Tailoring Multi-asset Multi-factor Strategies

Joo Hee Lee
Invesco

Harald Lohre
Invesco

Jay Raol
Invesco

Carsten Rother
Invesco

Factor investing cuts through the traditional way of organizing an investor's asset allocation. But not every investor can simply overhaul their investment process and go directly for the magic bullet solution – especially if an allocation to traditional asset classes is already in place. So, how do multi-asset factors work in such a context?

Recent years have seen rapid development in the ability to diversify through factors in an attempt to construct more efficient and better risk-managed portfolios. In the process, it is obviously necessary to identify the most salient drivers of assets' risk and return. Thus, we developed a diversified risk parity strategy that maximizes diversification benefits across asset classes and style factors.[1] The ensuing top-down allocation combines traditional market premia associated with equity, duration and credit risk as well as style factor premia associated with carry, value, momentum or quality style investments.

Striving for Maximum Diversification in a Multi-asset Multi-factor World

Style factor investing has a long history in both academic research and quantitative equity investing. Yet the general notion of style factors to explain the cross-section of asset returns also extends to other asset classes: e.g., the phenomenon that recent winners outperform recent losers applies not only to equities, but is also pervasive for commodity, rates and FX investments.

Clustering Styles Across Asset Classes

While adding such style factor strategies can serve to advance a given portfolio's diversification, the flip side is that the quality of portfolio optimization suffers from increasing the size of the variance-covariance matrix. Aggregate factor analyses are designed

to overcome these shortcomings, but it is a challenge to create and organize the factors in the multi-asset space. Adopting a pure style factor view, it seems straightforward that single factor strategies that follow the same style should be aggregated across asset classes, rather than aggregating different styles within asset classes. For instance, an aggregate momentum style factor would be based on equity momentum, commodity momentum, rates momentum as well as FX momentum. Aggregate carry, value and quality factors are built in the same vein.[2]

To investigate the merits of integrating these four top-down style factors into a traditional asset allocation, we likewise aggregate three market risk factors for traditional asset classes. Following the method used for our previous analysis, we consider equity, duration and credit risk factors. The equity and bond factors derive from aggregating global equity and bond index futures. The credit risk factor is based on US investment grade and high yield investments.

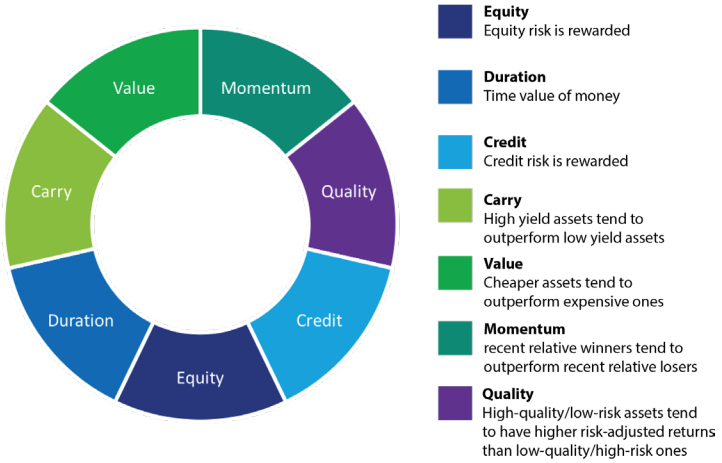


Exhibit 1: Diversified Risk Parity; Building Blocks and Stylized Risk Allocation
Source: Invesco, For Illustrative purposes only.

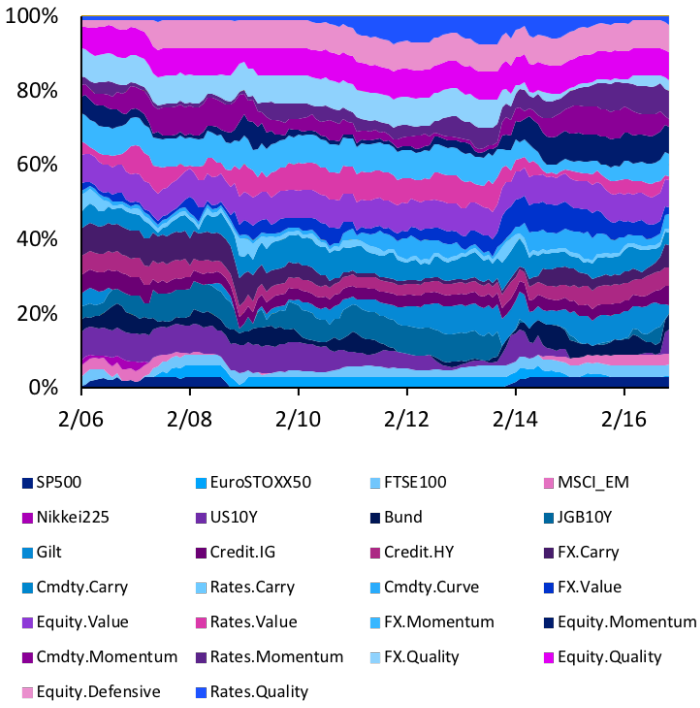
Diversified Risk Parity

A diversified portfolio allocation is best suited to ensuring balanced and effective harvesting of premia from market risk and style factors. Specifically, a diversified risk parity strategy (DRP strategy) maximizes portfolio diversification in a way that resonates with the intuition that 'a portfolio is well-diversified if it is not heavily exposed to individual shocks' (Meucci, 2009).[3] A DRP strategy incorporating these general building blocks would allocate equal risk budgets across asset classes and factors, as depicted in Exhibit 1, such that each aggregate asset class and style factor accounts for one-seventh of overall portfolio volatility.

Given this parsimonious structure, the DRP strategy can handle complex portfolios comprising many asset classes and factors without compromising the stability of the variance-covariance matrix.

Maximum Diversification in a Multi-asset Multi-factor World

To illustrate the strategy's characteristics, Exhibit 2 depicts weights and risk allocation for a DRP strategy subject to standard investment constraints, such as long-only and full investment constraints. Still, the corresponding risk allocation is fairly balanced across global asset class and style factors. On average, the risk profile corresponds to 6.44 effective bets[4] out of 7 (= 3 market + 4 style factors) that would constitute the unconstrained optimal solution.



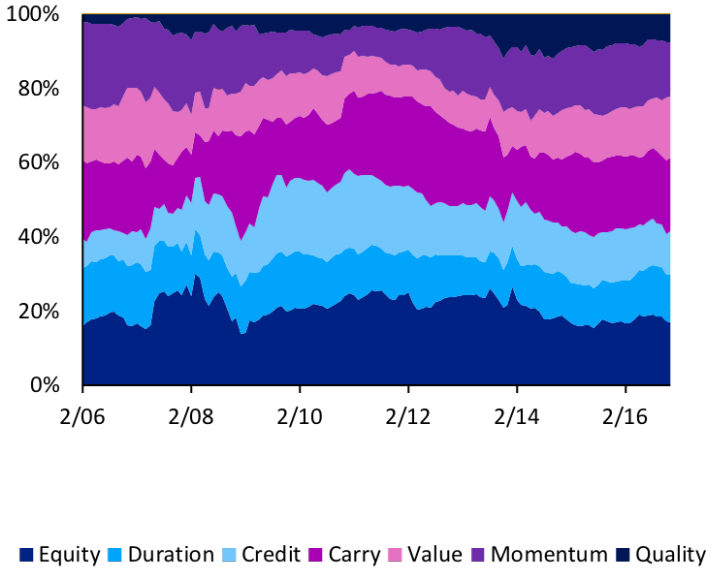


Exhibit 2: Diversified Risk Parity; Weights and Risk Allocation
Source: Bloomberg, Invesco, Goldman Sachs. Data period: January 31, 2006 to December 31, 2016

Thus, although DRP takes into account evolving market dynamics, its factor allocations will be far from over-fitting or over-reacting to markets. Below, we demonstrate how to integrate factor investing and the notion of DRP into the toolkit of a traditional asset allocator.

Monitoring and Managing Market and Style Factors

Despite the mounting evidence of style factors' relevance, the predominant allocation paradigm is centred around traditional asset classes. However, there will always be implicit factor tilts embedded in traditional asset allocations, even if style factors are not managed explicitly. Obviously, it would be more appealing to assume explicit control of these style factor tilts. Utilizing style factors in the risk and portfolio management of multi-asset solutions can be highly beneficial. At the very least, one can prevent unwanted exposure to factor risks that way. At best, one can optimize the overall risk profile along market and style factors to efficiently harvest the associated asset and factor premia.

Traditional Asset Allocation Through the Factor Investing Lens

To illustrate the relevance of style factors, we x-ray a traditional multi-asset allocation in terms of its global market and style factor exposures. In particular, we consider a client whose strategic asset allocation is one-third in global equities, one-third in global government bonds and one-third in corporate bonds.[5]

To flesh out the risk exposures of this allocation over time, we linearly map the returns R of the underlying 11 market assets and 15 style factors on the seven factors F:

$$R = B'F$$

where B is a 7 x 26 matrix containing the factor sensitivities. In turn, the variance-covariance-matrix Σ of returns R can be decomposed as:

$$\Sigma = B' \ \Sigma_F B + u$$

where Σ_F is the global factor variance-covariance-matrix and u captures the idiosyncratic variance.

Equipped with this linear risk model, we can decompose the systematic portfolio volatility of the above strategic asset allocation (see Exhibit 3). Notably, half of the portfolio's volatility is attributed to equity risk. Also, there is a strong exposure to pure credit risk, whereas duration risk adds only marginally to overall portfolio risk. Finally, there are notable implicit exposures towards the carry and quality style factors. On average, this risk profile corresponds to 3.61 effective bets over time. Thus, one is only partially exploiting the diversification spectrum available in the underlying multi-asset multi-factor universe. With 7 being the maximum number of effective bets, there is obviously room to further improve the risk allocation.

Tapping Factors for Multi-asset Multi-factor Management

In this section, we present alternative ways of embracing factor investing and the notion of diversified risk parity from the perspective of a traditional asset allocation.

Tail-hedging Using Style Factors

As a modest first step to allowing factor investing into the traditional asset allocator's toolkit, one might consider adding a style factor exposure in the pursuit of better risk management. In

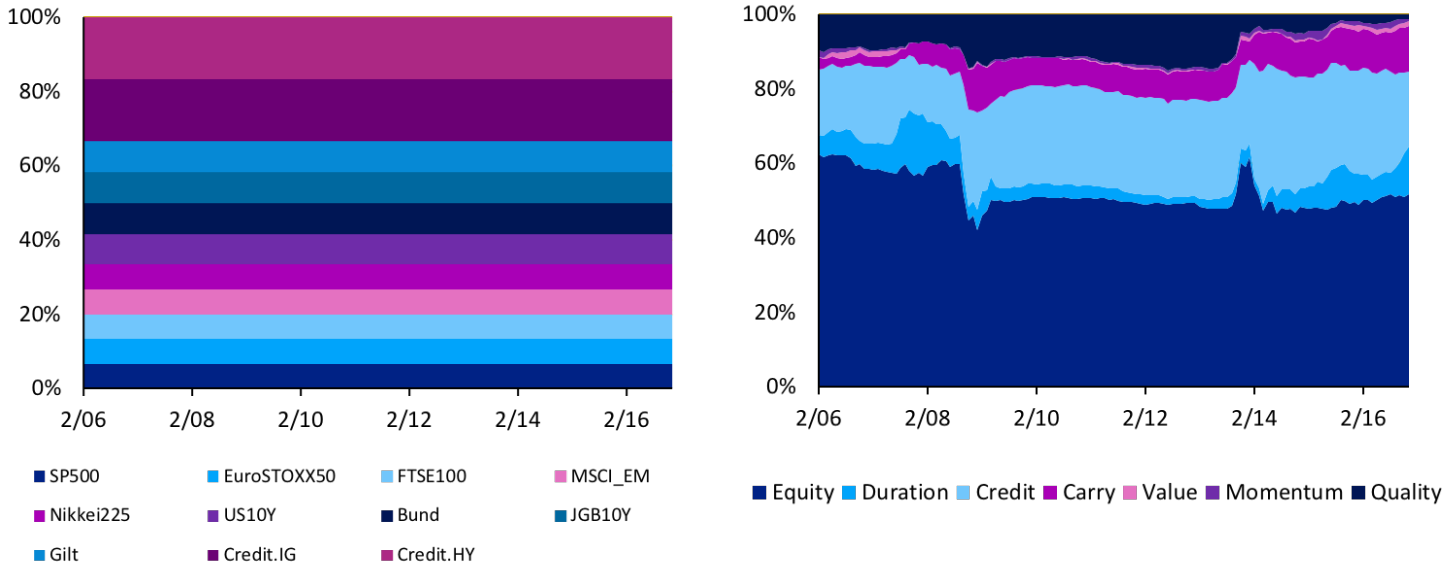


Exhibit 3: Traditional Asset Allocation Through the Factor Investing Lens
Source: Bloomberg, Invesco, Goldman Sachs. Data period: January 31, 2006 to December 31, 2016

this vein, we provide a portfolio optimizer with both traditional asset and factor returns. While we fix investments in traditional assets to equal the strategic asset allocation, we allocate style factor weights such that ex-ante portfolio risk is minimized. Thus, one could think of the additional factor allocation as a minimum-variance or tail hedge. From the first row in Exhibit 4, (on the next page) we learn that the quality factors in equity, rates and FX are particularly useful in hedging portfolio risk. In addition, equity and FX momentum help achieving the optimization objective.

Indeed, the corresponding strategy volatility (6.2%) is reduced relative to the benchmark volatility of the strategic asset allocation (7.1%), as set out in Exhibit 5. What's more, the devastating benchmark drawdown of 25.2% is reduced by more than 10 percentage points to -14.3% by including the tail hedge factor allocation. Obviously, this risk mitigation also increases risk-adjusted performance (as demonstrated by the Sharpe ratio of 1.30). However, in terms of diversification, the pick-up is rather modest: the average number of effective bets increases from 3.61 to 3.92. This marginal increase derives largely from the reduction in equity risk exposure vs. the pick-up in duration risk implied by the style factor allocation. While this observation makes sense from a pure tail-hedging perspective, we will investigate ways to achieve a more diversified risk allocation.

Factor Completion Based on Diversified Risk Parity

To more directly balance the overall portfolio's risk profile, we consider an alternative strategy that we label factor completion. Essentially, this strategy endeavours to integrate a factor portfolio that optimally completes the risk allocation of a given strategic benchmark asset allocation. To this end, we first extract implicit asset and factor return forecasts from the optimal diversified risk parity allocation. In an unconstrained portfolio optimization, these return forecasts would simply yield the DRP allocation. Given the benchmark allocation, we provide this diversified risk parity view to a mean-variance portfolio optimization in which the underlying strategic benchmark asset allocation is again fixed.

The second row of Exhibit 4 illustrates the corresponding weights and risk allocation. Now that we seek to balance risk and return based on the above view assumption, the overall allocation steps more strongly into a broad style factor completion portfolio. As a result, the risk allocation over time is considerably less concentrated in equity risk, yet there is a limit to equity risk reduction given the strategic benchmark allocation constraints. However, the diversification benefits of the factor completion solution are sizeable, as represented by 5.58 effective bets on average. These benefits arise from the fact that equity risk accounts for only a quarter of the risk budget, while the style factors carry, value and momentum play a more prominent role given their larger nominal weights (or leverage). While the strategy's volatility is on par with that of the benchmark strategy, we have succeeded in reducing the maximum drawdown relative to the tail hedge portfolio by a further 3 percentage points.

Pure Diversified Risk Parity

To effectively maximize portfolio diversification, we need to lift the investment constraints that have fixed the strategic benchmark allocation in the preceding examples. To still live up to the client's risk profile, we additionally need to lever the diversified risk parity allocation. As a result, the risk allocation exhibits reduced equity risk exposure at a total number of bets of 6.46 (see final row of Exhibit 4 and Exhibit 5, below). Note that this pure DRP approach would more than double the annualized return of the benchmark strategy. Given a single-digit drawdown of -8.6%, the pure DRP portfolio posts a highly attractive return to drawdown ratio of 1.39.

The presented framework naturally lends itself to exploiting tactical asset allocation signals while still embracing the merits of diversified risk parity. A future article will investigate the inclusion of trend signals, which allow investors to meaningfully operationalize the common trend style permeating many asset classes.

Conclusion

Style factors are salient drivers of returns for several asset classes. Traditional asset allocations tend to be minimally balanced across style factors and would benefit from explicit management of both asset and factor exposures. Based on a meaningful set of market and style factors, we have illustrated a reasonable allocation mechanism centred around a diversified risk parity view. The ultimate outcome of a diversified risk parity strategy is a highly sophisticated portfolio solution that benefits from better building blocks as well as technical advancements in portfolio construction. This article highlights the strengths and flexibility of this novel technique in creating multi-asset multi-factor portfolios that can serve various clients' needs.

Performance Statistics	Benchmark	Tail Hedge	Factor Completion	Pure DRP
Return p.a.	4.9%	9.3%	12.9%	12.0%
Volatility p.a.	7.1%	6.2%	7.3%	7.1%
Sharpe ratio	0.56	1.30	1.57	1.49
Maximum drawdown	-25.2%	-14.3%	-11.4%	-8.6%
Calmar ratio	0.19	0.65	1.13	1.39
Number of bets	3.61	3.92	5.58	6.46
Turnover	0.0%	8.6%	19.8%	28.3%

Exhibit 5: From Traditional Multi-Asset to Multi-Asset Multi-Factor Management
Source: Bloomberg, Invesco, Goldman Sachs. Data period: January 31, 2006 to December 31, 2016

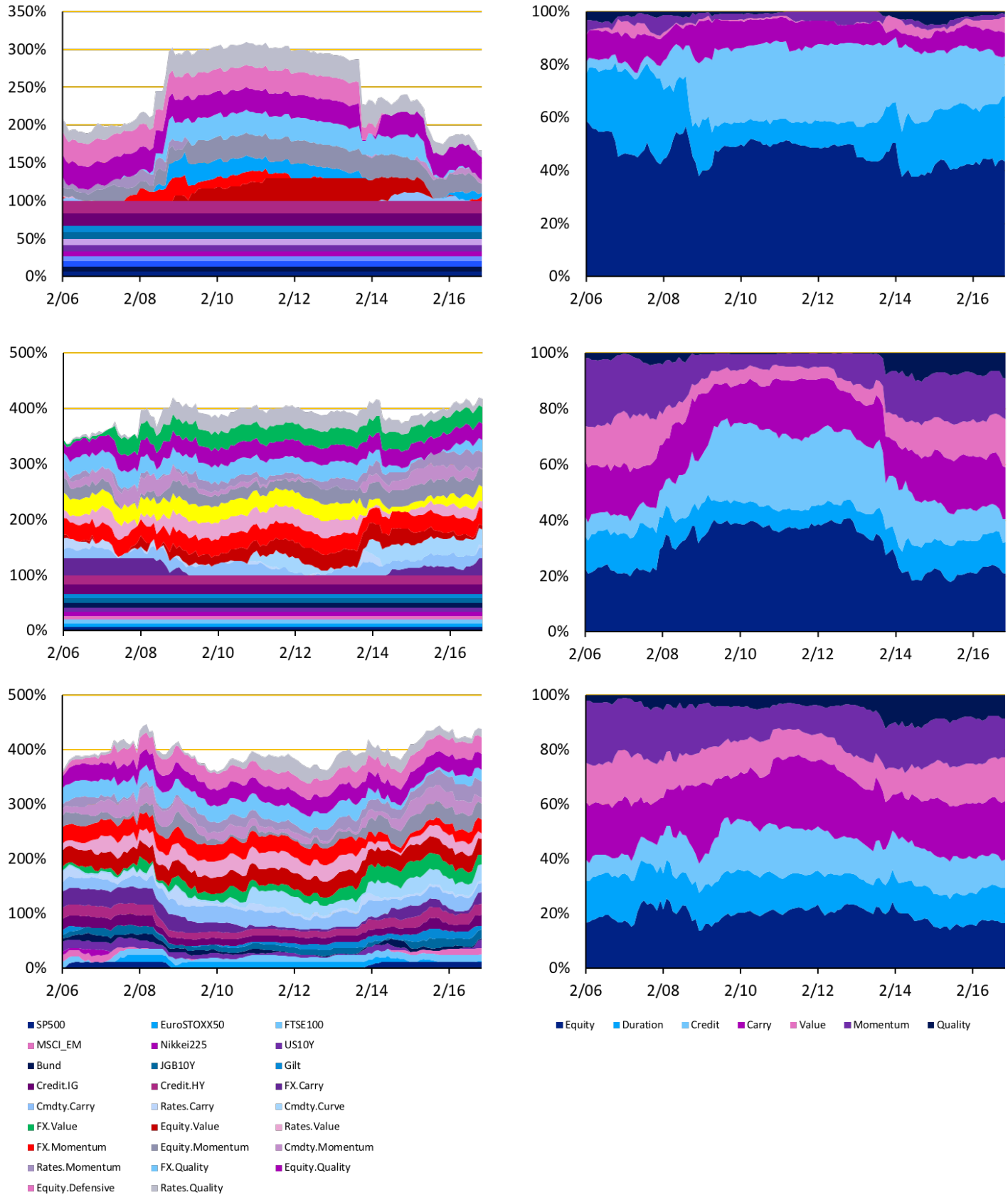


Exhibit 4: Multi-Asset Multi-Factor Strategies; weights and Risk Allocation
Source: Bloomberg, Invesco, Goldman Sachs. Data period: January 31, 2006 to December 31, 2016

Endnotes

This article was previously published in *Risk & Reward's* 1st issue of 2018.

1. See"Investing in a multi-asset multi-factor world," *Risk & Reward*, #3/2017.
2. To obtain risk-balanced aggregate asset class and factor returns, the aggregate factor return time series derive from a risk parity weighting of the underlying constituents. The set of constituents is the same as the one in *Risk & Reward* #3/2017, op. cit. Return calculations are from the perspective of a US-dollar investor; all returns are either in local currency or USD-hedged.
3. To this end, the set of three asset classes and four style factors are first translated into uncorrelated risk sources. Running a risk parity strategy along these uncorrelated risk sources then provides maximum diversification, cf. Lohre, Opfer and Orszag (2014), Bernardi, Leippold and Lohre (2018) and our previous analysis in *Risk & Reward* #3/2017.
4. The effective number of bets relates to the number of uncorrelated risk sources represented by a given allocation through time. Mathematically, it is computed as cf. Meucci (2009). For a completely concentrated portfolio, it holds that NEnt = 1, whereas for a fully diversified portfolio NEnt = 7.
5. Within asset class buckets, we assume a simple equal-weighted allocation scheme across the constituent single assets.

References

Bernardi, S., M. Leippold and H. Lohre (2018): "Maximum Diversification Along Commodity Risk Factors", *European Financial Management*, 24, 53-78.

Deguest, R., A. Meucci and A. Santangelo (2015): :"Risk Budgeting and Diversification Based on Optimized Uncorrelated Factors," *Risk,* 11, issue 29, 70–75.

Lohre, H., H. Opfer and G. Orszag (2014): "Diversifying Risk Parity," *Journal of Risk*, 16, 53-79.

Meucci, A. (2009): "Managing Diversification," *Risk*, 22, 74–79.

Authors' Bio

Joo Hee Lee, PhD, CFA, CQF
Invesco Quantitative Strategies

Joo Hee Lee, Senior Portfolio Manager, is involved in the development of client solutions and the management of quantitative multi-asset multi-factor strategies.

Herald Lohre, PhD
Invesco, Quantitative Strategies

Harald Lohre, Senior Research Analyst develops quantitative models to forecast risk and return used in the management of multi-asset strategies.

Jay Raol, PhD
Invesco, Fixed Income

Jay Raol, Senior macro Analyst, is a member of the macro research team at Invesco Fixed Income. He works on macro-economic based models for asset allocation and fixed income investing.

Carsten Rother
Invesco, Quantitative Strategies

Carsten Rother develops quantitative multi-factor models in equities and across asset classes.