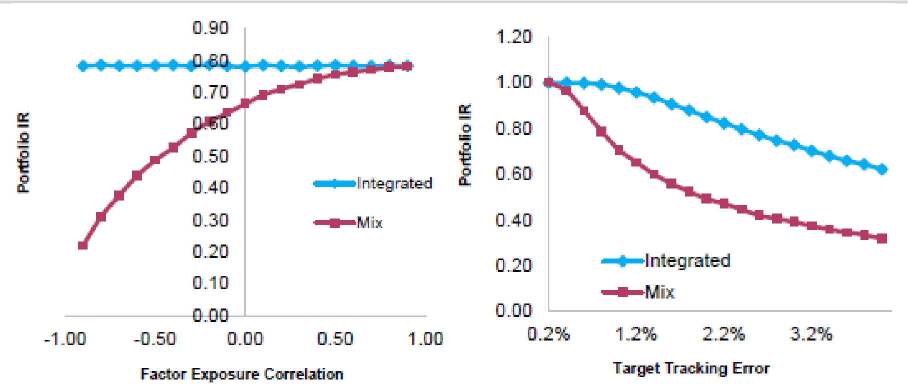
2. Correlation between factors

This effect is further reinforced as the negative correlation between factors increases; since highly negatively correlated factors more frequently offset each other, the outperformance of the integrated portfolio becomes more prominent as it isolates stocks that are jointly attractive on both factors. In the extreme opposite case of perfect positive correlation between factors, the mixed and integrated portfolios are identical. This effect is illustrated by the authors using their simulation framework, which demonstrates the effect of correlation between styles on the IR of the mixed and integrated portfolios (see Figure 10, left pane).

3. Targeted tracking error

Finally, the magnitude of targeted TE has a positive relationship with integration benefits. The long-only constraint forces the IRs of portfolios to drop with increasing TE, as portfolios move further away from the theoretical ideal of a long-short portfolio. In the mixed portfolio this effect is imposed on each standalone factor portfolio and is thus repeated multiple times in the final mixed portfolio. The integrated portfolio, on the other hand, only experiences this effect once. Using their simulation framework, the authors demonstrate the behaviour of the IRs of the two portfolios as a function of TE (see Figure 10, right pane).

Figure 10: Integration benefits increase with higher TE



Source: "*Long-Only Style Investing: Don't Just Mix, Integrate*" by s. Fitzgibbons, J. Friedman, L. Pomorski & L. Serban (2016); Figures 2a and 3, reproduced with permission.

In conclusion

To conclude, the integration method achieves superior performance to the mixing method when factors are numerous and are negatively correlated. Furthermore, the method is most advantageous to managers who target a higher tracking error. We believe that the paper offers substantial insight on the important task of building multi-factor portfolios.

"Size Matters, Book Value Does Not! The Fama-French Empirical CAPM Revisited"

by Marie Lambert and Georges Hubner

and

"Size and Value Matter, But Not the Way You Thought"

by Marie Lambert, Boris Fays and Georges Hubner

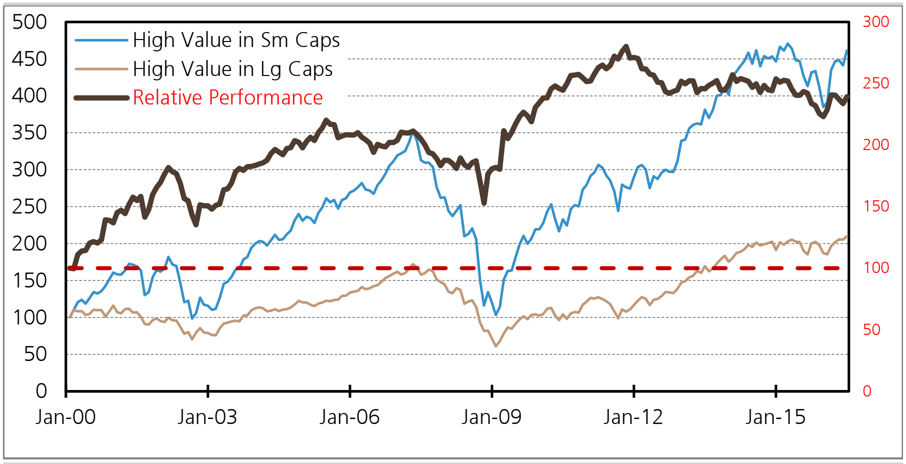
How to neutralise exposure to unintended factor tilts?

The last section of this note continues on the theme of combining factors. More specifically, Lambert and Hubner (2015) and Lambert, Fays and Hubner (2016) focus on how one should build a portfolio with exposure to a certain factor, while neutralising any other unintended factor titles. The key takeaway from both papers is that stocks should be sorted sequentially on preferred factors; the first sorts apply to the "control risk" dimensions and the last sort must be associated with the risk dimension of interest. This approach differs to Fama and French's (1993) sorting methodology which suggests ranking stocks on each factor independently resulting in premia contaminated by cross effects. Whilst the approach documented in both papers that we review here can be applied to any combination of factors, the emphasis is on exposure to value and size factors.

In order to motivate their analysis, the authors highlight the potential weaknesses associated with Fama and French's (1993) independent sorting methodology.

On the one hand, the value effect is more prominent in small caps than in large caps (for recent evidence see Asness, Frazzini, Israel and Moskowitz, 2015; we have reviewed this paper in our December 2015 ARM); this is a well-known phenomenon which is not properly captured in Fama and French's (1993) framework (henceforth FF). To illustrate this, we took the universe of US stocks within MSCI All World Index, over the period January 2000 to August 2016, and found that a market-cap weighted portfolio containing stocks that rank highest on value within small caps outperforms a portfolio of high value stocks within large caps on an absolute and risk-adjusted basis; see Figure 11 below. The conclusions remain true for stocks in MSCI Europe, Asia ex Japan and Japan.

Figure 11: High book-to-price portfolios in small and large caps: 2000-2016



Source: UBS Quantitative Research. Cumulative returns of market-cap weighted portfolios consisting of MSCI US stocks that rank highly according to book-to-price values within small-caps and large-caps. Sample period: January 2000 – August 2016.

On the other hand, focusing on size, FF use NYSE breakpoints to group stocks into two buckets by market capitalisation on an annual basis. A pure small cap premium cannot adequately be captured here as stocks with market caps in the low- and mid-range are grouped together. At the same time, stocks are ranked on a scale of 1-3 according to their book-to-price ratio (30% lowest – 40% – 30% highest). This sorting approach produces six value-weighted portfolios by, essentially, laying a grid divided equally across risk dimensions over the rankings.

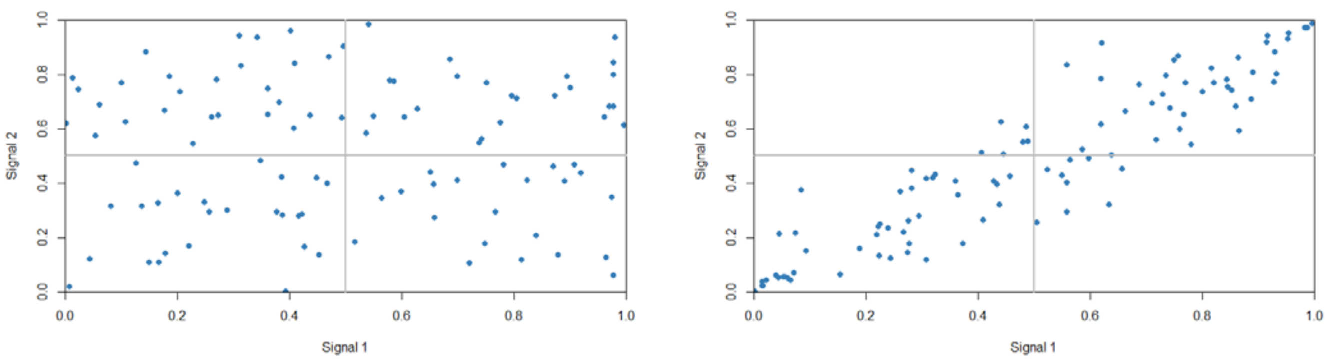
Independent versus dependent sorting

Independent sorting only makes sense in a scenario where the variables considered for sorting are uncorrelated. The fact that market capitalisation and book-to-price (henceforth B/P) are broadly negatively correlated means that a portfolio containing high B/P stocks under the FF framework will be tilted to small caps.

Figures 12 and 13 visually demonstrate the difference in sorting approaches given two variables which are either positively correlated (around 90%) or uncorrelated. In this example, we split the universe in two halves based on each variable.

Figure 12: Independent Sorts

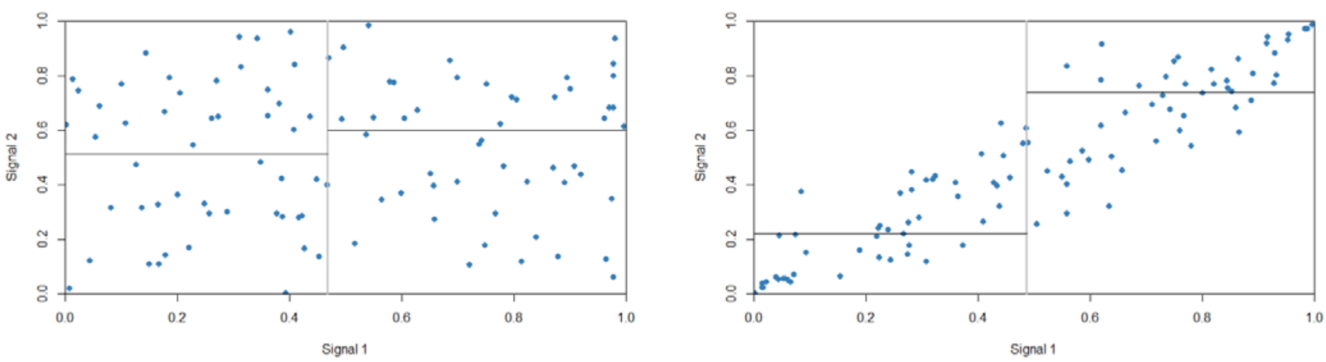
Panel A: Uncorrelated Variables | **Panel B: Correlated (90%) Variables**



Source: UBS Quantitative Research. The figure illustrates the scatterplot for an independent double-sort between uncorrelated and correlated (90%) variables.

Figure 13: Sequential (dependent) Sorts

Panel A: Uncorrelated Variables | **Panel B: Correlated (90%) Variables**

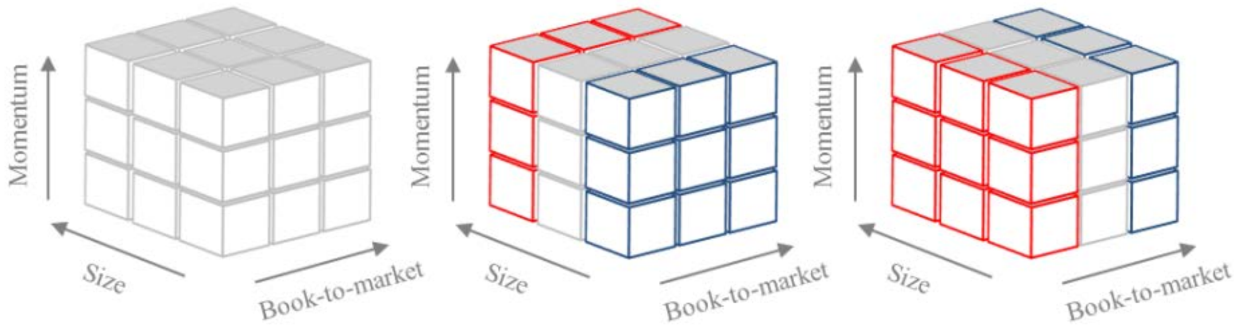


Source: UBS Quantitative Research. The figure illustrates the scatterplot for a sequential double-sort between uncorrelated and correlated (90%) variables.

How can the FF methodological issues be resolved?

The authors of the two papers that we review here propose an alternative approach to combining factors which does not suffer the same drawbacks as the FF methodology. Instead of applying heuristic breakpoints and independent sorting, the authors suggest using the same number of breakpoints (1/3, 2/3) in order to group stocks and a sequential sorting procedure for constructing portfolios with exposures to multiple factors. Ranking stocks on a scale of 1-3 across all dimensions via this method creates 3^M portfolios where M is the number of factors each portfolio has low-, mid- or high exposure to. The authors claim this approach is more systematic than FF's and is analogous to integrating over a cube, as Figure 14 demonstrates.

Figure 14: Sequential Sorting



Source: "*Size and Value Matter, But Not the Way You Thought*" by M. Lambert, B. Fays and G. Hubner; Figure 2, reproduced with permission.

The benefits of sequential (i.e. dependent) sorting

Their sequential sorting technique has several benefits:

- It leads to purification of factors;
- It treats each dimension on an equal footing in;
- Factors are rebalanced monthly in order to capture more frequently the factor premia;
- Correlations between factors are taken into account thus avoiding contamination of exposures;
- Diversification is improved as (approx.) the same number of stocks is allocated to each basket.
- Returns generated from spread portfolios (high-low) are highly correlated with the priced factor whilst the other sources of risk are adequately isolated.

Factor premia are then computed by taking the average of the "*differences between portfolios scoring high and low on the risk dimension to be priced, but scoring at the same levels for the control risk dimensions*". If X is the risk dimension to be priced, and Y, Z represent control risks, the risk premium associated with factor X is given as:

$$X_{Y,Z,t} = \frac{1}{9}\left[\sum_{b=H,M,L}\sum_{c=H,M,L} R_t(HX|bY|cZ) - \sum_{b=H,M,L}\sum_{c=H,M,L} R_t(LX|bY|cZ)\right]$$

where H, M, L represent high, mid and low, respectively and $R_t(aX|bY|cZ)$ is the return of the portfolio where stocks are ranked first on dimensions Y and Z and finally on dimension X. In what follows we denote this sequential sorting method by SS for brevity.

Lambert and Hubner (2015):

Is there a value premium after controlling for market and size?

In the first of the two papers that we review here (Lambert and Hubner, 2015), SS is used to form value portfolios with size and momentum dimensions used as control risks. The objective is to evaluate whether a value premium really exists or whether its magnitude is due to a theoretical bias in the FF's sorting procedure.

The authors use a universe of US stocks (NYSE, AMEX and NASDAQ screened for outliers and free-float) over the period 1980 – 2007 and split them on a monthly basis by size so to create three portfolios. Within these size buckets, stocks are then split according to their return over the past year (excluding the preceding month) and, finally, each size-momentum portfolio is scaled by value to form 27 triple-sorted portfolios. Keeping only those portfolios which score high or low on value, nine high-low spread (difference) portfolios are formed where the first two factors (control risks) are ranked the same:

$$Size - Mom - Value\ Portfolios \rightarrow \{abH - abL\}\ where\ \{a, b\} \in \{L, M, H\}$$

A high-minus-low (HML) factor is then calculated as the arithmetic average of the nine portfolios just described (see the rightmost image in Figure 14).

Main findings

Comparing the nine difference portfolios created by the SS methodology and FF's sorting procedure, the authors document the following findings:

- Returns generated by the difference portfolios coming from SS are more stable than those generated from FF. This is confirmed by the reduction in the coefficient of variation[4] associated with SS.
- Returns from SS difference portfolios exhibit high correlations with the priced risk factor but display low correlations with the other sources of risk. These results are not evident under the FF framework;
- Correlations between SMB and HML portfolios from the two different methodologies are approx. 67% and 68%, respectively, implying that there is around 33% variation or information difference in going from one sorting technique to another;
- Combining factors via SS leads to improvements in terms of reduced specification errors and the ability to price passive benchmark indices.

In addition to the above findings and in contrast to what is found with the FF portfolios, the authors report strong size effects and insignificant value effects over their sample period. This confirms the overestimation of the value effect in Fama and French (1993, 1996).

Lambert, Fays and Hubner (2016):

When do size and value effects matter?

In the second paper that we review here (Lambert, Fays and Hubner, 2016), comparisons are made between using SS and FF's independent sorting technique from the perspective of how well each method generates a "turn-of-the-year" size effect and "through-the-year" book-to-price effect.

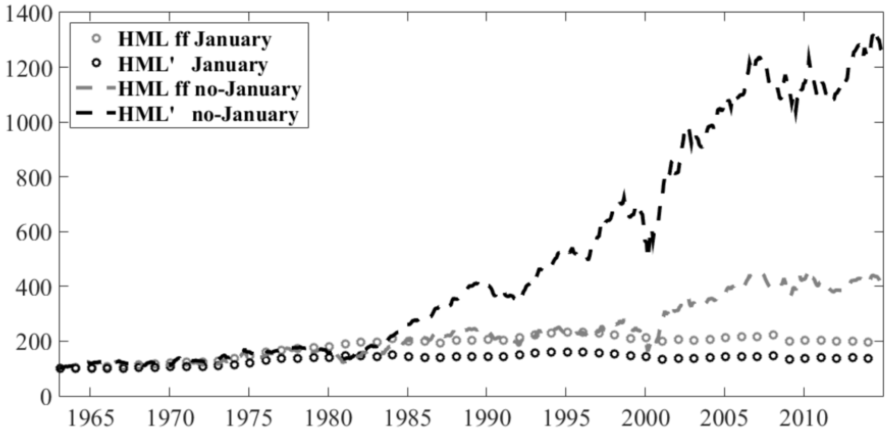
Through better allocation of stocks to characteristic portfolios, the SS procedure is shown to better distinguish between risk dimensions and offers an improvement in terms of identifying whether a risk dimension has a significant effect on return variation after controlling for other factors.

Over the period 1963-2014, the authors form size-momentum-value portfolios using the SS methodology and compare the resulting portfolios with those constructed via the FF methodology.

Figure 15 presents the cumulative returns of the HML (value) strategy based on SS and FF where one either invests only in Januaries or throughout the year but not in Januaries. Figure 16 displays a similar plot for SMB (size) strategies.

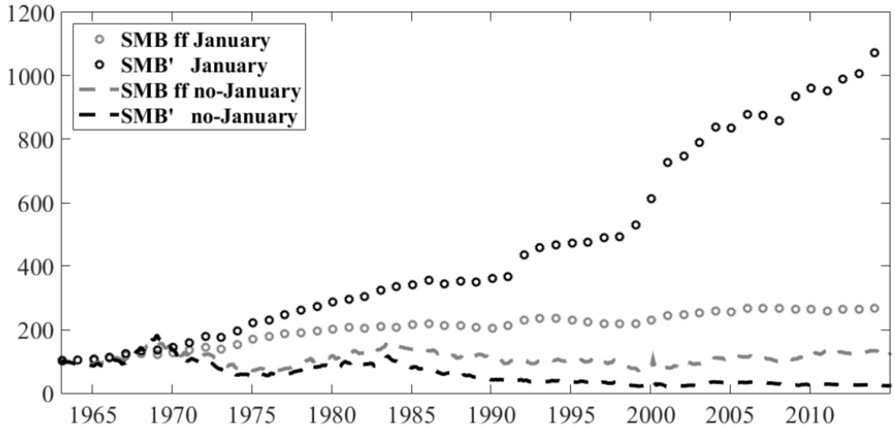
[4] The coefficient of variation is a measure used to gauge how stable a result is.

Figure 15: Value Calendar Effect



Source: "*Size and Value Matter, But Not the Way You Thought*" by M. Lambert, B. Fays and G. Hubner; Figure 4, reproduced with permission.

Figure 16: Size Calendar Effect



Source: "*Size and Value Matter, But Not the Way You Thought*" by M. Lambert, B. Fays and G. Hubner; Figure 5, reproduced with permission.

Regarding HML (Figure 15), a "turn-of-the-year" effect is only evident under FF (see the graph for "*HML ff January*") which is due to the value factor being contaminated by size effects; SS does not reveal this pattern. Furthermore, under SS, we notice the steady "through-the-year" value effect (see the graph for "*HML' no-January*").

Contrary to value, the size strategy exhibits more clearly a "turn-of-the-year" effect under SS (see the graph for "*SMB' January*"), which is what we would expect given the well-documented calendar anomaly for size.

In summary

To sum up, replacing the FF independent stock-ranking procedure with a sequential (i.e. independent) sorting methodology appears to better isolate factor effects, because it takes into account the pairwise correlations between factors.

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