



# #04

4th issue 2018

**Implementing a  
multi-factor  
commodity strategy:  
a practitioner's  
approach**

Tail risk management for multi-asset  
multi-factor strategies

ESG integration for equities: evolving  
our systematic investment process

ESG integration for fixed income: sound  
stewardship and social responsibility

What do corporate managers' words  
reveal about their firms' value?

# Risk & Reward

Research and investment strategies



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Full audience information is available inside the front cover.

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Invesco is one of the world's leading specialists in factor investing, and has been using factor approaches to meet client needs for more than 30 years - long before they became mainstream. For us, factor investing is indeed more than a fashion, so it will come as no surprise that our feature article and the interview once again deal with this popular investing approach.

In this edition, my colleagues show that the factor approach is by no means confined to equities. In their latest research, they apply it to commodities, where their profound knowledge of equity factors provided a number of synergies. Doubtless, however, commodity factors are different and specialized, so being a multi-asset class manager like Invesco certainly has its advantages.

In another article on factors, we also looked at tail risk management through the factor lens. Their results are as simple as they are compelling: diversification helps to mitigate tail risks, even in the factor space.

As important as it is, factor investing is only part of the comprehensive range of capabilities we offer to help meet client needs. Another major topic in today's markets is ESG integration, i.e. mainstreaming of ecological, social and governance considerations in investment processes. We demonstrate how two of our investment teams operationalize this concept: first, we report on ESG integration in our systematic processes, then about ESG integration in Fixed Income. While the details of the approaches differ, they share a common philosophy. This is one of the key strengths of our multi-product multi-style approach: individual concepts based on shared values.

Finally, let me draw your attention to a special highlight in this issue: three colleagues have investigated the predictive power of managers' talk in financial results conference calls. They derive hard indicators from seemingly soft rhetoric - and show how useful manager-tone can be when forecasting an individual stock's return.

We hope you enjoy this latest issue of Risk & Reward.

Best regards,

A handwritten signature in blue ink that reads "Marty L. Flanagan".

**Marty Flanagan**  
President and CEO of Invesco Ltd.

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# Implementing a multi-factor commodity strategy: a practitioner's approach

By Scott Hixon, Hua Tao, PhD, and Scott Wolle



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## In brief

In this paper we propose a commodity strategy that incorporates cross-sectional factors grounded in the rich research available on commodity futures pricing. Over the period studied, the strategy exhibited an attractive return profile with no significant correlation to general commodity markets. To the best of our knowledge, the methodology employed differs from existing commodity factor research in two ways: First, rather than simply applying equity factor definitions to commodity markets, we have incorporated the unique characteristics of commodity markets into factor construction. Second, the final portfolio is constructed using a risk parity framework along with several implementation considerations. Liquidity, leverage and turnover, which are largely overlooked in most factor research literature, are important implementation constraints.

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**Factor investing has become mainstream, but most approaches still focus on equities. We have developed a factor-based commodity strategy which takes note of the particular features of this asset class. Read on to learn more about the motivations, potential issues and implementation considerations from a practitioner's perspective.**

Since 1992, when Fama and French proposed size and value as powerful descriptors of cross-sectional equity returns, factor investing research has generated increasing interest among both academics and practitioners. Over the past twenty-five years, there have been so many anomaly papers published that it is almost impossible for anyone to keep up with the entire scope of this research. Harvey, Liu and Zhu (2013) identify 316 different factors in 313 articles, representing just a sample of the universe of papers.<sup>1</sup> Whether described as smart beta, factor investing or enhanced indexing, these strategies are all derived from the same idea: go long (overweight) assets with high values in a particular metric and short (underweight) assets with low values in the same metric. However, most of these studies and strategies have one thing in common - they refer to equities.

Commodities have a much shorter history as a mainstream asset class. Institutional investors had invested only USD 18 billion in commodities in 2003 according to a Barclays Capital survey.<sup>2</sup> But due to the growth in multi-asset strategies and the inflation hedging property of commodities, institutional investors have become increasingly interested in the asset class. Therefore, we believe that the time has come to look at commodities from a factor perspective.

#### Four commodity factors

To start with, commodity factors should satisfy the same three properties as equity (or indeed currency or bond) factors: first, their definitions should be

intuitive and driven by a fundamental understanding of commodity markets instead of empirical results, in order to minimize the risk of mere data mining. Second, they should offer positive returns over time,<sup>3</sup> though achieving the highest in-sample return is never the goal. Third, factors used in a multi-factor commodity strategy should be differentiated in terms of their information content. In other words, there should be no strong positive correlations among them.

With these properties in mind, we constructed three cross-sectional factors - momentum, value and carry - using 20 commodity futures. We also constructed a fourth factor, which we identify as defensive, with a somewhat different structure described later in this study. We will now discuss these four factors one by one.

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**We construct three cross-sectional factors - momentum, value and carry - and a fourth factor, which we identify as defensive, with a somewhat different structure.**

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#### Momentum

Momentum was first proposed as a factor by Jegadeesh and Titman in their seminal 1993 paper. It is based on the assumption of price continuation, i.e. stocks with the highest intermediate-term returns (winners) will outperform stocks with the worst past

#### Our commodity futures universe

Our commodity futures universe is similar to that of the S&P GSCI Commodity Index, with some modifications due to liquidity considerations:

Agriculture	Energy	Industrial metals	Precious metals
<ul style="list-style-type: none"> <li>- Cocoa</li> <li>- Coffee</li> <li>- Corn</li> <li>- <del>Cotton</del></li> <li>- <del>Feeder Cattle</del></li> <li>- <del>Lean Hogs</del></li> <li>- <del>Live Cattle</del></li> <li>- Soybeans</li> <li>- Soybean Oil</li> <li>- Soy Meal</li> <li>- <del>Sugar</del></li> <li>- Wheat</li> <li>- Wheat (KC)</li> </ul>	<ul style="list-style-type: none"> <li>- Brent Crude</li> <li>- Gas Oil</li> <li>- Gasoline</li> <li>- Heating Oil</li> <li>- Natural Gas</li> <li>- WTI Crude</li> </ul>	<ul style="list-style-type: none"> <li>- Aluminum</li> <li>- Copper</li> <li>- <del>Lead</del></li> <li>- Nickel</li> <li>- Zinc</li> </ul>	<ul style="list-style-type: none"> <li>- Gold</li> <li>- Silver</li> </ul>

Legend: ~~Included in GSCI, not in strategy~~  
**Not included in GSCI, included in strategy**

We exclude six of 24 commodities (lead, sugar, cotton, lean hogs, live cattle and feeder cattle) in the index and include two additional commodities (soybean oil and soy meal). The resulting universe of 20 commodities includes six energy commodities (crude oil, Brent crude oil, heating oil, gasoil, natural gas and gasoline), two precious metals (gold and silver), four industrial metals (copper, aluminum, zinc and nickel) and eight agricultural commodities (cocoa, coffee, corn, wheat, wheat (KC), soybeans, soybean oil and soymeal).

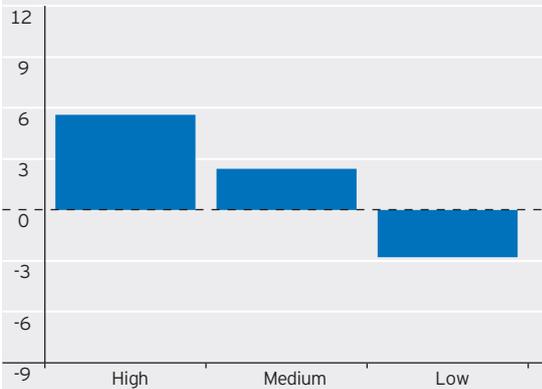
Source: Invesco, as at 30 June 2018.

Figure 1

### The momentum factor

- The tendency for assets that have risen in value to continue to rise
- Adjust for differences in asset volatilities
- Representative academic research: "Momentum Strategies in Commodity Futures Markets"

Simulated annualized excess return by factor rank, in %  
(30 June 1998 - 30 June 2018)



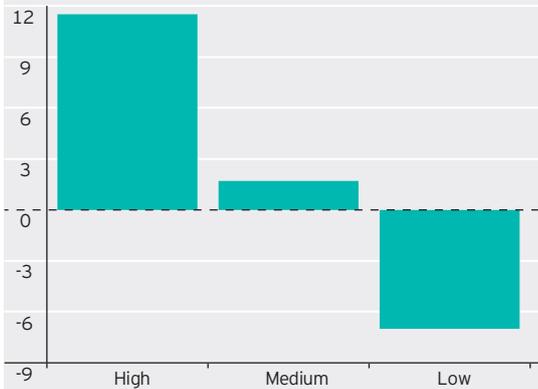
Sources: Bloomberg, Datastream, Invesco analysis. Joëlle Miffre, and Georgios Rallis, "Momentum Strategies in Commodity Futures Markets", (5 August 2006). Journal of Banking and Finance, Vol. 31, No. 9, 2007. Available at SSRN: <https://ssrn.com/abstract=702281> or <http://dx.doi.org/10.2139/ssrn.702281>. Returns based on changes in prices for future contracts which are by nature excess returns above cash. **Figures refer to simulated past performance and past performance is not a reliable indicator of future performance.**

Figure 2

### The carry factor

- The tendency for assets that have high implied roll yields to produce higher total returns than other assets
- Representative academic research: "The Strategic and Tactical Value of Commodity Futures"

Simulated annualized excess return by factor rank, in %  
(30 June 1998 - 30 June 2018)



Sources: Bloomberg, Datastream, Invesco analysis. Claude B. Erb and Campbell R. Harvey, 2005. "The Strategic and Tactical Value of Commodity Futures", NBER Working Papers 11222, National Bureau of Economic Research, Inc. Returns based on changes in prices for future contracts which are by nature excess returns above cash. **Figures refer to simulated past performance and past performance is not a reliable indicator of future performance.**

performance (losers) for up to 12 months. Much later, momentum strategies were applied to commodity futures markets, e.g. by Pirrong (2005), Erb and Harvey (2006) and Miffre and Rallis (2007), and similar positive returns were observed.

Rather than raw one-year returns, a common measure in the literature, we define momentum in terms of risk-adjusted returns.<sup>4</sup> Volatility can vary widely across commodities and focusing on risk-adjusted returns will prevent simply selecting assets with extreme volatilities. Figure 1 shows summary results for commodity momentum.

We construct the momentum factor portfolio by ranking the 20 commodities by their risk-adjusted momentum signals, going long the top 40% and short the bottom 40%. These thresholds were chosen to balance the desire to have some buffer between long and short assets and to avoid concentrating risk in a small number of positions; however, a range of definitions produces similar results. We apply the same ranking process to the carry and value factors.

### Carry

A significant body of research supports the notion that the futures price curve, also called the term structure, contains information about the market and its related economic fundamentals.<sup>5</sup> All things equal, one should expect an upward-sloping term structure since the futures curve needs to embed the costs of holding the asset (e.g. financing and storage costs). However, the curve will shift to a downward-sloping profile when market participants ascribe greater value to immediate delivery. This is generally referred to as the convenience yield.

For many assets, carry and momentum are negatively or, at best, weakly correlated. For example, a bond with weak momentum will likely have improved carry. Commodities are different, as the same basic phenomena drive both momentum and carry. For example, when demand for a commodity outstrips supply, we should expect the price of a commodity to rise. At the same time, the term structure will almost certainly respond with positive carry (also described as backwardation). Our research shows a 0.38 correlation between carry and momentum over the past twenty years.<sup>6</sup> Figure 2 depicts historical results for carry.

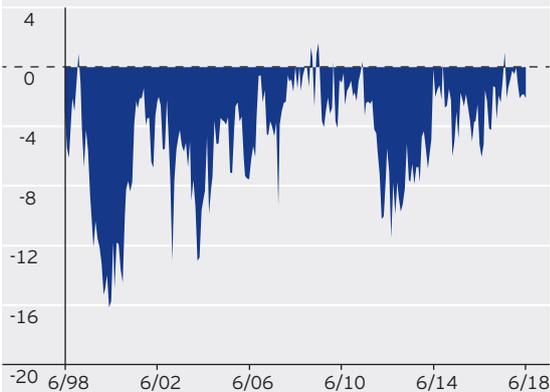
### Value

Value is often viewed as the natural complement to momentum, given its contrarian nature. For equities, Conrad and Kaul (1998) concluded that contrarian strategies tend to perform well over long horizons, while momentum strategies perform better over short-to-intermediate horizons. In recent years, a number of researchers have explored applying both momentum and value (reversal) metrics in the asset selection process. We construct the momentum and value factors separately in order to benefit more fully from the available diversification among factors.

Asness, Moskowitz and Pedersen (2013) proposed a quite reasonable definition of value for commodities: the five-year change in spot returns.<sup>7</sup> Such a definition possesses the virtues of simplicity, negative correlation to momentum and at least some degree of efficacy. The challenge is that it also has a material negative exposure to carry. Fundamentally, this makes sense. Asset prices generally fall due to a surplus of supply over demand, a situation generally accompanied by sizable negative carry (also known as contango).

Figure 3  
**"Simple value" has substantial negative carry**

Annualized carry loadings of a simple value strategy based only on the five-year change in the spot price, in %



Sources: Bloomberg, Datastream, Invesco analysis. Data as at 30 June 2018.

This means that, for commodities unlike most other assets, value and carry will tend to have a negative correlation.

While a negative correlation between factors is certainly attractive, negative loadings on a factor with positive expected returns is not (figure 3). Therefore, we augment our definition by neutralizing the negative loadings on carry using negative carry for an asset as an additional hurdle to its classification as an undervalued asset. For example, an asset with -10% annualized carry must have fallen more significantly over the past five years to be considered inexpensive than one without negative carry. The resulting definition has a near-zero correlation with both momentum and carry while providing a far more compelling return profile, as shown in figure 4.

**Defensive**

Defensive strategies cover a range of approaches, including quality (Asness, Frazzini and Pedersen [2013]) and low volatility (Haugen and Heins [1975]). Although some research has explored a cross-sectional low volatility strategy in commodities (Lin [2017]), we chose to define our defensive strategy based on contract selection for the same asset. Instead of buying front month contracts, we buy contracts with a more distant expiration (deferred). Deferred contracts typically have lower volatility than front month contracts (for example, the third available WTI crude oil contract has about 90% of the volatility of the front month). This approach is consistent with Szymanowska, De Roon, Nijman and Van Den Goorbergh (2014), who found that buying contracts with distant maturities instead of front month contracts improved the Sharpe ratio from 0.48 to as high as 1.06. Figure 5 shows the results for the defensive factor.

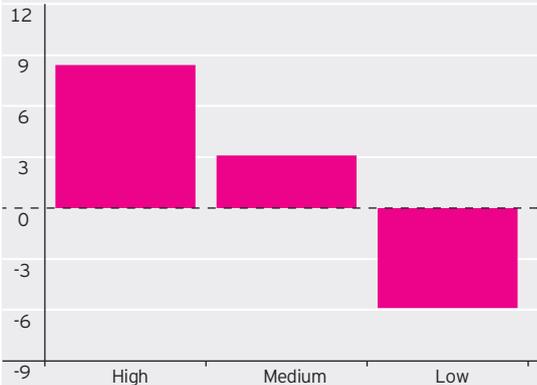
**From commodity factors to a factor portfolio**

For each of the three cross-sectional factors, we apply a risk parity framework to create a factor strategy. Both the long and short side of each factor strategy are weighted according to each asset's volatility and correlation characteristics. In this case, more volatile,

Figure 4  
**The value factor**

- Assets that have fallen in value over an extended period of time will tend to outperform other assets
- Adjust for bias to have negative carry
- Representative research: "Combining Momentum with Reversal in Commodity Futures"

Simulated annualized excess return by factor rank, in % (30 June 1998 - 30 June 2018)



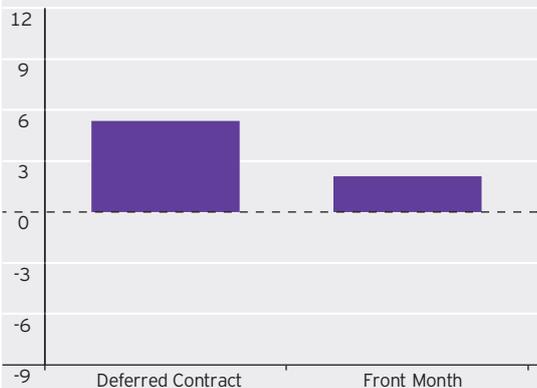
Sources: Bloomberg, Datastream, Invesco analysis. R. Bianchi, M. Drew and J. Fan (2015). "Combining momentum with reversal in commodity futures". Journal of Banking & Finance, 59, 423-444. Returns based on changes in prices for future contracts which are by nature excess returns above cash. **Figures refer to simulated past performance and past performance is not a reliable indicator of future performance.**

highly correlated assets will tend to receive smaller weights than less volatile uncorrelated assets. In our experience, a risk parity approach helps to improve portfolio diversification versus a simple 1/N allocation approach, particularly when there are wide variations in the characteristics of the asset universe. In addition to the allocation framework, we have also included a risk target (10%) for both the long and short side of each factor strategy.

Figure 5  
**The defensive factor**

The tendency for lower volatility assets - in the case of commodities, deferred contracts - to outperform higher volatility ones

Simulated annualized return by factor rank, in % (30 June 1998 - 30 June 2018)



Sources: Bloomberg, Datastream, Invesco analysis. **Figures refer to simulated past performance and past performance is not a reliable indicator of future performance.**

For the defensive factor, trading two futures contracts in the same asset tends to lead to a strategy with relatively low volatility. In order to maintain low leverage, we have chosen to implement the strategy only on the assets where we have a long position based on the three preceding factors rather than as a fully independent factor. Despite this more limited exposure to the factor, the annualized return of the multi-factor portfolio improved by approximately 2% without increasing portfolio risk.

### Factor construction

The goal of factor construction is to isolate the performance of the factor in question, thus minimizing idiosyncratic risk exposures. In a relatively small investment universe such as we have with commodities, standard approaches to portfolio construction can result in risk concentration, especially when some of the assets possess vastly different volatilities than the average. For example, a highly volatile asset like natural gas can have an outsized impact on results under an equally weighted approach. Likewise, a weighting scheme based on ordinal rank presents difficulties due to both the small number of assets and the wide range of volatilities.

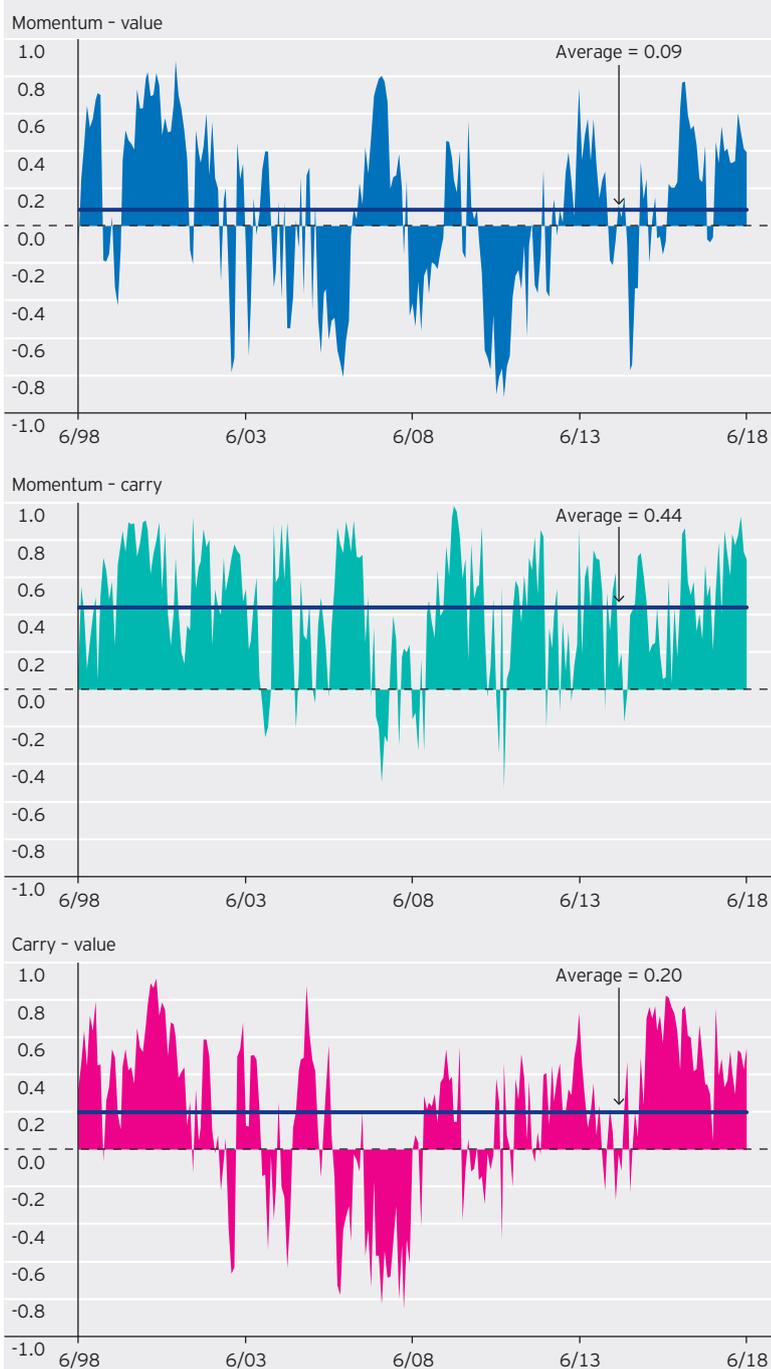
As a result, we use a risk parity framework for long/short factor construction. The process has two steps: First, we calculate the long-side asset weights, such that each individual asset has the same marginal risk contribution to the long-side portfolio. We apply the same process to create the short-side portfolio. Second, we scale the long and short sides so that each has the same marginal risk contribution to the factor portfolio.

A key input to this risk parity framework is the asset covariance matrix, which determines both the correlation structure of commodity assets and the risk estimation of individual assets. Investors need to balance two considerations when deciding how to construct the covariance matrix. A shorter-term matrix will tend to have greater accuracy on average but will tend to be wrong at inconvenient times. A longer-term matrix will have the opposite properties along with lower turnover unrelated to changes in the factors. We have a bias toward the latter in order to incorporate the full-cycle behaviour of the assets and therefore apply a matrix with a seven-year half life.

### Portfolio allocation on factors

The next phase focuses on constructing a multi-factor portfolio using three cross-sectional factors: momentum, value and carry. We again apply a risk parity approach to achieve this goal. We could have chosen to do so based on historic returns of each factor or the current holdings of each factor. Many people naturally gravitate to the former. Despite the appeal of its simple and straightforward nature, it has a material flaw: factor portfolios are dynamic. For example, the momentum and value factors may typically have a negative correlation but in a particular month may have similar holdings and thus be highly correlated. This results in at least two challenges: (1) value and momentum contribute more than the targeted level of risk relative to carry in this example and (2) the overall portfolio risk rises above the target due to the reduced diversification benefit.

Figure 6  
**Holding-based factor correlations**  
Ex-ante factor correlations



Sources: Bloomberg, Datastream, Invesco analysis. Data as at 30 June 2018.

To alleviate these challenges, we look through each factor to the underlying holdings and weigh the factors in a way that results in an equal risk contribution from each. This means changing the factor weights each month based on changes in their holdings. As shown in figure 6, the fact that factor correlations can change from quite high (2018) to very low (late 2010 - early 2011) means that this approach is the only realistic means of maintaining a consistent strategy risk target and factor risk contribution.

Occasionally, all three factors may buy or sell the same assets at the same time, which means the multi-factor portfolio may have very large exposure to individual assets. Even though the multi-factor portfolio has equal risk contributions from underlying factors, we may find a concentration of risk in a few assets. We address this issue by limiting the exposure to any single asset to a maximum of 20% of the portfolio's net asset value.

By combining three diversified factors, the multi-factor portfolio can offer much better performance than any of the factors individually. The return profile is also very attractive due to low correlation to traditional commodity, equity and bond returns.

### Simulated results

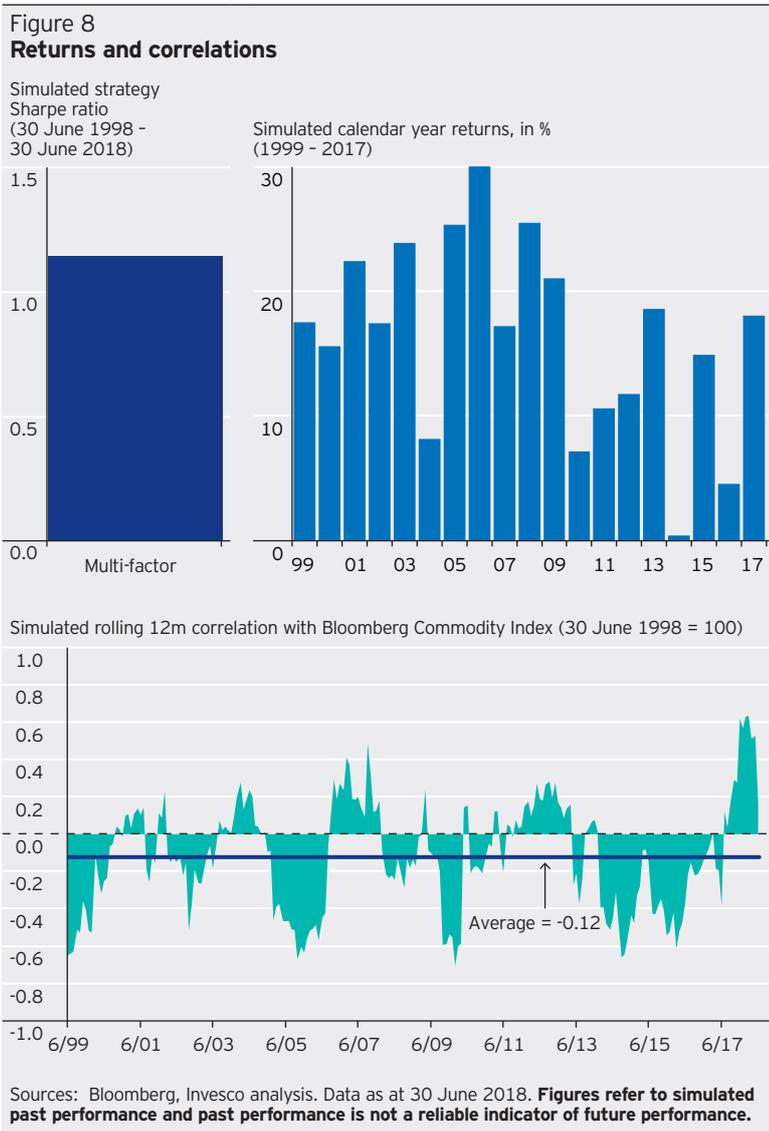
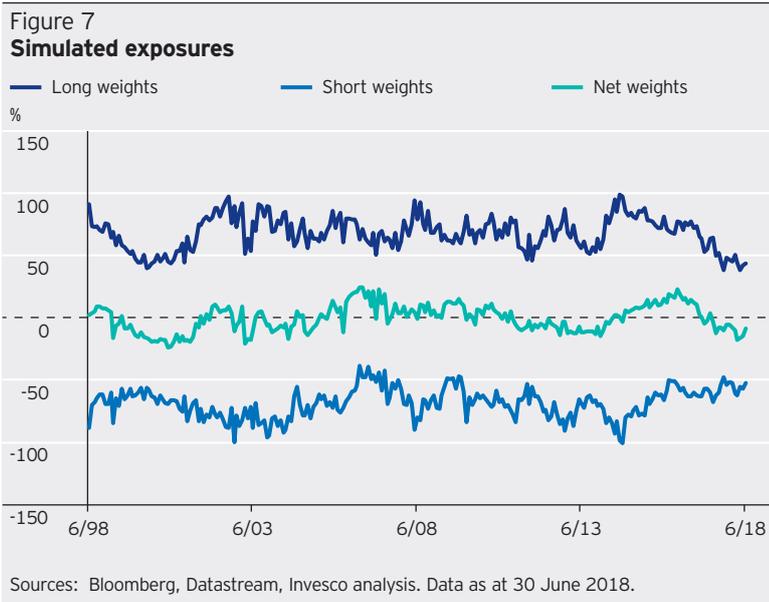
Backtested results always merit a skeptical eye. This is all the more true when the strategy exhibits high turnover. As described so far, the process would require more than 30% monthly turnover, which could limit strategy capacity, incur unnecessarily high transaction costs and generally reduce the reliability of the backtests.

Of course, some turnover is simply noise. Changes of one or two percent in commodity weights in any given month may have very limited influence on results but still have a large cumulative effect on turnover and costs. Accordingly, we explored how limiting trades to only the most meaningful ones would impact performance. The answer - consistent with our experience in other strategies - is that limiting trades does not have a meaningful impact on performance, even on a pre-transaction cost basis. We therefore apply a turnover threshold to the strategy.

Investors understandably care about leverage as well. In this sense, commodities fit well within a factor strategy. Their high volatility and relatively limited correlations mean that little or no leverage is required to implement a strategy at 10% volatility. As highlighted in figure 7, the gross exposure (long positions plus short positions) seldom breaches 200% and is often closer to 100% (though with much less volatility than a long-only investment).

## The historical performance of the strategy lends strong support for factor investing in commodities.

The historical performance of the strategy, even after imposing the constraints described above, lends strong support for factor investing in commodities. As shown below, the high Sharpe ratio for the full period studied is driven by consistent returns by calendar year (top right panel in figure 8). In addition, the strategy has a slightly negative correlation to the Bloomberg Commodity Index over the full period, though this is punctuated by episodes of moderately high and low correlations, peaking at an absolute value of just above 0.5. In all, the performance fits well with our initial objectives.



## Conclusion

Factor investing research to date has generally focused on equities. However, commodities are a natural next frontier given the deep roots of research into pricing anomalies. Based on the results of this research, factor investing in commodities appears to offer the potential to extend the asset class from a reliable inflation hedge to a consistent return generator, irrespective of the economic environment. As we have found in virtually all of our research, the inputs - underlying factors in this case - are important but require a sound portfolio construction process to achieve the desired results: in this case, attractive prospective returns and low expected correlation to traditional financial markets.

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## Notes

- 1 One manifestation of the interest in factor investing can be found in the growth of so-called "smart beta" funds, which, have surpassed USD 1 trillion in assets as of the end of 2017 (Thompson, Jennifer. "Smart beta funds pass \$1tn in assets." Financial Times, 27 December 2017. Web. 5 November 2018.).
- 2 However, research supporting the theories that underpin commodity futures pricing started much earlier, e.g. the theory of storage of Kaldor (1939) and Working (1949) and the hedging pressure hypothesis of Keynes (1930) and Hirshleifer (1989).
- 3 The rationale for a return premium generally falls into one of three categories: behavioural anomaly, compensation for a specific risk or market structure-related.
- 4 We construct all factors in this study with a simple prior and then test the parameter for robustness. In the case of momentum, the definition is twelve-month return relative to twelve-month volatility. A range of different parameter settings yields similar results.
- 5 Fama and French (1987), Swanson and White (1995) and McCallum and Wu (2005).
- 6 For the purposes of this paper, we define carry as the difference in price between the contract that is closest to expiration and the next available contract. Alternative definitions provide similar results.
- 7 Unlike stocks and bonds, commodities have no series of future cash flows to be discounted and used for valuation. Accordingly, a simpler definition based on the change in real spot prices is reasonable.

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## About risk

The value of investments and any income will fluctuate (this may partly be the result of exchange rate fluctuations) and investors may not get back the full amount invested. Investments in instruments providing exposure to commodities are generally considered to be high risk and these may result in large fluctuations in value.

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# “A practitioner’s approach should combine rigor with pragmatism”

Interview with Scott Hixon, Hua Tao, PhD, and Scott Wolle



**Scott Hixon**, Portfolio Manager and Head of Research, Invesco Global Asset Allocation



**Hua Tao, PhD**, Research Analyst, Invesco Global Asset Allocation



**Scott Wolle**, Chief Investment Officer, Global Asset Allocation, Portfolio Manager, Invesco Global Asset Allocation

**Risk & Reward spoke to Invesco’s Scott Hixon, Hua Tao and Scott Wolle, authors of the commodity factor study in this issue, about their experiences when adapting the factor approach to commodities.**

## **Risk & Reward**

*Why have the world of commodities and the world of factors remained comparatively distant from one another?*

## **Scott Wolle**

The idea of using factors in commodities investing isn’t entirely novel. There are studies going back to the early 20th century that try to explain how commodities are priced. But I think part of the reason they haven’t come to the fore is that the commodities universe is comparatively small in terms of assets and managers. This makes it much less of a mainstream way to generate returns than would be true for a larger asset class.

Commodities are often thought of as an inflation hedge. We effectively set that property aside in our study. Instead, we focused on sources of commodity return that are unrelated to the inflation environment and to indices like the Bloomberg Commodity Index.

## **Risk & Reward**

*The framework you propose uses just four factors – momentum, carry, value and defensive. You also mention in your study that it has become almost impossible to keep pace with the number of reported anomalies and the factors that they supposedly indicate. How important is it to identify and use “real” factors?*

## **Hua Tao**

It’s crucial to start with a theory for the properties that should be rewarded and to have reasonable priors for those definitions. Otherwise, it’s just a data mining exercise. Since we’ve managed commodity strategies for many years, we had a strong sense for what would explain relative returns.

## **Scott Wolle**

When people talk about the explosion of factors, it’s really more related to the equity universe. Think of the 300 factors in the Harvey, Liu and Zhu paper we cited in our study. I don’t think I’ve ever read a commodity paper that looks at more than ten factors. Anyway, there’s less data available to describe commodities than for stocks – e.g. no balance sheets and income statements. Since we’re working primarily with prices, there are simply fewer possibilities.

## **Risk & Reward**

*In a similar context, you stress that simply taking factors that have been applied to equities and trying to apply them to commodities isn’t acceptable. Can you elaborate?*

## **Scott Wolle**

The returns from factors are generally viewed as coming from one of three sources: behavioural biases, reward for accepting some sort of risk, or market structure. While there may be some behavioural explanations that are common to both stocks and commodities, the participants and types of potential risks in each market can be quite different. It seems reasonable to apply a similar conceptual framework, but not to simply extend equity factor definitions to commodities. Applying our knowledge of commodity markets to factor definitions was crucial.

## **Risk & Reward**

*Another interesting feature of your framework is that your factor definitions are intuitive and driven by fundamental understanding rather than empirical results. Could you explain the thinking behind this approach and why minimizing the risk of data mining was one of your key objectives?*

## **Scott Wolle**

This is the way we approach investing in general, but especially with a limited universe like commodities. It’s very easy to find yourself in a position where you data-mine yourself into a very attractive return profile on paper without any kind of intuitive understanding.

For example, the annualized return for natural gas over the past 15 years is something like -30%.<sup>1</sup> So, any factor you can come up with that would have been perpetually short natural gas is going to look like a huge winner. The question is whether natural gas is going to have a -30% annualized return for the next 15 years – and I suspect the answer is no.

If you don't have an intuitively based approach, you can end up doing things that look great in a backtest but which could be an absolute disaster on a forward-looking basis. Especially with a small universe where there are some assets with outsized relative returns, you have to be careful not to come up with something that emphasizes certain factors for the wrong reasons in history.

In our case, for a factor like carry, we have a strong conviction that the term structure is shaped the way it is for very clear economic reasons. So we can be confident that even if there were an extended rough period, it could potentially add value again because of that direct linkage to an economic phenomenon.

#### **Scott Hixon**

Robustness was a key part of the testing. There are multiple possible definitions to capture the phenomena we're looking for, so we attempted to use all of them. When all of the multiple definitions broadly returned the same result, that gave us much more confidence that the intuitiveness of the factor category itself was actually capturing what we were after.

#### **Risk & Reward**

*Does that explain why you call it a "practitioner's approach"?*

#### **Scott Wolle**

Yes, because a practitioner's approach should combine rigor with pragmatism. You have to take the rigor you apply from an academic perspective and bind that to the pragmatism that comes from being someone who has gained deep experience of commodity markets over time. It's pragmatism and experience that allow you to say: 'We've got to be careful about x' or 'We know y is likely to happen.' It's a case of getting behind the numbers and asking: 'Could we really get this in a portfolio and still generate the returns we've committed to for investors?'

It's this kind of thinking that brings a strategy to life. Our job isn't just to identify factors, it's also to deploy them in a way that may provide attractive returns. We have our mathematical, theoretical and academic expertise, and alongside that we know what happens in the real world – it would be unwise to ignore either aspect. It's ultimately a matter of bringing together the best of both worlds.

#### **Risk & Reward**

*Invesco describes factors as "a third pillar of investing". How does your study strengthen or build on that pillar?*

#### **Scott Hixon**

Commodities have generally been thought of as an inflation hedge, and most investors' experience with them over the past decade or so has been disappointing. What we're doing here more or less is taking a traditional asset class and showing how it can be added to a portfolio in a new and unique way.

Furthermore, showing that the factor approach works not only with equities, but also with an asset class like commodities, shows that the concept is more than just a specific technique for managing equities. It is a unique approach to capital markets, regardless of whether you invest in equities, commodities or indeed bonds or currencies.

#### **Hua Tao**

Invesco has put a lot of effort into factor research, and by focusing here on commodity factors we've tried to strengthen that effort. This will help us use factors to build more diversified portfolios. Factor investing is confined to equities for many asset managers, but at Invesco it is not.<sup>2</sup>

#### **Scott Wolle**

It also highlights one of Invesco's strengths – having a variety of teams with extensive experience investing in a range of asset classes. In essence, we can take a specialist approach with focused expertise in each asset class.

#### **Risk & Reward**

*Thank you very much for your time.*

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#### **Notes**

- 1 Source: Thomson Reuters / Bloomberg. Bloomberg Commodity Subindex for Natural Gas as at 30 November 2018.
- 2 E.g.: "Currency carry strategies: unconventional weightings may improve performance and diversification", Risk & Reward #2/2018.

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#### **About risk**

The value of investments and any income will fluctuate (this may partly be the result of exchange rate fluctuations) and investors may not get back the full amount invested. Investments in instruments providing exposure to commodities are generally considered to be high risk and these may result in large fluctuations in value.

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# Tail risk management for multi-asset multi-factor strategies

By David Chambers, PhD, Dr Harald Lohre and Carsten Rother

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## In brief

Multi-asset multi-factor portfolio allocation is typically centred around a risk-based allocation paradigm, often striving for maintaining equal volatility risk budgets. Given that the common factor ingredients can be highly skewed, we specifically incorporate the notion of tail risk management into the construction of multi-asset multi-factor portfolios. Indeed, we find that the minimum CVaR concentration approach of Boudt, Carl and Peterson (2013) effectively mitigates the dangers of tail risk concentrations. Yet, diversifying across multiple assets and style factors can be in and of itself a good means of tail risk management, irrespective of the risk-based allocation technique employed.

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**In an attempt to construct better risk-managed portfolios, investors are turning to diversifying their portfolios through factors rather than traditional asset classes alone. In this vein, diversified risk parity strategies seek to maximize diversification benefits across asset classes and style factors. While this risk parity paradigm is usually concerned with volatility risk, we explore whether it can effectively navigate the non-normality of factor returns and control overall portfolio tail risk.**

The rationale behind adding factors as building blocks in the portfolio allocation decision is often attributed to the correlation breakdown of traditional asset classes in the global financial crisis in 2008. With factors exhibiting lower and more stable correlations over time, however, multi-asset class allocation would have significantly benefitted from the inclusion of factor strategies before the crisis as well. As a consequence, factor investing has attracted widespread interest, and multi-asset solutions have sought to further amplify their value propositions through the inclusion of these genuine return drivers.

## Investing in a multi-asset multi-factor world

Holistic multi-asset multi-factor solutions consider a menu of traditional asset classes complemented by a rich set of style factors, such as carry, value, momentum and quality. While the notion of style factor investing is common among quantitative

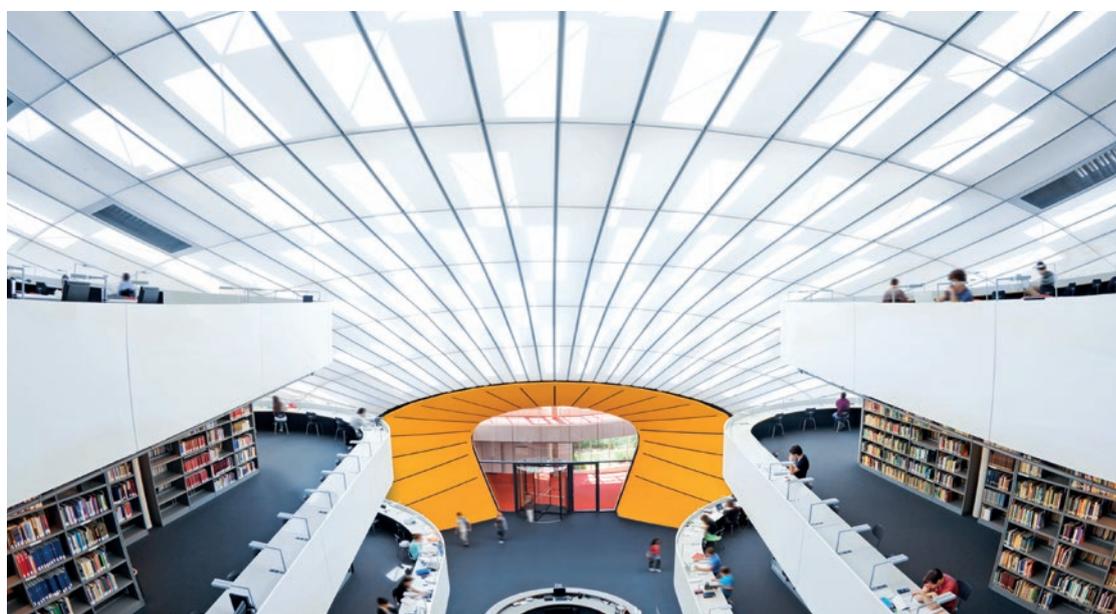
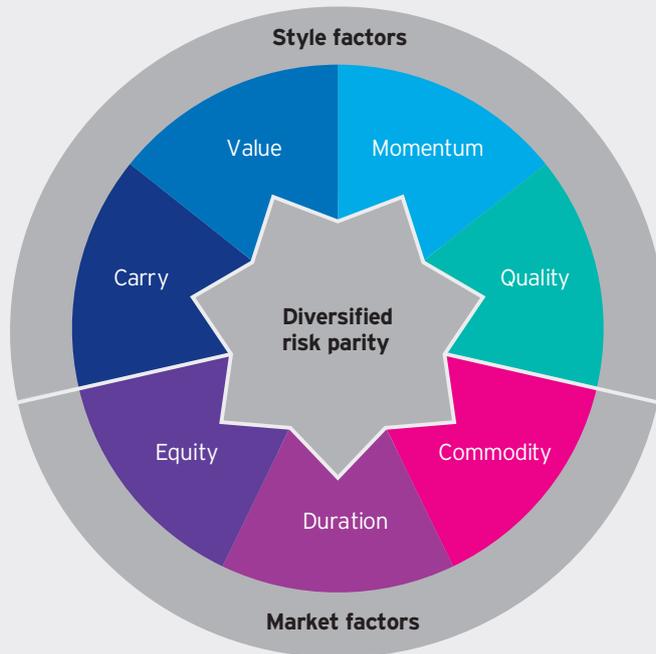


Figure 1  
**Diversified risk parity: building blocks and stylized risk allocation**



Source: Invesco. For illustrative purposes only.

equity managers, there is mounting evidence that similar rationales also apply to other asset classes, such as commodities, rates and foreign exchange (FX); e.g. see Kojien et al. (2018) for carry and Asness et al. (2013) for value and momentum.

In figure 1, we have assembled the most salient market and style factors. Adopting a pure market and style factor investing view across asset classes, we cluster factor strategies in aggregate factor buckets according to style rather than clustering them along asset classes. These clusters are meaningful building blocks to optimally integrate style and traditional market exposures into one portfolio. The baseline allocation solution we have investigated in prior research strives for maximum diversification across these 7 market and style factors, following a diversified risk parity (DRP) strategy.<sup>1</sup> Advancing this framework, Lee, Lohre, Raol and Rother (2018) demonstrate its application to various investor needs, such as factor-based tail hedging, factor completion or leveraging a fully diversified multi-asset multi-factor proposition.<sup>2</sup>

#### The notion of tail risk in style factor strategies

Introducing style factor strategies to the asset allocator's toolkit should also bring about an increased awareness of the embedded tail risk of these strategies. By design, some style factors exhibit skewed return distributions, often signalling considerable tail risk. A prime example is the FX carry trade, which exploits the return differential of high vs. low-yielding currency investments. The nature of this strategy is thus often likened to collecting pennies in front of a steamroller. The latter typically strikes during the onset of a crisis when currency investors quickly shift their allocations from

high-yielding to perceived safe haven currencies. This leaves carry trade investors with significant losses. Such occurrences naturally bring about a highly skewed return distribution with considerable tail risk.

Allocating towards skewed factor strategies thus raises the question as to how one should explicitly manage tail risk, if at all. This topic has also been studied by academics, notably Lezmi et al. (2018). The authors put forward a skewness-aware risk parity approach that allows the strategy to stay invested in skewed assets even after the tail has occurred; by contrast, a classic risk parity strategy would de-invest after such a tail event because of the increase in volatility. While this approach is quite involved, we resort to an alternative allocation paradigm as advocated by Boudt, Carl and Peterson (2013) that seeks to minimize tail risk concentration.

#### Measuring and managing tail risk

Historically, portfolio tail risk has often been framed in terms of the portfolio's value at risk (VaR). Value at risk predicts the maximum portfolio loss over a certain investment period and for a specific confidence level. For instance, the 95%-quantile would provide the portfolio loss that is only breached 5% of the time. Put differently, VaR is simply a quantile of the portfolio return distribution. Yet, when it comes to assessing tail risk, one is particularly interested in gauging the severity of losses beyond the VaR. It is thus more informative to resort to the conditional value at risk (CVaR), which would explicitly estimate the expected loss beyond a given VaR-level, i.e. in the very tail of the return distribution. Therefore, the CVaR is often referred to as expected shortfall.

Having settled on CVaR as the tail risk measure of choice, we next turn to explicitly managing portfolios by balancing asset and style factor contributions to tail risk. Specifically, we focus on decomposing portfolio CVaR, and the CVaR contribution of an asset (or style factor) is given by

$$C_{(i)}CVaR_{(w)}(\alpha) = w_{(i)} \frac{\partial CVaR_{(w)}(\alpha)}{\partial w_{(i)}}$$

where  $w_{(i)}$  is the portfolio weight in asset/style factor  $i$  and  $\alpha$  denotes the confidence level. The corresponding percentage CVaR-contribution is

$$\%C_{(i)}CVaR_{(w)}(\alpha) = \frac{C_{(i)}CVaR_{(w)}(\alpha)}{CVaR_{(w)}(\alpha)}$$

Based on this, Boudt et al. (2013) define the portfolio CVaR concentration as the largest component CVaR of all portfolio positions:

$$C_{(w)}(\alpha) = \max_i C_{(i)}CVaR_{(w)}(\alpha)$$

To effectively manage tail risk, the authors suggest determining the minimum CVaR concentration (MCC) portfolio and the corresponding portfolio weights  $w^{MCC}$  emerge from

$$w^{MCC} = \underset{w \in W}{\operatorname{argmin}} C_{(w)}(\alpha)$$

Rewriting the component CVaR as

$$C_{(w)}(\alpha) = CVaR_{(w)}(\alpha) \cdot \max \left\{ \%C_{(1)}CVaR_{(w)}(\alpha), \dots, \%C_{(N)}CVaR_{(w)}(\alpha) \right\}$$

helps to reveal the intuition behind computing MCC portfolios - this portfolio optimization technique essentially strikes a balance between minimizing CVaR and diversifying the CVaR allocation.<sup>3</sup>

### Minimum CVaR concentration portfolios in practice

The general technique of MCC portfolio optimization can be applied in different ways. Principally, it could be applied either using the 30 single assets and style factors in a kitchen sink manner or using the clustered 7 market and style factors. Indeed, there are good reasons to consider a parsimonious set of clustered factors. Portfolio optimization then benefits from a meaningful factor structure that is less cumbersome for the numerical MCC optimization technique to digest.

### Balancing risk allocations: CVaR versus volatility risk

In this section we run a horse race between MCC-optimised portfolios and alternative risk-based allocation approaches. The multi-asset multi-factor opportunity set consists of 30 single asset classes and style factors in the sample period from 31 January 2001 to 31 December 2017 - see the

Figure 2  
Minimum CVaR concentration portfolios:  
weights and risk allocation

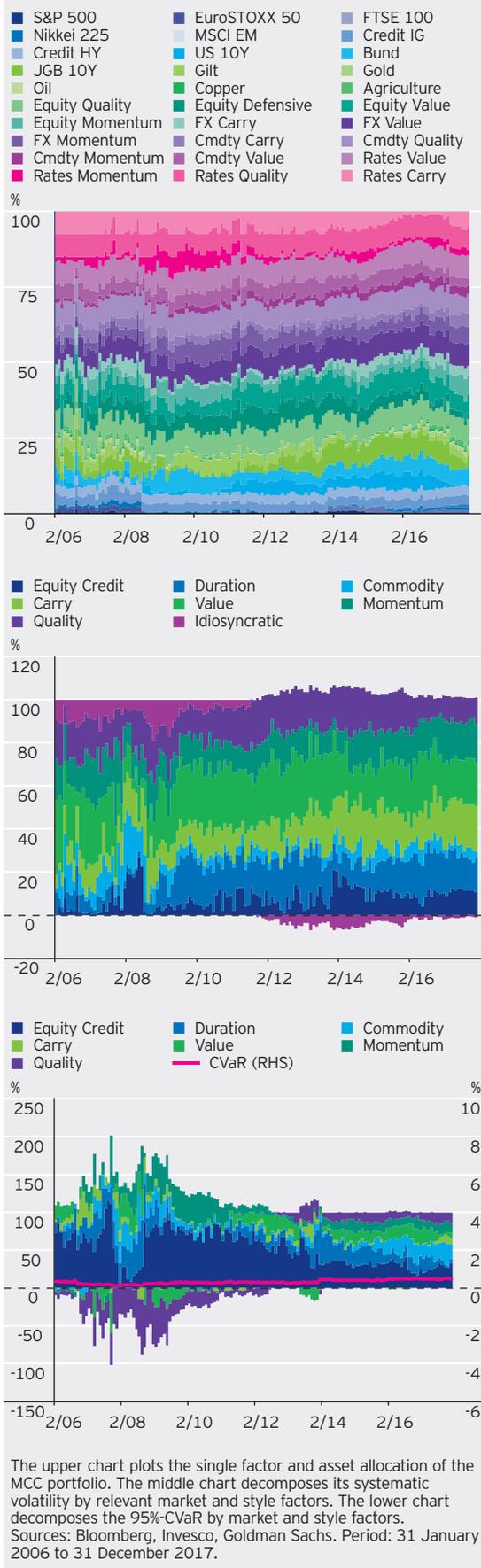


Table 1  
**Risk-based multi-asset multi-factor allocation: performance**

Performance statistics	MCC	1/N	MV	DRP
Return p.a., gross (%)	4.57	4.43	4.06	4.31
Return p.a., net (%)	3.87	4.08	3.54	3.82
Volatility p.a. (%)	1.33	3.44	1.29	1.35
Sharpe ratio, net	1.85	0.79	1.67	1.80
CVaR 95% (%)	-1.64	-5.90	-1.64	-1.69
Maximum drawdown (%)	-1.15	-8.78	-0.84	-1.02
Calmar ratio, net	3.38	0.46	4.21	3.76
Turnover (%)	10.11	1.48	5.13	3.22

**This is simulated past performance and past performance is not a guide to future returns.** The table provides simulated performance figures for four multi-asset multi-factor strategies from the perspective of a US-dollar investor. Sources: Bloomberg, Invesco, Goldman Sachs. Period: 31 January 2006 to 31 December 2017.

appendix for an overview of the underlying indices and style factor strategies. Each asset class or style factor is used in constructing one of the 3 overarching aggregate market factors (equity-credit, duration and commodity) or 4 style factors (carry, value, momentum and quality). These 7 factors are formed by risk parity weightings. Out-of-sample backtesting of strategies commences in February 2006, and we consider monthly rebalancing based on a rolling window of 60 monthly returns.

As the MCC strategy seeks to minimize tail risk and balance its risk contributions, we start off with the respective CVaR decomposition in figure 2. In particular, we note that the MCC portfolio maintains a stable CVaR over time. In some periods, this could only be achieved by sacrificing diversification in CVaR allocation. Notably, the second half of the sample period is still characterized by broad tail risk diversification.

The corresponding volatility risk decomposition is also quite diversified throughout time, with the exception of 2008. While this might be considered a negative, one could very well argue that sacrificing risk diversification for the sake of tail risk minimization is a prudent thing to do. Yet, the MCC strategy incurs relatively high turnover in striving to balance the two objectives (table 1).

Table 1 further depicts the overall performance figures of the MCC strategy and alternative risk-based portfolio strategies. Whilst MCC has the highest return before costs (together with the equal weight strategy 1/N), its after-cost return is significantly reduced given the considerable mean monthly turnover of 10.11%. More importantly, we find its CVaR statistics to be comparable to those of minimum-variance (MV) and diversified risk parity (DRP). Notably, 1/N is the highest returning strategy after costs, albeit with an undue amount of risk, whether measured in volatility or CVaR terms. One is not surprised to find the volatility and tail risk decompositions of the 1/N strategy to be highly concentrated in commodity and equity risk, see figure 3. Conversely, minimum-variance is less prone to these biases but rather favours low-volatility asset classes and, particularly, style factors. In all, we

document its risk allocations to be considerably more diversified than that of 1/N.

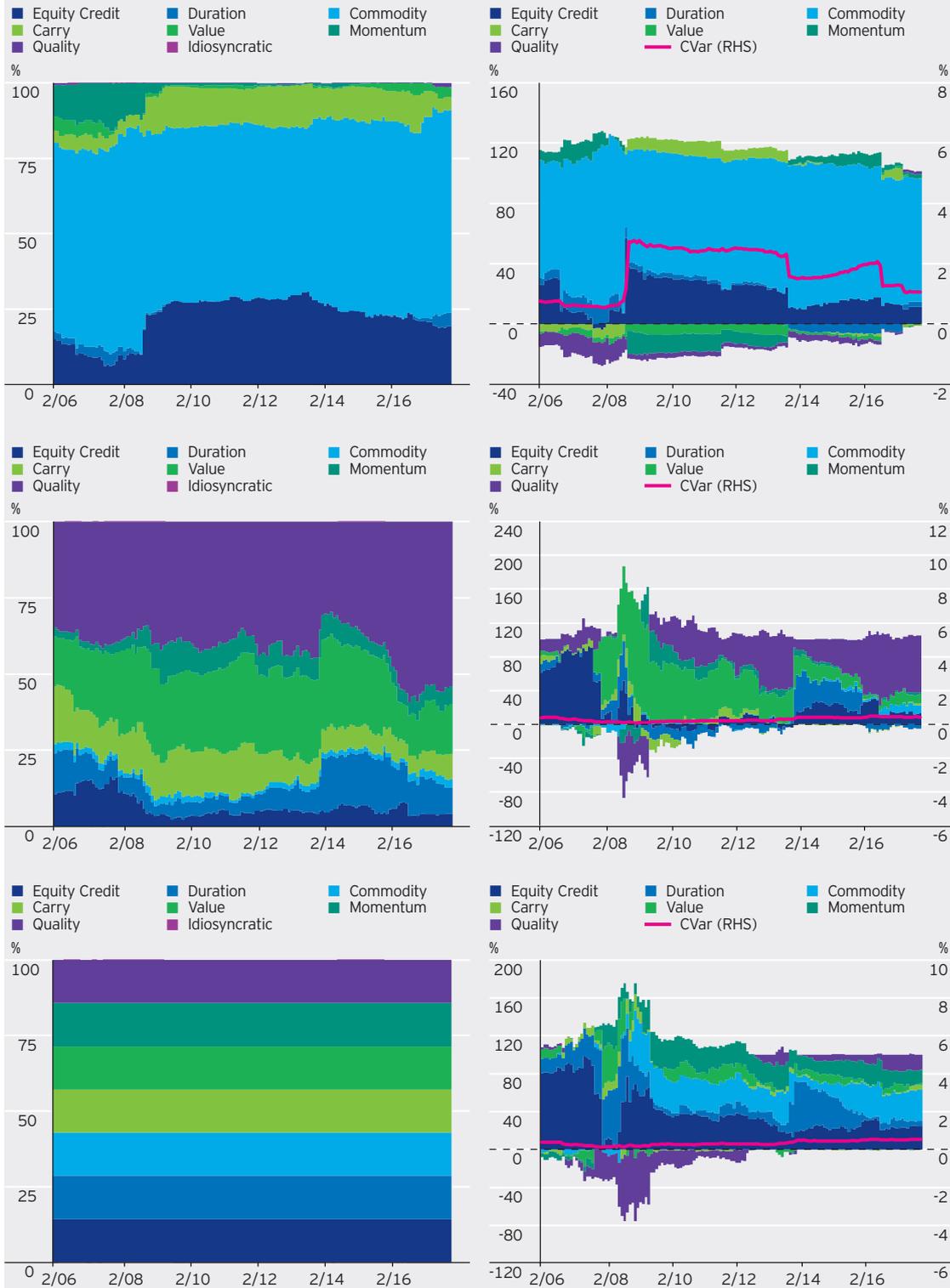
Of course, in the volatility space the DRP strategy is maximally diversified by construction. Also, its CVaR decomposition is fairly balanced and less jumpy relative to that of the MCC strategy. In this regard, it follows that the DRP evenly harvests the associated asset and style factor premia with a high risk-adjusted performance (Sharpe ratio 1.80).

#### Stability of risk-based allocations

While historical analysis of these risk-based allocation techniques helps in understanding their general behaviour, it is hard to make comparisons based on one historical path only. Because risk-based asset allocation techniques merely build on the historical covariance structure, we shall next investigate their sensitivity and stability with respect to the variance-covariance matrix. Similar to Ardia et al. (2017), we create 500 block-bootstrap simulations of the historical asset and style factor data. Effectively, this bootstrap simulation generates 500 alternative price paths for asset and style factors, along which we apply the four allocation techniques. Collecting performance statistics in each run enables us to estimate the ensuing distributions (as opposed to just comparing point estimates).

Figure 4 compares risk and performance statistics in terms of boxplots that characterize the main features of the resulting distributions. By and large, we find the simulation exercise confirms the historical evidence collected in table 1. Not only do we find 1/N to be the most risky strategy, we also document a fairly wide range of outcomes in terms of risk numbers (in between 2% and some 5% for volatility and between -2% and roughly -35% for maximum drawdown). In each of the 500 simulations, DRP, MV and MCC deliver more favourable outcomes. Comparing the latter three in terms of volatility and maximum drawdown, we find them to be quite close, with a similar range of outcomes (in between 0.9% and 1.5% for volatility and between 0% and -5% for maximum drawdown). As the corresponding net return figures are fairly close as well (not shown), the boxplots for the risk-adjusted performance metrics, Sharpe and Calmar

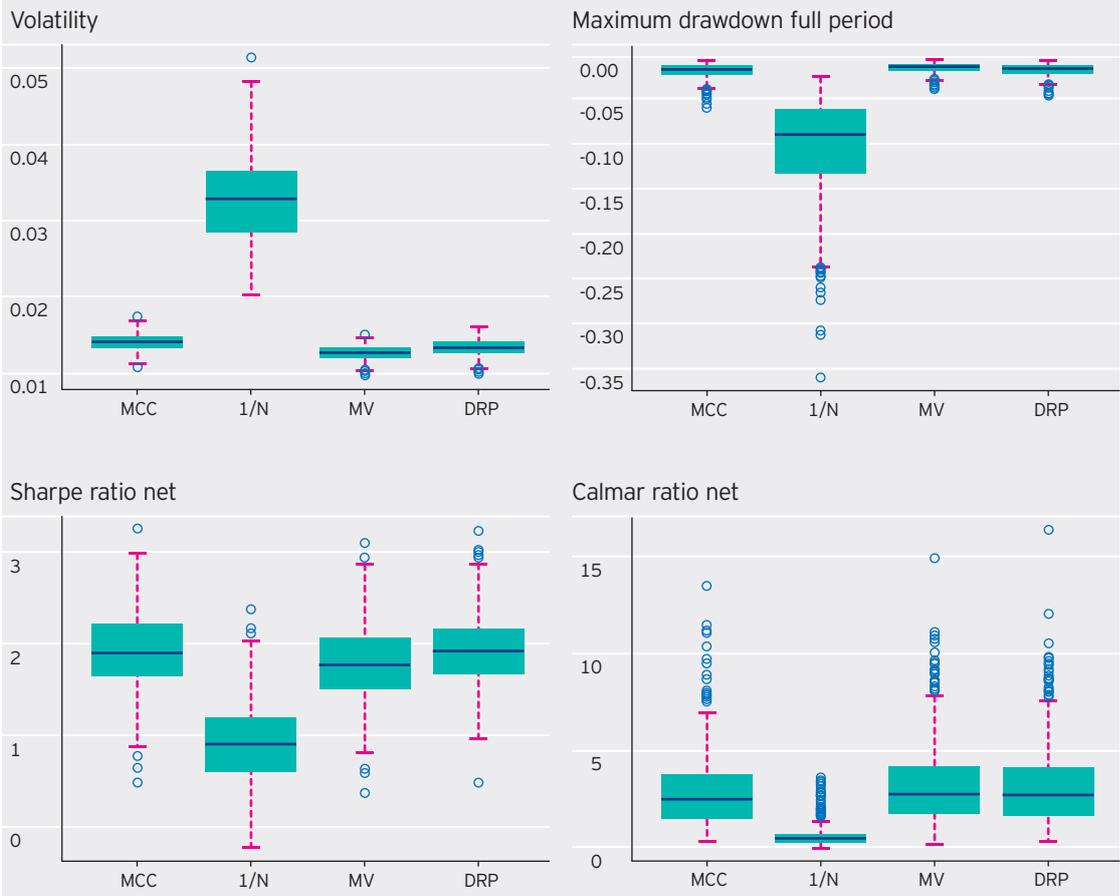
Figure 3  
**Risk-based allocation strategies: volatility and CVaR allocations**



The left column decomposes the systematic volatility of various risk-based allocation techniques by relevant market and style factors. The right column likewise decomposes the corresponding strategies' CVaR over time, depicted as the solid pink line. The first row relates to the equal weight strategy (1/N), the second row to the minimum-variance portfolio (MV) and the third row to the diversified risk parity portfolio (DBR).

Sources: Bloomberg, Invesco, Goldman Sachs. Period: 31 January 2006 to 31 December 2017.

Figure 4  
**Simulating risk-based allocations: risk and risk-adjusted returns**



**This is simulated past performance and past performance is not a guide to future returns.** The left column shows boxplots of strategies' volatility distributions (upper chart) and the corresponding distribution of the Sharpe ratios (lower chart). Likewise, the right column shows boxplots of strategies' maximum drawdown distributions (upper chart) and the corresponding distribution of the Calmar ratios (lower chart). Each figure features all tested risk-based allocation strategies, going from MCC (left) to 1/N, minimum-variance and diversified risk parity (right). Sources: Bloomberg, Invesco, Goldman Sachs. Data period: 31 January 2006 to 31 December 2017.

ratios, are similar in shape across MCC, DRP and MV. Of course, 1/N suffers from its excessive risk exposure.

**Conclusion**

Expanding the investment opportunity set to include style factor strategies brings about a reinforced awareness of tail risk. While a specific tail risk allocation approach is tempting, one has to note that style factors are an effective means to reduce portfolio tail risk in the first place. Minimum CVaR concentration allocations seek to further strike a balance between minimizing tail risk and diversifying its contributors. While effective in both risk dimensions, the higher turnover associated with this strategy leads to some degree of deteriorating returns. Notably, diversifying volatility risk in terms of a diversified risk parity strategy more often than not diversifies CVaR as well; yet, its allocation and performance figures have proved more robust in the historical simulations.

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## Notes

- 1 See Lohre, Opfer and Ország (2014) and Bernardi, Leippold and Lohre (2018) for diversified risk parity strategies in the multi-asset or commodity domain. For an application in the space of multi-asset multi-factor investing see "Investing in a multi-asset multi-factor world", *Risk & Reward*, #3/2017.
- 2 See "Tailoring multi-asset multi-factor strategies", *Risk & Reward*, #1/2018.
- 3 Note that solving for the minimum CVaR-concentration portfolio is not straightforward as the CVaR concentration is not a convex function of portfolio weights. We used the differential evolution algorithm to solve for the optimal weights, see Boudt et al. (2013).

## Appendix

Here, we briefly describe the single asset and style factor indices underlying the article's empirical analyses. The global equity and bond markets are represented by equity index futures for S&P 500, Nikkei 225, FTSE 100, EuroSTOXX 50, MSCI Emerging Markets and bond index futures for 10-year US Treasuries, German Bunds, 10-year JGBs and Gilts. The credit risk premium is captured by the Bloomberg Barclays US Corporate Investment Grade (Credit IG) and High Yield (Credit HY) indices (both duration-hedged to synthesize pure credit risk). To capture commodity markets, we consider total return indices of S&P GSCI for crude oil and gold as well as total return indices from Bloomberg for copper and agriculture.

All style factors are constructed in a long-short fashion and all non-equity style factors are sourced from Goldman Sachs (GS); see table 2 for the style factor indices used. For equity style factors, we utilize the Invesco Quantitative Strategies definitions as laid out in "Investing in a multi-asset multi-factor world", *Risk & Reward*, #3/2017. In particular, equity value, momentum and quality each follow a multi-factor approach that combines several metrics proxying for the respective style dimension. For equity defensive, we build on a long-short approach that is long a minimum-volatility portfolio while shorting a beta-adjusted market portfolio.

Table 2: Overview of style factor series

Style factor	Equity	Fixed Income	Commodity	FX
<b>Carry</b>	-	GS Interest Rates Carry 05	GS Macro Carry Index RP14	GS FX Carry C0115
<b>Value</b>	IQS Value	GS Interest Rates Value 05	GS Commodity COT Strategy COT3	GS FX Value C0114
<b>Momentum</b>	IQS Momentum	GS Interest Rates Trend	GS Macro Momentum Index RP15	GS FX Trend C0038
<b>Quality</b>	IQS Quality & IQS Defensive	GS Interest Rates Curve C0210	GS Commodity Curve RPO9	-

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# ESG integration for equities: evolving our systematic investment process

By Manuela von Ditfurth, Michael Fraikin and Alexander Uhlmann

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## In brief

With over twenty years of managing dedicated ESG mandates, Invesco Quantitative Strategies has been one of the pioneers in integrating environmental, social and governance (ESG) issues in portfolio management. Currently, we are undertaking a research project that analyzes the impact of ESG factors from a truly quantitative perspective - something that has not been possible in the past due to data limitations. The results of our research show the limitations of the widely available ESG scores, and we believe that our quality factor may capture the ESG credentials of a stock better than the common scores. We have made some modifications to our process due to the findings of our research but continue to believe in a fully integrated process with positive and negative ESG criteria, best-in-class concepts, engagement and proxy voting.

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**While our dedicated mandates have always focused on sustainable criteria, over the years we have periodically reviewed facets of our multi-factor investment process. We have added governance related signals to our quality factor and our emphasis has been on offering bespoke solutions to clients to meet specific objectives. Clearly the markets, our options and our client's requirements are evolving. Today, ESG has transitioned from an investment niche to becoming a mainstream theme which is also supported among others by demographic change, demonstrating good governance and a changing regulatory environment. The action plan on sustainable finance issued by the European Commission is only one example of a regulatory body taking sustainability into account.**

We have undertaken an intensive research project to reassess our understanding of key aspects of ESG. Our aim is to identify whether there are potential economic benefits from integrating ESG considerations in a systematic investment process. Other aspects of ESG integration beyond what can be captured by factors in our processes continue and will evolve alongside the ongoing development of our investment process.

## Our ESG research project

As practitioners of factor investing, we have been keen to explore ESG factors as drivers of returns and risk for some time. One of the barriers to thoroughly researching ESG has been the lack of high quality data that has extensive breadth across companies (and countries) as well as across time. Over the last few years, data providers have improved coverage such



that it is becoming more suitable to apply our deep quantitative analytical techniques. We have selected specialised providers of ESG data<sup>1</sup> and have three key observations from the analysis so far on: the effects of overall ESG rating scores as potential drivers of return and potential drivers of risk as well as the effects of sharp ESG ratings downgrades as outlined below.

### ESG as a potential driver of returns

An unsurprising initial observation in our analysis of the underlying ESG scores was that there is some correlation with a factor that is already in our existing model used to determine the attractiveness of all stocks within our global investment universe (around 4,000 stocks). This relates to Governance and what we have termed Quality. Our Quality signals prefer companies with less aggressive accounting, that are not “empire-builders” and that are not financially constrained. In short, they are well-managed companies which one would expect to be correlated to good governance. These individual aspects of our Quality factor tend to be more closely associated with returns than the aggregate governance scores we looked at, which confirms that the existing model is well positioned on that end.

To evaluate a combined E, S and G impact on returns, our first step was to analyse how ESG scores would work as return predicting factors<sup>2</sup> - with a view to comparing those results to the efficacy of Quality, Momentum and Value should they be promising. Given the relatively short history of the datasets (broadly 10 years and often with recognizable methodological changes), we had to work with less than we normally expect to work with but it still allowed meaningful analysis.

The results show that the evidence of overall ESG scores being a return driver is ambiguous. Table 1 shows the relationships between subsequent returns and ESG scores from the perspective of information coefficients or the spread between highly and poorly ranked companies across a number of providers. These are typically insignificant and often not consistent with the assumptions that strong ESG scores are associated with strong future returns and weak scores with poor returns.

The results for Momentum and a trend score we calculated mirror this (table 2). This does not mean that strong scores underperform or poor scores outperform; it just means that aggregate ESG scores

Table 1  
Aggregate ESG score test statistics

Indicator	Item	Global		Euro		USA	
		Value	t-stats	Value	t-stats	Value	t-stats
Provider 1	IC 1 month	0.00	-0.20	0.00	0.50	-0.01	-1.20
	Spread 1 month	-0.04	-0.60	-0.04	-0.20	-0.09	-0.70
Provider 2	IC 1 month	0.01	1.40	0.00	-0.30	0.01	0.90
	Spread 1 month	0.08	1.00	-0.18	-1.10	0.10	0.70
Provider 3	IC 1 month	0.00	-1.20	0.00	0.50	0.00	-0.90
	Spread 1 month	-0.05	-0.70	0.19	0.90	-0.06	-0.50

Sources: MSCI, Markit, OWL, Invesco, as at 30 September 2017. Period of analysis: 30 June 2003 to 30 September 2017. IC = information coefficient. “Spread” refers to the performance differential between highly and poorly ranked stocks. The research universe of Invesco Quantitative Strategies consists of around 4,000 global stocks.

Table 2  
ESG score-based variables test statistics

Indicator	Item	Global		Euro		USA	
		Value	t-stats	Value	t-stats	Value	t-stats
Momentum (1 month)	IC 1 month	0.00	-0.40	0.00	-0.10	0.00	0.90
	Spread 1 month	-0.09	-1.00	-0.32	-1.10	0.17	0.70
Momentum (6 month)	IC 1 month	0.00	-0.20	-0.01	-0.80	0.00	0.50
	Spread 1 month	-0.01	-0.10	-0.03	-0.10	0.06	0.50
Momentum (12 month)	IC 1 month	0.00	-1.00	0.00	-0.40	-0.01	-1.50
	Spread 1 month	-0.04	-0.40	-0.35	-1.80	-0.17	-1.10
Trend	IC 1 month	0.00	-0.70	0.00	0.00	-0.01	-1.40
	Spread 1 month	-0.08	-1.00	0.13	0.60	-0.21	-1.80

Sources: MSCI, Invesco, as at 30 September 2017. Period of analysis: 31 December 2006 to 31 August 2017. IC = information coefficient. “Spread” refers to the performance differential between highly and poorly ranked stocks. “Momentum” is defined as the change over the respective period (1, 3 or 6 months). “Trend” is calculated over a 12-month window. The research universe of Invesco Quantitative Strategies consists of around 4,000 global stocks.

**Figure 1**  
**Sample simulation of a global model portfolio with a tracking error of 3%**



Sources: MSCI, Invesco, as at 30 September 2017. Period of analysis: 31 December 2006 to 31 May 2017. Comparison of cumulative returns of a sample simulation of a global portfolio with ESG exposure constraint to a sample simulation of a global portfolio without ESG Exposure constraint. **Simulated past performance is not a reliable indicator of future performance.**

have not been strong predictors of future returns - which is something to be looked at over large samples. We also looked at the individual E, S and G portions of the aggregate scores without observing a material improvement.

As a final test, we simulated portfolios where we "forced" portfolios to be at least at the average score for their relevant benchmark. The conclusion of these tests was that such a constraint historically impacted performance negatively by effectively narrowing the opportunity set (figure 1 illustrates one such simulation).

**ESG as a potential driver of risk**

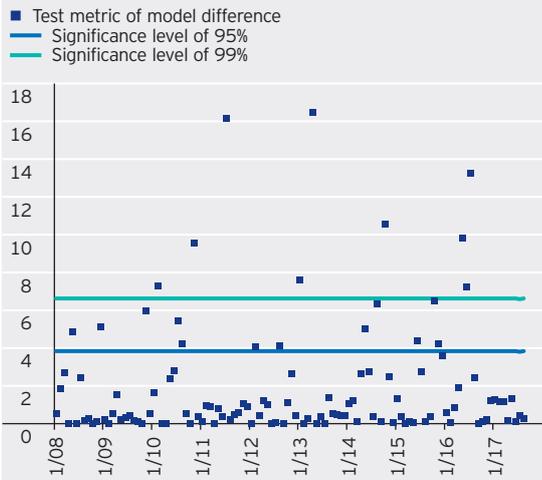
As we are using proprietary risk models, we were obviously interested in understanding whether integrating ESG scores in the risk models could be expected to improve risk forecasts. When analysing this question, we came to two conclusions: Based on historical data, the inclusion of aggregate ESG scores would have improved the risk forecast with a statistical significance (figure 2). The resulting improvement of risk forecasts, however, can only be considered economically immaterial (figure 3) and is for all practical intents irrelevant.

**Based on historical data, the inclusion of aggregate ESG scores would have improved the risk forecast.**

**ESG exposure control**

Another way of integrating risk is to manage exposures. Knowing that ESG exposure has historically been

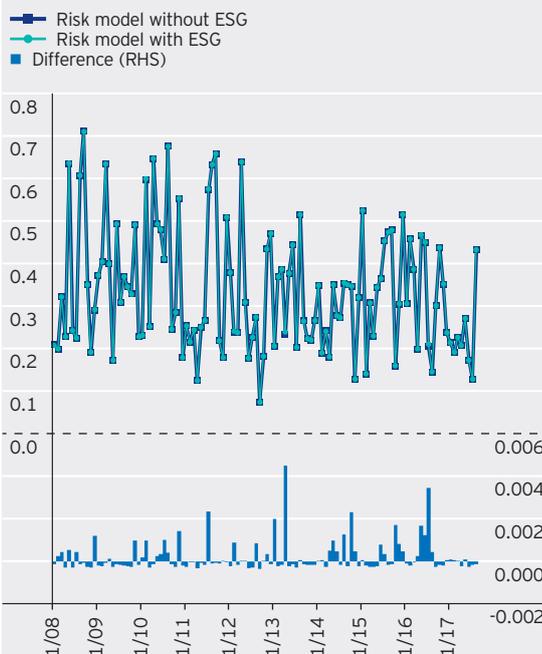
**Figure 2**  
**Significance of inclusion of ESG as a risk factor**



The dot is a metric of the test whether the addition of ESG has a significant impact on risk. If the proportion of the dots which are above the 95% (99%) threshold line is more than 5% (1%), it is interpreted as a significant result. Actually, 18% (8%) of the dots are above 95% (99%) threshold line, which implies a significant meaning for ESG.

Sources: MSCI, Invesco, as at 30 September 2017. Data basis of the analysis is the research universe of Invesco Quantitative Strategies which consists of around 4,000 global stocks. Period of analysis: 31 December 2006 to 31 August 2017. Values above the blue lines are statistically significant at the respective significance levels.

**Figure 3**  
**Comparison of the risk models with and without ESG**



The lines indicate the level of explanatory power of the two models. The bars show the difference in the two models' explanatory power. The almost perfectly overlapped lines imply economically immaterial improvement.

Sources: MSCI, Invesco, as at 30 September 2017. Data basis of the analysis is the research universe of Invesco Quantitative Strategies which consists of around 4,000 global stocks. Period of analysis: 31 December 2006 to 31 August 2017.

neither a key driver of return nor did we observe a significant historic impact on risk models across the universe, we may still and reasonably argue that this can change going forward and that ESG exposure is an important risk that has not yet materialized fully. Just like operating a nuclear power station would not have been seen as a key risk looking at historical prices of the operating company before any risk materialized. Even if we assume that nothing as drastic will happen in the foreseeable future, it still seems reasonable to ensure that portfolios are not heavily exposed to the risk of scoring much worse from an ESG perspective relative to their respective universes.

We find that management of the aggregate ESG exposure still enables our portfolio construction to build portfolios with attractive factor exposures subject to portfolio optimization constraints. In the instances where some of our portfolios would have historically hit the specific ESG threshold of their respective universes, the impact of the threshold would have been mildly beneficial. However, the key point from our perspective is guarding against a risk that historically has been relatively small, but may be material in the future. We believe that this step is key in ESG integration - the inclusion in the risk model would not have had noticeable impact until after the risk materialized.

#### Adverse ESG momentum

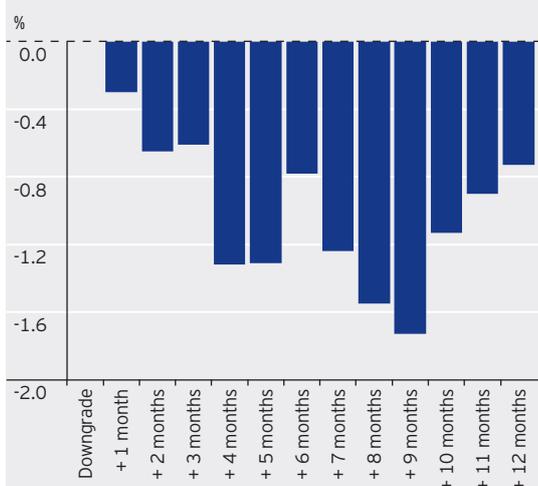
At the intersection of return and risk is the case of stocks that experience severe downgrades to their ESG scores. These tend to be companies that have delivered highly disappointing news that caused the market to reassess the companies' core processes and values. Historically, we have found evidence that these companies continued to underperform after downgrade events, and based on the much higher importance attached to ESG today, we expect this to have a greater impact going forward (figure 4).

We therefore integrate sharp downgrades of ESG scores into our risk management and treat such stocks as exceptional. This means that for a period of at least six months, we will disregard the calculated factor exposure of such stocks and sell them out of all strategies that are not managed to a tight tracking error. For those highly benchmark-aware strategies, we will limit the relative exposure to a quarter of the allowed maximum position in a strategy. For most stocks, this would mean they are likely to be sold out, and for the largest benchmark holdings we would likely move to an underweight position. With a reasonable ESG assessment for most companies now firmly in place, we find that the number of stocks experiencing such downgrades has declined, but that the impact on future price performance has likely risen.

#### Conclusion of the research project

Certain signals within our Quality factor show positive correlations with governance ratings but tend to be more closely associated with returns than the aggregate governance scores we investigated. In addition, management of a portfolio's overall exposure, as well as exception-handling of stocks showing an adverse ESG momentum, is expected to be economically beneficial. We now turn to aspects of our ESG integrated investment process that are beyond using ESG scores as additional factors.

Figure 4  
Average active performance of sharply downgraded stocks



Sources: MSCI, Invesco, as at 30 September 2017. Period of analysis: 31 December 2006 to 31 August 2017. Returns are industry and region-neutral.

#### Customized ESG

This is where it all started (at least for us). For over twenty years, the Invesco Quantitative Strategies team has managed accounts for clients that required inclusion or exclusion of companies based on customised ESG criteria. Exclusion criteria and negative criteria serve to eliminate companies, sectors or countries that fail to meet certain ESG principles. These include violating international norms and standards according to the definitions of the International Labour Organisation (ILO), the OECD or the United Nations. Negative screening is one of the most frequently used approaches.

With positive criteria, companies, sectors or countries are identified which have sustainable economic development, positively rated products or processes. They fulfil ecological and social requirements particularly well, ranging from climate efficiency and low water consumption to labour safety and satisfaction.

To implement those criteria in equity and multi-asset portfolios, we use a specialised database that covers 4,000 listed companies worldwide. Companies are analysed on the basis of 250 different criteria for all relevant ESG fields. These include environment, corporate governance, human rights, labour conditions etc.

Within our multi-asset product range, we facilitate sustainability criteria in sovereign bonds with a country sustainability rating. To assess a country in terms of sustainability criteria, a large number of indicators are used from the area of political and social issues as well as environmental issues. These are combined into an overall rating. In addition, details of how well countries perform on specific concerns, like nuclear power as percentage of nationally produced energy consumption and religious freedom, can be provided as well.

Best-in-class strategies refer to the composition of an equity portfolio by the active selection of companies

Figure 5  
**Engagement - direct dialogue with companies**

Theme-based engagement	Controversy-led engagement
<ul style="list-style-type: none"> <li>- Water</li> <li>- Climate change</li> <li>- Bribery &amp; corruption</li> <li>- Supply chain labour standards</li> <li>- Human rights</li> </ul>	<p>Encourage companies to fully address allegations of corporate breaches of global norms and conventions.</p>

Source: Invesco. Overview of available engagement approaches. For illustrative purposes only.

that rank among the leaders of their sectors in terms of environmental, social and governance issues. We use a ranking framework whereby no companies or sectors are automatically excluded from a given investment universe. Instead, all companies are provided with a score based on the points achieved relative to any number of positive and negative factors. These point scores can then be used to develop a preference approach by either identifying companies that are best-in-sector or are over a certain point threshold. The best-in-class approach is therefore not necessarily restricted to classic sustainability sectors such as renewable energies or environmental technology. Carmakers or oil and chemical companies are also considered - provided they score particularly well in their ESG rating and are effective at implementing ecological and social standards within their industry.

Some of our clients have also decided to benchmark their portfolios against dedicated best-in-class indexes that emphasize ESG aspects to varying

degrees and for a wide variety of markets. Together with our clients, we aim to set the parameters in a way to achieve the desired ESG exposure with a minimal negative impact on expected return and risk characteristics.

**Engagement**

For many years, Invesco Quantitative Strategies has taken an active stance towards engaging with companies that represent significant holdings across client portfolios. Together with a specialist consultant, we identify themes on which Invesco Quantitative Strategies wishes to engage. We then contact these companies and seek, at a minimum, to achieve recognition of our concerns and a response. Ideally, we hope to help steer companies towards improving their ESG footprint - something we have witnessed with some pride over the years.

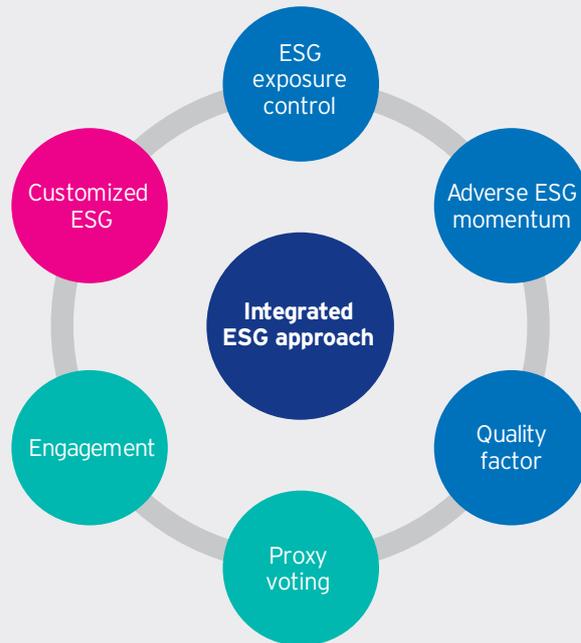
In the past, Invesco Quantitative Strategies' engagement strategy has typically focused upon five key environmental, social and governance themes:

Figure 6  
**Support of ESG shareholder proposals through Invesco's proprietary proxy voting platform**



Source: Invesco. For illustrative purposes only.

Figure 7  
**Invesco Quantitative Strategies – holistic ESG approach**



Source: Invesco. For illustrative purposes only.

bribery reporting, climate change, human rights management systems, supply chain labour policy and water scarcity.

The success of any engagement is dependent upon having clear and consistent engagement objectives that are challenging for a company to meet but also provide demonstrable goals to measure individual performance and monitor wider trends. To develop these objectives, we together with our external consultant undertake baseline assessments for each company in the theme selected.

**Proxy voting**

Another way of exerting pressure on companies to make them more sustainable is through proxy voting. Over the years, investors have realized the need to do more than simply exclude or sell stocks in companies that do not meet the investor's sustainability requirements. This has given rise to the desire to use voting rights as a means of influencing companies.

Our particular interest lies in supporting good governance at the companies we invest in on behalf of our clients – and we have done so for many years. With this aim in mind, we have defined a proxy voting policy that ensures the respective votes are cast to support especially good governance. Well-governed companies are characterized by a primary focus on the interests of shareholders, accountable boards of directors, ample transparency in financial disclosure, performance-driven cultures and appropriate consideration of all stakeholders.

Additionally, we are able to apply customized proxy voting policies which vote on certain ESG topics which can include, amongst others, gender pay gap proposals, reporting on climate change and gender diversity on public boards.

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We have defined a proxy voting policy that ensures the respective votes are cast to support especially good governance.

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**Summary**

Invesco Quantitative Strategies employs a fully integrated ESG investment process in managing client portfolios. This is built on longstanding experience in customized ESG solutions, active engagement with companies and the Invesco proxy voting approach. Having incorporated proprietary aspects of governance for many years (“Quality” factor), we have now enhanced risk management by introducing a dedicated ESG exposure control for all portfolios as well as an adverse ESG momentum measure to restrict certain companies. We are confident that these steps, combined with a continuous dialogue with clients and companies, will make us well prepared for future challenges with regard to ESG investing.

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## About the authors

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### **Manuela von Ditzfurth**

Senior Portfolio Manager,  
Invesco Quantitative Strategies  
Manuela von Ditzfurth is responsible for the management of global and European equity portfolios and is an expert in the field of Responsible Investing.

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### **Michael Fraikin**

Global Head of Research,  
Invesco Quantitative Strategies  
Michael Fraikin and his team are responsible for the maintenance and further development of the quantitative models that drive the decisions within the investment products.

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### **Alexander Uhlmann**

Global Head of Portfolio Management,  
Invesco Quantitative Strategies  
Alexander Uhlmann leads the portfolio management team which focuses on client account management, portfolio construction and implementation, as well as investment communication.

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## Notes

- 1 For our customized ESG solutions, we also use research data from Sustainalytics and Vigeo Eiris.
- 2 Despite the relatively short history of the ESG datasets (broadly 10 years, and often with considerable methodological changes), we still consider our analysis meaningful. Due to different data histories, data periods for various analysis can vary.

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## About risk

The value of investments and any income will fluctuate (this may partly be the result of exchange rate fluctuations) and investors may not get back the full amount invested.

# ESG integration for fixed income: sound stewardship and social responsibility

By Paul English

## In brief

We are convinced that ESG integration not only makes the world more sustainable, but can also lead to better risk-adjusted investment results. We describe some aspects of the Invesco Fixed Income ESG process - data collection, calculation of proprietary ESG scores and engagement - that supplement our traditional credit research, thus helping ensure that our clients achieve their goals.

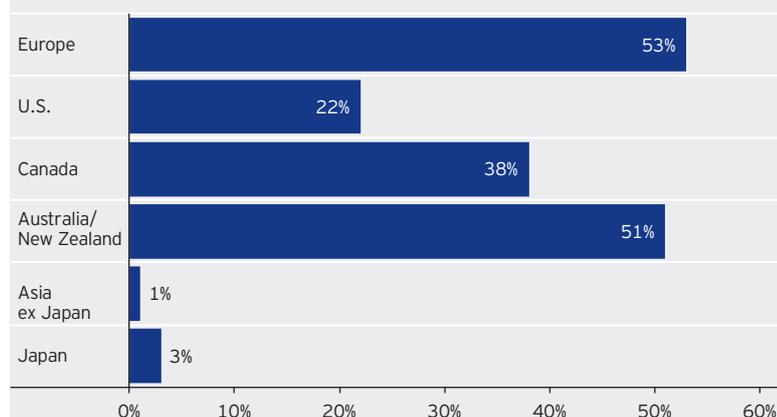
**At Invesco Fixed Income, we are convinced that sound environmental, social and governance (ESG) practices can lead to better value for our clients. We view integrating ESG factors into our long-term investment framework as an additional layer of due diligence in the best interest of clients and markets. In this article, we describe our approach in detail.**

Asset owners are increasingly interested in investment approaches that better align with their views on ESG issues. Moving beyond basic ESG screening techniques, we believe they will ultimately demand evidence that their investments are making a positive impact on our collective futures.

The increase in demand for sustainable investment solutions has been most prominent among financial institutions and corporate sponsored funds. Insurance companies have recognized the need to align underwriting and investment practices, for example, ensuring assets (e.g. tobacco bonds) are not undermining their assumed insurance liabilities (e.g. life insurance). Corporations have also moved to express corporate vision and sustainability policies through directed investments.

Though it's true that ESG first reached scale in Europe (figure 1), ESG investing is no longer a purely European phenomenon. We have seen increased ESG interest in Japan, the United States and, most recently, China. Invesco Fixed Income's approach to ESG investing takes account of this growing interest.

Figure 1  
**Socially responsible investing as a percent of total managed assets**  
SRI 26% of total managed assets globally



Source: GSIA's 2016 Global Sustainable Investment Review. Data as at 31 December 2015, except for Japan which is as at 31 March 2016.

**We believe full ESG integration can improve long-term risk-adjusted returns**

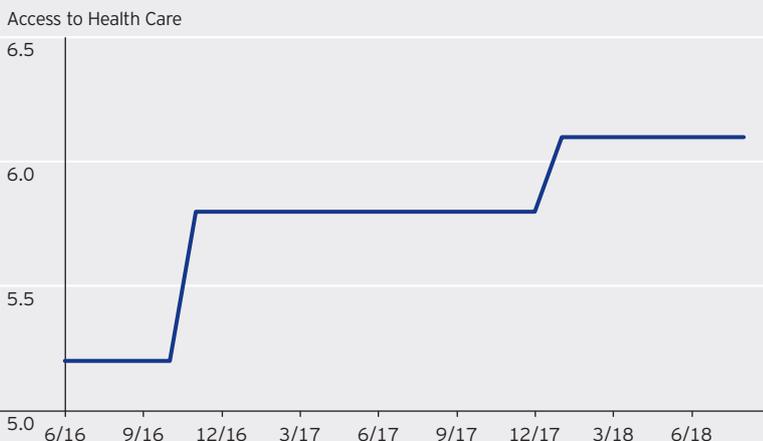
At Invesco Fixed Income, we believe that ESG-oriented investment can lead to better long-term risk-adjusted returns, driven by improved profitability (due to lower funding costs) and lower asset price volatility.<sup>1</sup> Consequently, we have fully integrated ESG risk factors into our fundamental credit research.

**We believe that ESG-oriented investment can lead to better long-term risk-adjusted returns.**

Our starting point is data collection. With robust historical data, we can analyze multiple ESG risk factors against market pricing and credit ratings. Data is collected from multiple sources, including issuing companies, Corporate Sustainability Reports (CSR) and external research providers. Our database contains time series of various ESG indicators for the issuers in our investment universe.

Such time series may be derived from: the corporate governance section of financial reports, the size of the board, its proportion of independent directors and its share of women, to name a few. In addition, we use scores for particular ESG themes provided by MSCI - figure 2 shows the historical development of the MSCI Access to Health Care score - as well as data from Sustainalytics and smaller research boutiques. This all supplements the information provided by Invesco's Global Responsible Investment Office, a central function that supports Invesco's investment teams with tools, research, education and client support.

**Figure 2**  
**Example of a company's MSCI key historical score - Access to Health Care**



Source: MSCI, data from 1 June 2016 to 1 August 2018. Key issue scores are assigned by MSCI on a scale of 0 to 10, with 10 being the best. The Access to Health Care score evaluates the extent to which companies take advantage of opportunities for growth and protecting their license to operate through efforts to improve access to health care in developing countries and underserved markets. Scores are based on exposure to underserved geographies, access to health care strategy and programmes in areas such as R&D, pricing and licensing. For illustrative purposes only.

**ESG analysis: interwoven into fundamental credit analysis**

Based on this data, we have recently established a proprietary ESG rating process (figure 3). It brings together both quantitative and qualitative factors, ensuring alignment with our existing fundamental credit research process.

To obtain our proprietary ratings, ESG data is reviewed in absolute terms and by peer percentile rankings, guiding the establishment of independent E, S and G risk factor scores. These scores are evaluated along with analysts' assessments of issuers' policies and management engagement, providing the foundation for an overall ESG rating

**Figure 3**  
**Invesco Fixed Income's credit research**  
Proprietary ESG ratings process

Invesco Fixed Income's proprietary ESG ratings process is rooted in data collection, historical and peer analysis, issuer engagement and awareness of external resources, providing meaningful insights into ESG factor risks.

Data	Analysis	Resources
<ul style="list-style-type: none"> <li>■ Bloomberg</li> <li>■ Sustainability report</li> <li>■ MSCI pillar scores</li> </ul>	<ul style="list-style-type: none"> <li>■ Everest                             <ul style="list-style-type: none"> <li>- Sector ranking</li> <li>- Historical trend</li> <li>- Disclosure</li> <li>- Leading/lagging</li> <li>- Policy review</li> <li>- Engagement prioritization</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>■ MSCI / sustainalytics                             <ul style="list-style-type: none"> <li>- Identify key issues</li> <li>- Controversies</li> <li>- Business involvement screens</li> <li>- Methodologies</li> <li>- Index eligibility</li> </ul> </li> </ul>

**ESG scorecards:**

E, S & G factor scores	1 2 3 4 5
Overall ESG score	A B C D E

Source: Invesco. Quantitative ESG factor risk reviews are supported by detailed "ESG Monitors," which aggregate multiple datasets across ESG pillars. For illustrative purposes only.



and trend relative to sector peers. To avoid high absolute risk scores specific to one industry, an additional industry screening takes place at portfolio level. We also offer negative/exclusionary screening on a customized mandate basis as well as inclusion based on positive/best-in-class.

The output of our ESG analysis is integrated into our "Issuer Scorecards", which consolidate our fundamental credit opinions on each issuer. The addition of a ESG risk lens to our fundamental credit process has led to differentiated views of companies within the same sector. For example, we credited a US-based exploration and production company with providing quarterly disclosures to investors on positive safety and environmental performance, which may lead to better operating performance with fewer risks. On the other hand, we penalized a US-based pipeline company due to its lack of basic safety monitoring metrics and poor peer rankings. This highlights how issuer-level ESG risks and fundamental credit views are often interwoven.

Full ESG process integration ensures that all portfolios benefit from the evaluation of environmental, social and governance risks at issuer level through our proprietary ESG ratings process, as well as its influence on our internal fundamental credit rating and trend analysis. In the end, ESG risk assessments may be the decisive factor when similar opportunities exist in

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## Full ESG process integration ensures that all portfolios benefit from the evaluation of environmental, social and governance risks at issuer level.

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credit markets. With a uniform process across fixed income asset classes, portfolio managers can compare risks and opportunities.

### **Engagement: next frontier of ESG investing**

Issuer engagement in the fixed income asset class is thought to be more challenging relative to equities. While this is due largely to the lack of voting rights as fixed income investors, we have found that most companies welcome engagement on ESG, recognizing that investors ultimately decide their cost of funding.

To make the most of limited time with management teams, we utilize peer analysis and key issue relevance to prioritize engagement opportunities. In other words, our engagement strategy is directed by the relevance and level of ESG risk factors. Lower-risk

### **Invesco awarded top grades for ESG two years in a row**

As a signatory to the Principles for Responsible Investment (PRI), Invesco has reported, was assessed and is honored to have been awarded an A+ rating in 2018 for its overall approach to responsible investment (Strategy and Governance) for the second consecutive year.

The PRI carries out the annual assessment based on a signatory's progress year-over-year and relative to peers. The investment categories are evaluated using six performance bands (A+, A, B, C, D, and E), where A+ distinguishes the top scoring signatories, representing a score of 95% or above.

Invesco is committed to adopting and implementing responsible investment principles in a manner that is consistent with our fiduciary responsibilities to clients. Invesco supports the PRI and recognizes the importance of considering environmental, social and governance (ESG) issues as part of a robust investment process.

Any reference to a ranking, a rating or an award provides no guarantee for future performance results and is not constant over time.

items can be handled via written communication with investor relations departments. Higher risk factors provide opportunities for direct contact with senior management. We recognize that industry engagement practices are in the early stages and we are committed to finding practical ways to promote ESG awareness among company managements.

### Conclusion

ESG integration is evolving: companies are expanding ESG factor reporting and working to enhance the overall quality of their corporate disclosures. Data providers have developed new products and end-investors are demanding more ESG-related product options. Asset owners are increasingly committed to aligning with the United Nations Climate Change Conference, which advocates limiting the rise in global temperatures to two degrees Celsius. Clients are also becoming interested in mapping corporate policies to the United Nations Sustainable Development Goals (SDG), which span several societal priorities, including eliminating poverty, reducing inequality and climate action. The SDGs represent a universally recognized agenda in this space.

Invesco Fixed Income continues to promote the integration of ESG capabilities across multiple fixed income asset classes to help clients meet these objectives and to deliver on our dual goals of maximizing risk-adjusted returns and contributing to a more sustainable future.

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### About the author



#### Paul English, CFA®

Head of US Investment Grade Research,  
Invesco Fixed Income

Paul English's primary responsibilities include the management and coordination of the investment grade research function, credit strategy, resource requirements and standards of practice. His coverage responsibilities are focused on the analysis of financial institutions. In addition, Paul acts as Director of ESG Research for Invesco Fixed Income, responsible for research process integration.

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#### Note

- 1 The strategic direction of our responsible investment practices is governed by the Corporate Responsibility Committee, chaired by Invesco's CEO Marty Flanagan.

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### About risks

The value of investments and any income will fluctuate (this may partly be the result of exchange rate fluctuations) and investors may not get back the full amount invested.

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# What do corporate managers' words reveal about their firms' value?

By Michael Fraikin and Xavier Gerard, PhD

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## In brief

We investigate the predictive power for future stock returns of several indicators of managers' sentiment derived using conference calls of companies that belong to a US universe of large and mid-cap securities from 2004 to 2017. We find that the average sentiment of managers over the last twelve months and their degree of Emotional Levelness during these calls explain future returns and constitute significant additions to an investor's factor toolkit.

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**Most financial analysis focuses on hard facts - income statements, earnings estimates, sales figures and everything else that is easily countable. But what should a quantitative analyst do when important clues to a stock's future performance are to be found elsewhere? In this study, we derive hard indicators from seemingly soft rhetoric - and show how useful manager-tone can be when forecasting an individual stock's returns.**

Our study is motivated by the dramatic increase in the availability of valuable unstructured, text-heavy data as well as developments in the use of textual analysis in accounting and finance. While textual analysis has been fruitful in uncovering important information across a range of document types, we focus our analysis on earnings conference calls. These occur every quarter and provide managers with a platform to discuss recent performance and future prospects. Earnings conference calls begin with a typically well-rehearsed presentation by managers, followed by a relatively unscripted Q&A session with security analysts. It is the somewhat spontaneous nature of this interaction with analysts that could be particularly conducive to the identification of hidden cues in the language used by managers. We believe that these may effectively offer an additional and differentiated clue to the future evolution of analysts' expectations and revisions.

Related studies have concentrated on the immediate vicinity of the call or the first few months just following it (Dzielinski, Wagner and Zeckhauser 2017; Brockman, Li and Price 2015; Price, Doran, Peterson and Bliss 2012, Zhou 2016 and Lee 2016). While the findings in these studies shed important light on the value-relevance of linguistic analysis in conference calls, these insights may not easily lend themselves to implementable trading strategies. Previous studies use a short-term formation window, typically the last conference call, so that it is unclear whether the information in these calls can be easily acted upon. An investor who wishes to trade on the proposed linguistic signals would have to text mine several transcripts of conference calls, and the processing time required to do so might well impede them from harvesting the effect efficiently. Moreover, such short-term strategies often require extremely high levels of portfolio turnover and might therefore incur significant implementation costs.

For these reasons, we choose to investigate the predictive power of medium-term measures of managers' sentiment. Our sentiment metrics, which we use every month to rank stocks and construct portfolios, do not merely focus on the latest conference call but instead capture the sentiment



conveyed across all the conference calls of a firm within the last twelve months. We also assume a five-day lag between the date of a conference call and the availability of the transcript of that call for text mining purposes. This, coupled with the monthly rebalancing of our proposed investment strategies, means that, on average, we use a transcript for the first time twenty-one days after the date of the conference call.

Finally, we conduct our investigation over the period from 2004 to 2017, with securities selected from the large and mid-cap segment of the US stock market, which should help mitigate concerns that our findings are the results of significant limits to arbitrage.

### **Capturing the average level of managers' sentiment**

Apart from the longer-term nature of our sentiment indicators, our first signal family shares many similarities with prior work in this field. In line with previous studies, we compute a sentiment metric (Net Sentiment) based broadly on the difference between the occurrence of words with positive and negative connotations. In line with previous academic studies, we use the now widely accepted finance-specific Loughran and McDonald dictionary to identify words that convey positive and negative sentiments and only slightly modify this dictionary to account for the context of our study. For instance, an analysis of the frequency of positive and negative words points to some obvious misclassifications in the dictionary: The word "question" is widely used in Q&A sessions as managers often thank analysts for their "question" or ask for the next "question" to be raised. However, this word is assigned a negative connotation in the Loughran and McDonald dictionary. Therefore, to avoid obvious misclassifications, we exclude it from our analysis. The word "good" is also problematic since managers often wish attendees a "good morning", "good afternoon", "good evening" etc. - for which reason we do not consider the word "good" when it is accompanied by certain nouns that do not relate to the performance of the firm. Still further, when analysing the sentiment reflected by a conference call, we verify that no sentiment word is contained in the company name and, if so, we remove such words when text mining the transcripts. We then simply classify a sentence spoken by a manager as positive if it contains at least one positive expression, no negative expression and if no negation can be found. The opposite is done to identify negative sentences, and our overall indicator of sentiment for the call is the proportional difference between the positive and negative sentences across all identified managers. Finally, every month, a stock is given a score equal to the average value of its scores on all quarterly earnings conference calls available within the last twelve months, assuming a five-day lag between the date of the call and the availability of the transcript for text mining purposes.

In addition to this rather reductive measure of sentiment, which relies on a simple binary classification of words into positive or negative connotations, we conduct a sentiment strength analysis of the responses given by managers (Sentiment Strength). This requires that we recognize that positive and negative sentiment words can have different levels of Sentiment

Strength intensity, like "poor" and "horrible" or "good" and "outstanding". But it should also acknowledge that the Sentiment Strength of a word can be further boosted or attenuated through the addition of specific words. For instance, a low intensity "sad" can be turned into a high intensity "very sad". Similarly, a high-intensity emotion word like "great" can be lowered in intensity by an attenuating addition, "not so great". Still further, sentiment words can be negated, in which case their Sentiment Strength switches valence in our study. To perform this analysis, we partnered with a team of linguists who helped us devise a set of proprietary dictionaries that capture high and low-intensity sentiment words, as well as common boosters and degraders. Another important difference relative to competing dictionaries is our reliance on emotion words. For instance, the Loughran and McDonald dictionary was calibrated on annual reports and unsurprisingly it is lacking in emotional expressions, a unique feature of managers' responses in the Q&A session of earnings conference calls. Finally, as with Net Sentiment, a stock is assigned a monthly Sentiment Strength score that is equal to the average value of its scores on all the quarterly earnings conference calls available within the last twelve months, assuming a five-day lag between the date of the call and the availability of the transcript for text mining purposes.

The last indicator in the average sentiment family is a relatively unexplored, but nonetheless important, dimension of sentiment known as Self-Deprecation. This is what managers do when describing the performance of their firms in unfavourable terms. The rationale for this indicator is that when managers use an excessive amount of Self-Deprecation they may inadvertently reveal their lack of certainty about their firm's future prospects and, more generally, the validity of their statements. To identify Self-Deprecation one must attend to the occurrence of a first-person pronoun and a tentative word ("may", "could", "probably" etc.) or a negated certainty word ("sure", "certain", "obvious", "always", "clearly" etc.). Here again, the lists of tentative and certainty words were compiled by our team of linguists with particular attention to the specific context of our analysis. The signal construction follows the usual approach, where we use the last twelve months of quarterly earnings transcripts to come up with an average measure of Self-Deprecation.

A recurrent theme in linguistic studies is that the use of signals should always be relative. One control that comes immediately to mind is the personal style of managers. For instance, the results in Dzielski et al. (2017) and Davis, Ge, Matsumoto and Zhang (2015) suggest that managers have a personal linguistic style and one may want to control for it when assessing whether their tone is unusually optimistic or pessimistic. However, research on the identification of managers' linguistic style is still in its relative infancy, and there are arguably so many confounding effects that could impact the sentiment of the call that discerning a linguistic "fingerprint" seems rather daunting given our limited history of data. Instead, we decided to settle for a less ambitious, but nonetheless important, neutralization based on industry classifications. Industries tend to perform differently across the business cycle and may also be at different stages in their life cycle. For all these reasons, it seems reasonable to argue that the

sentiment of the call is likely to reflect the broad industry context and that this may be confounded with cues about firm-specific performance. Our industry-unadjusted sentiment signals give a score of +1 to those stocks in the top decile of their monthly distributions and -1 to those in the bottom decile. Using the subset of securities with signal values, we then compute industry-adjusted indicators that subtract from each score their industry averages. By construction, these metrics are bounded between -2 and +2. They give a value of zero to those industries where we cannot differentiate between firms based on the average sentiment of their managers, and they emphasize those firms where managers' sentiment is most at odds with that of their peers. Finally, every month we construct long/short portfolios based on the scores of the adjusted and unadjusted indicators, standardized so that the sums of the long and short positions are equal to +100% and -100%, respectively.

#### Capturing the Emotional Levelness of managers

The second dimension of sentiment captured in this study relates to its dynamics rather than its average level. In this sense, it captures a novel and, as it turns out, important linguistic dimension. One would anticipate that managers attempt to keep their emotions in check during an earnings conference call. Therefore, while we should observe some degree of variation between their reasoning intensity and the use of explicit sentiment expressions across sentences, any extreme deviations from a "natural" pattern would be highly suspicious. Either the managers are being deceptive or they are under some extreme pressure that makes them behave in an erratic manner. Our measure of Emotional Levelness is the variation of the change from one sentence to the

next in the proportion of words that convey either positive or negative emotions. Our measure is computed for each manager individually, as long as he/she speaks at least ten sentences. Every month, we average the indicator values of each manager over all available conference calls in the last twelve months and come up with a security-level value by weighting these individual managers' averages according to the number of sentences each spoke over the period. As with the average level of sentiment metrics, firms with a level of variability in emotion words that falls in the top decile of the distribution each month get a value of -1. Instead of comparing them against those conference calls with the lowest level of variability, we match against the ten percent of firms in the middle of the distribution. The assumption is that these should accurately reflect the natural level of variability between reasoning intensity and sentiment expressions. By contrast, an overly cohesive level of argumentation is unlikely to be natural and could even hint at deception - although in the context of conference calls, over-structuring an argumentation is surely not as troubling as being easily unsettled by questions. For similar reasons to those already discussed, we also industry-adjust our signal, and the resulting strategies go long and short portfolios based on the scores of each factor, standardized so that the sums of long and short positions are equal to +100% and -100%, respectively.

#### Signal combination

Finally, we compute a monthly composite Linguistic Indicator that is an equally weighted average of unadjusted portfolios based on Net Sentiment, a combination of Sentiment Strength & Self-Deprecation and Emotional Levelness. This combination is then re-scaled such that the resulting portfolio is 100%

Table 1  
Sample descriptive statistics

	Firms with signal	Averages of all firms with signal					
		Number of conference calls	Sentences per call	Total number of sentences	Managers per call	Sentences per call (most active manager)	Sentences per call (least active manager)
2005	1,058	3.35	134	457	1.63	135	26
2006	1,006	3.62	145	532	1.66	140	26
2007	1,063	3.57	147	534	1.69	139	24
2008	1,091	3.80	149	569	1.72	142	23
2009	1,090	3.90	161	627	1.75	149	23
2010	1,097	3.86	175	677	2.09	151	18
2011	1,111	3.86	180	696	2.08	153	18
2012	1,122	3.91	180	704	2.07	153	18
2013	1,130	3.88	181	700	2.04	153	18
2014	1,147	3.84	181	696	2.00	154	19
2015	1,146	3.84	182	700	2.00	153	19
2016	1,158	3.84	183	707	2.03	153	19
2017	1,148	3.88	183	709	1.97	153	19
Average	1,105	3.78	168	639	1.90	148	21

Source: Invesco calculations. Subject to rounding differences.

long and -100% short. As with the individual indicators, we also use the non-zero values from this portfolio to come-up with an industry-neutral version of the strategy.

### Sample and descriptive statistics

We conduct our investigation over the period from 2004 to 2017 and only consider the largest 1300 publicly traded US securities each year for inclusion in our study. Our universe is therefore a combination of large and mid-cap names, which should alleviate concerns that our findings are driven by significant limits to arbitrage. To compute the key variables of our analysis, we sourced all available transcripts of quarterly earnings conference calls for the stocks in our universe from FactSet Research Systems Inc. The transcripts of conference calls are XML formatted, which is key to easily targeting specific sections of the call or specific participants. These transcripts are also formatted in a consistent way, which further facilitates the text mining process. In short, each transcript has two main elements: one where information about each participant can be found and another that includes the Management Discussion and the Q&A sections of the call. Our analysis only considers managers' answers to questions from analysts in the Q&A section. To mitigate the risk of analysing text that does not relate to the answers of managers, we use a three-step filtering process. Firstly, we require a paragraph in the Q&A session to be flagged as an answer and that an ID for the person talking is available so that we can ascertain that a manager is indeed speaking. This is because, in a few instances, the questions from analysts are incorrectly flagged as answers. Secondly, the IDs in the previous step must be related to a participant identified as a corporate representative in the section on participant information. Some difficulties arise at this stage since the same participant may sometimes be assigned different IDs; it can also happen that only some of these IDs are shown to relate to a manager. We therefore consolidated the list of managers' IDs by matching names, accounting for the fact that the spelling of the names can sometimes change and the ordering of the first and last names can be switched. Thirdly, our analysis is

strictly limited to transcripts where the number of managers identified in the previous step is lower than six. The very rare instances where this number is greater than six typically relate to cases where analysts, corporate representatives and questions and answers were all incorrectly flagged in the participant information section and the Q&A section. Finally, to mitigate the impact of non-key representatives, we only consider those who speak more than five sentences in a given conference call.

In table 1, we report some descriptive statistics for our sample. While we collected data from 2004 onwards, the computation of our indicators requires the last twelve months of data, so that we start reporting monthly scores only from 2005 onwards. We are able to derive signal values for approximately 1100 names each month. The number of cross-referenced managers in the call who speak more than five sentences is just below 2. The most active participant speaks, on average, 148 sentences and the least active one only 21 sentences. The average number of sentences spoken by all identified managers in a call is 168. Given that we use the transcripts of approximately four quarterly earnings conference calls to compute our monthly signal values, we end up text mining a total of 639 sentences per company.

### Empirical analysis

In table 2, we report the performance of monthly re-balanced portfolios based on Net Sentiment, Sentiment Strength & Self-Deprecation and Emotional Levelness, as well as our composite Linguistic Indicator. The performance of the unadjusted portfolios is presented in panel A and that of their industry-adjusted counterparts in panel B.

It is interesting to note that the industry neutralization benefits only the average sentiment indicators. While the monthly portfolio return of the unadjusted Net Sentiment indicator is statistically insignificant over the study period, controlling for industries has a positive impact on both return and risk. A moderate risk reduction coupled with a noticeable increase in the average monthly portfolio return, from 35bp

Table 2  
Monthly performance of linguistic indicators

	Long (%)	t-Stat	Short (%)	t-Stat	Spread (%)	Stdev. (%)	t-Stat	MD (%)
<b>A. Unadjusted returns</b>								
Sentiment Strength & Self-Deprecation	0.13	1.79	-0.12	-1.93	0.25	1.46	2.11	11.00
Net Sentiment	0.09	0.92	-0.26	-1.77	0.35	2.77	1.59	19.03
Emotional Levelness	0.14	1.90	-0.14	-1.62	0.28	1.60	2.17	13.64
Linguistic Indicator	0.14	2.08	-0.19	-2.25	0.32	1.71	2.37	8.59
<b>B. Industry-adjusted returns</b>								
Sentiment Strength & Self-Deprecation	0.13	2.28	-0.10	-1.93	0.24	0.98	3.04	4.08
Net Sentiment	0.14	1.56	-0.27	-2.12	0.41	2.01	2.55	16.19
Emotional Levelness	0.06	0.76	-0.16	-2.23	0.22	1.42	1.97	12.77
Linguistic Indicator	0.09	1.92	-0.18	-2.98	0.27	1.10	3.03	7.90

Source: Invesco calculations.

Table 3  
Correlation matrix of linguistic indicators

	SS & SD	NS	EL	SS & SD ex Ind.	NS ex Ind.	EL ex Ind.
Sentiment Strength & Self-Deprecation	1.00	0.67	0.06	0.72	0.41	0.00
Net Sentiment	0.67	1.00	0.33	0.37	0.67	0.21
Emotional Levelness	0.06	0.33	1.00	-0.16	0.15	0.89
Sentiment Strength & Self-Deprecation ex industry	0.72	0.37	-0.16	1.00	0.43	-0.08
Net Sentiment ex industry	0.41	0.67	0.15	0.43	1.00	0.22
Emotional Levelness ex industry	0.00	0.21	0.89	-0.08	0.22	1.00

Source: Invesco calculations.

prior to the industry adjustment to 41bp afterwards, combine to generate statistically significant strategy returns. For the combined Sentiment Strength & Self-Deprecation indicator, the industry adjustment leaves the monthly spread return barely unchanged at 24bp, but it also reduces the risk of the strategy and leads to a significant increase in t-statistic from 2.11 to 3.04.

By contrast, the net impact of the industry adjustment is negative for Emotional Levelness. Its risk is reduced, but this comes at the expense of a proportionally larger reduction in monthly returns. However, irrespective of whether or not we implement an industry adjustment, we always find that this strategy earns a statistically significant monthly return over the period of our analysis. The unadjusted monthly return is of similar magnitude to that of the average sentiment indicators at 28bp, and it decreases to 22bp when industry neutralizing the strategy.

One additional noteworthy result is the asymmetric performance of Net Sentiment, where all the predictive power of the signal comes from the short side, both before and after the industry neutralization. This is in contrast to the combined Sentiment Strength & Self-Deprecation indicator, whose predictive power is equally shared between the short and long sides of the strategy. Emotional Levelness also shows balanced predictive power before industry neutralizing the indicator but, as with Net Sentiment, the short side largely dominates after the industry neutralization. These observations are important given well-known impediments to short selling. In fact, one would be

well advised to recognize these differences when combining the signals and depart from the equally weighted combination that we use in this study for illustration purposes.

The correlation matrix of strategy returns in table 3 broadly supports the notion that the average sentiment indicators and Emotional Levelness capture different dimensions of managers' sentiment. While Net Sentiment only displays moderate positive correlations with Emotional Levelness, at 0.33 before the industry adjustment and 0.22 afterwards, the correlation between Emotional Levelness and the combined Sentiment Strength & Self-Deprecation indicator is largely insignificant. In short, there should be important diversification opportunities from using a combination of these linguistic signals. This can be readily seen in table 2, where we find that the combined strategy earns some of the highest return-to-risk ratios (t-statistics) before and after the industry neutralization. The signal monthly returns are also significant and equal to 32bp before the industry neutralization and 27bp thereafter.

#### Abnormal performance of linguistic indicators

The next important question to answer is whether our strategies continue to earn significant returns once we control for common drivers of equity returns. When implementing a control, we only consider the industry-adjusted versions since the use of relative signals is a priori our preferred way of handling linguistic information. The common drivers that we use include all the factors in the newly introduced five-factor model of Fama and French

Table 4  
Performance of common drivers of equity returns

	Spread (%)	Stdev. (%)	t-Statistic	Max. Drawdown (%)
Mkt-RF	0.73	4.09	2.24	51.51
SMB	0.07	2.38	0.37	16.13
HML	-0.02	2.56	-0.08	28.00
RMW	0.28	1.56	2.23	12.10
CMA	0.02	1.38	0.14	15.58
UMD	0.10	4.53	0.27	57.42

Source: Kenneth French's website ([http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data\\_library.html](http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html)) and Invesco calculations.

Table 5  
Abnormal performance of linguistic indicators

	Alpha	Mkt-RF	SMB	HML	RMW	CMA	UMD	Adj. R2
<b>A. Sentiment Strength &amp; Self-Deprecation</b>								
Coefficient	0.26%	-0.02	-0.10	-0.09	-0.02	0.06	0.01	0.15
t-Statistic	3.47	-1.10	-2.92	-2.38	-0.43	0.92	0.58	
<b>B. Net Sentiment</b>								
Coefficient	0.48%	-0.06	-0.04	-0.22	-0.10	-0.13	0.07	0.20
t-Statistic	3.13	-1.42	-0.56	-3.00	-0.92	-1.09	2.06	
<b>C. Emotional Levelness</b>								
Coefficient	0.20%	0.08	-0.07	-0.13	-0.09	-0.04	-0.04	0.08
t-Statistic	1.74	2.33	-1.28	-2.33	-1.14	-0.40	-1.33	
<b>D. Linguistic Indicator</b>								
Coefficient	0.28%	0.01	-0.07	-0.17	-0.05	-0.04	0.03	0.26
t-Statistic	3.43	0.32	-1.90	-4.40	-0.96	-0.57	1.75	

Source: Invesco calculations.

(2015). These are: the excess return on the market portfolio (Mkt-RF), the returns of a size portfolio (SMB), a book-to-market portfolio (HML), a portfolio that captures the operating performance of the firms (RMW) and one based on their asset growth (CMA). In addition to these factors, we also control for the returns of a price momentum portfolio (UMD). All these portfolio returns were sourced from Kenneth French's website.

In table 4, we report performance statistics for all the control variables in this analysis. One of the most striking features in this table is that almost all non-market factors earned insignificant premiums over the thirteen-year period of our study. The only significant non-market factor is RMW. Incidentally, this factor was only recently added to the Fama and French asset pricing model after operating profitability became popularized by Novy-Marx (2013) over the period of our analysis. This is perhaps indicative of the singularity of our study period, and one should therefore remain cautious before extrapolating our findings too much.

The first key observation in table 5, where we report the results of spanning tests on our strategies, is

that each one of them earns an abnormal return that is statistically significant at conventional levels. Moreover, with the exception of Emotional Levelness, the magnitude of these abnormal returns is typically higher than their raw values. For the average sentiment metrics, this can be explained by the fact that the strategies earned a negative market beta at a time when the market performed particularly well. In turn, the abnormal return of the combination of Sentiment Strength & Self-Deprecation increases to 26bp when its raw return is equal to 24bp. Similarly, the abnormal return of the Net Sentiment strategy reaches a staggering 48bp per month, a 7bp improvement over and above its raw return. By contrast, Emotional Levelness has a significant positive market beta that detracts from performance. While its raw return is 22bp, its abnormal return is only slightly lower at 20bp per month. The net effect on the Linguistic Indicator is marginal; its abnormal return increases to 28bp from a raw value of 27bp.

A second interesting observation is that all signals are significantly negatively exposed to HML. These findings are corroborated by the correlation matrix presented in table 6, where we show that the Linguistic Indicator behaves most similarly to a

Table 6  
Correlation matrix of factor returns

	SMB	HML	RMW	CMA	UMD	Linguistic Indicator
SMB	1.00	0.31	-0.38	0.14	-0.20	-0.27
HML	0.31	1.00	-0.23	0.50	-0.41	-0.50
RMW	-0.38	-0.23	1.00	0.00	0.23	0.09
CMA	0.14	0.50	0.00	1.00	-0.11	-0.28
UMD	-0.20	-0.41	0.23	-0.11	1.00	0.31
Linguistic Indicator	-0.27	-0.50	0.09	-0.28	0.31	1.00

Source: Kenneth French's website ([http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data\\_library.html](http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html)) and Invesco calculations.

Momentum indicator and displays a strong negative correlation with Fama and French's Value factor. However, given the poor performance of HML during the period of our analysis, we also find that exposures to this common driver of equity returns are not enough to explain away performance. The significant abnormal return earned by each strategy and the weak performance of most common drivers of equity returns during the period should not obfuscate the fact that these factors explain a quarter of the variation in the monthly strategy returns of our Linguistic Indicator. In other words, while the return of our combined indicator is not spanned by common drivers of equity returns, its exposures to these factors indicate that the strategy may still be subject to a significant amount of systematic risk.

### Robustness to different holding periods

Lastly, we investigate the persistence of the predictive power of our strategies, as this should give important insights into the ease with which they could be implemented into our portfolio. If the predictive power of our indicators was to remain significant over several months, one could contemplate reducing the frequency and/or magnitudes of portfolio rebalances and, in turn, incur lower implementation costs. To assess whether this is the case, we test the monthly performance of a strategy where each month the strategy portfolio is an equally weighted average of the previous T monthly portfolios, rescaled such that holdings are 100% long and -100% short. T is varied from one to twelve, meaning that a portfolio created twelve months ago could be used to harvest the next month's strategy returns.

The results of this analysis for the industry-adjusted linguistic indicators are presented in table 7. In panel A, we report our findings for the combined Sentiment Strength & Self-Deprecation indicator.

The return of the strategy is relatively persistent and only ceases to be significant at conventional levels for holding periods longer than nine months. Nonetheless, the drop in return is substantial, from 24bp in the unconstrained version down to 13bp with a nine-month holding period.

Panel B presents results for Net Sentiment, which also appears to be the signal with the fastest decaying predictive power. The return of the strategy is significant for holding periods shorter than eight months. A strategy based on the holdings of the last eight monthly portfolios generates a return of 26bp per month, which is 15bp lower than its unconstrained value.

Compared to Net Sentiment, the predictive power of Emotional Levelness in panel C appears to be highly persistent. The return of the strategy continues to be significant when averaging the holdings of the last eleven monthly portfolios. Using this holding period, the abnormal return of the strategy is equal to 13bp, which is only 9bp lower than the abnormal return of the unconstrained approach.

Finally, the results for the combined indicator in panel D are particularly impressive and a testament to the significant diversification opportunities available when combining the individual strategies. The strategy earns a significant return until averaging the holdings of the last twelve monthly portfolios. Using this holding period, the strategy earns a monthly return of 16bp, which is on par with the highest spread return across the set of individual strategies. In all, these results suggest that there is ample room to meaningfully reduce turnover and implementation costs by combining our linguistic signals in a way that best recognizes their distinct information decays.

Table 7

### Robustness to different holding periods

	A. Sentiment Strength & Self-Deprecation		B. Net Sentiment		C. Emotional Levelness		D. Linguistic Indicator	
	Spread (%)	t-Statistic	Spread (%)	t-Statistic	Spread (%)	t-Statistic	Spread (%)	t-Statistic
t	0.24	3.04	0.41	2.55	0.22	1.97	0.27	3.03
[t-1; t]	0.24	3.16	0.40	2.59	0.26	2.55	0.30	3.62
[t-2; t]	0.24	3.14	0.36	2.34	0.25	2.56	0.30	3.64
[t-3; t]	0.22	2.87	0.32	2.04	0.26	2.73	0.29	3.66
[t-4; t]	0.19	2.54	0.28	1.77	0.25	2.74	0.28	3.50
[t-5; t]	0.18	2.38	0.27	1.70	0.23	2.66	0.26	3.36
[t-6; t]	0.16	2.20	0.27	1.72	0.22	2.58	0.26	3.29
[t-7; t]	0.14	1.92	0.26	1.65	0.19	2.33	0.24	3.03
[t-8; t]	0.13	1.71	0.23	1.51	0.17	2.04	0.22	2.76
[t-9; t]	0.11	1.45	0.23	1.48	0.15	1.89	0.19	2.50
[t-10; t]	0.10	1.33	0.21	1.35	0.13	1.70	0.17	2.25
[t-11; t]	0.09	1.26	0.18	1.16	0.11	1.53	0.16	2.06

Source: Invesco calculations.

## Conclusion

Our main findings on the textual analysis of earnings conference calls suggest that the insights gathered from this burgeoning area of research can find their way into implementable trading strategies in a manner that adds substantively over and above traditional drivers of equity returns. Another important takeaway is that it is not merely the average sentiment of managers during an earnings conference call that matters for future returns, but that one should also pay attention to the dynamics of their interaction with analysts. Future research will be invaluable in ascertaining the robustness of these initial findings, which have galvanized our interest in this apparently useful source of new information.

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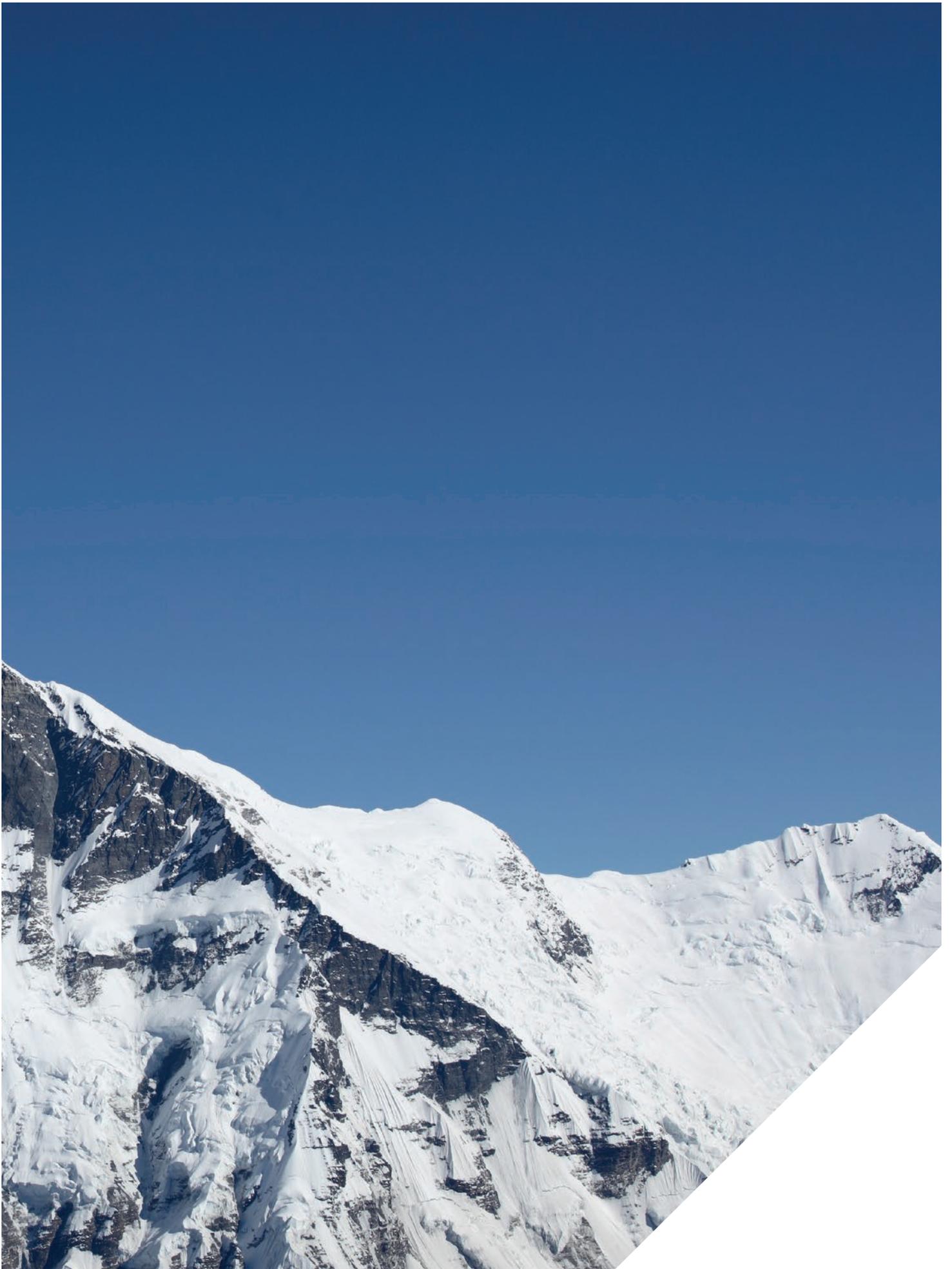
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