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

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

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.

Factor investing has become mainstream, but most approaches still focus on equites. 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.[1] 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.[2] 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,[3] 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.

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

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
– Cocoa	– Brent Crude	– Aluminum	– Gold
– Coffee	– Gas Oil	– Copper	– Silver
– Corn	– Gasoline	– ~~*Lead*~~	
– ~~*Cotton*~~	– Heating Oil	– Nickel	
– ~~*Feeder Cattle*~~	– Natural Gas	– Zinc	
– ~~*Lean Hogs*~~	– WTI Crude		
– ~~*Live Cattle*~~			
– Soybeans			
– ***Soybean Oil***			
– ***Soy Meal***			
– ~~*Sugar*~~			
– Wheat			
– Wheat (KC)			

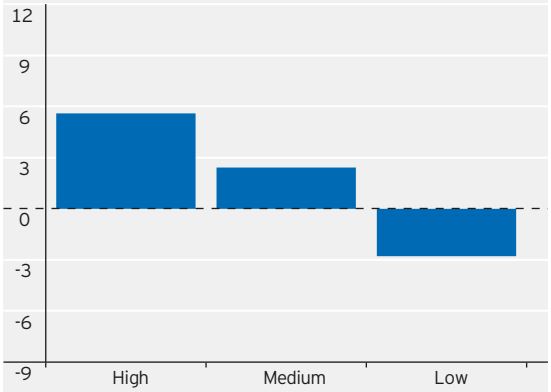
Legend: ~~*Included in GSCI, not in strategy*~~
Not included in GSCI, included in strategy

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"

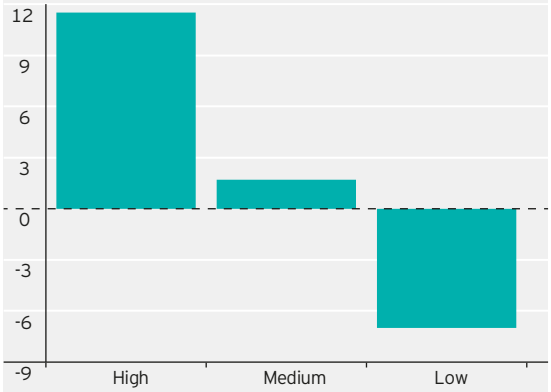
Simulated annualized excess return by factor rank, in %
(30 June 1998 – 30 June 2018)



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.[4] 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.[5] 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.[6] Figure 2 depicts historical results for carry.

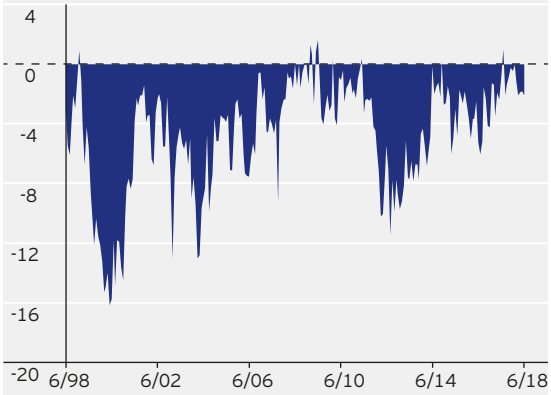
Value

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.[7] 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

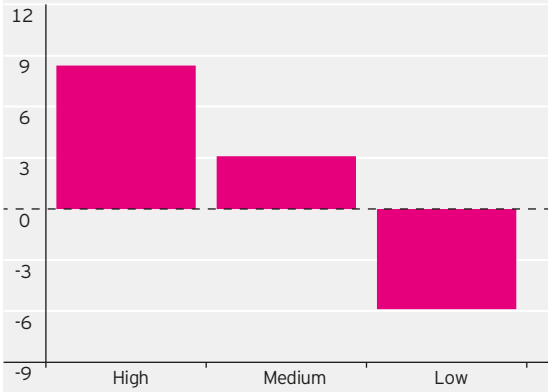
Defensive strategies cover a range of approaches, including quality (Asness, Frazzini and Pedersen [2013]) and low volatility (Haugen and Heins [1975]). Although some research has explored a cross-sectional low volatility strategy in commodities (Lin [2017]), we chose to define our defensive strategy 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, 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 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"

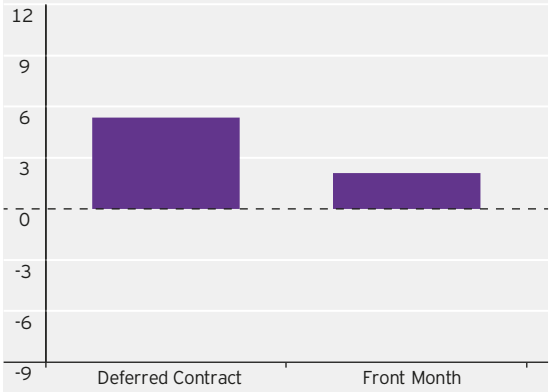
Simulated annualized excess return by factor rank, in %
(30 June 1998 – 30 June 2018)



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.**

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.

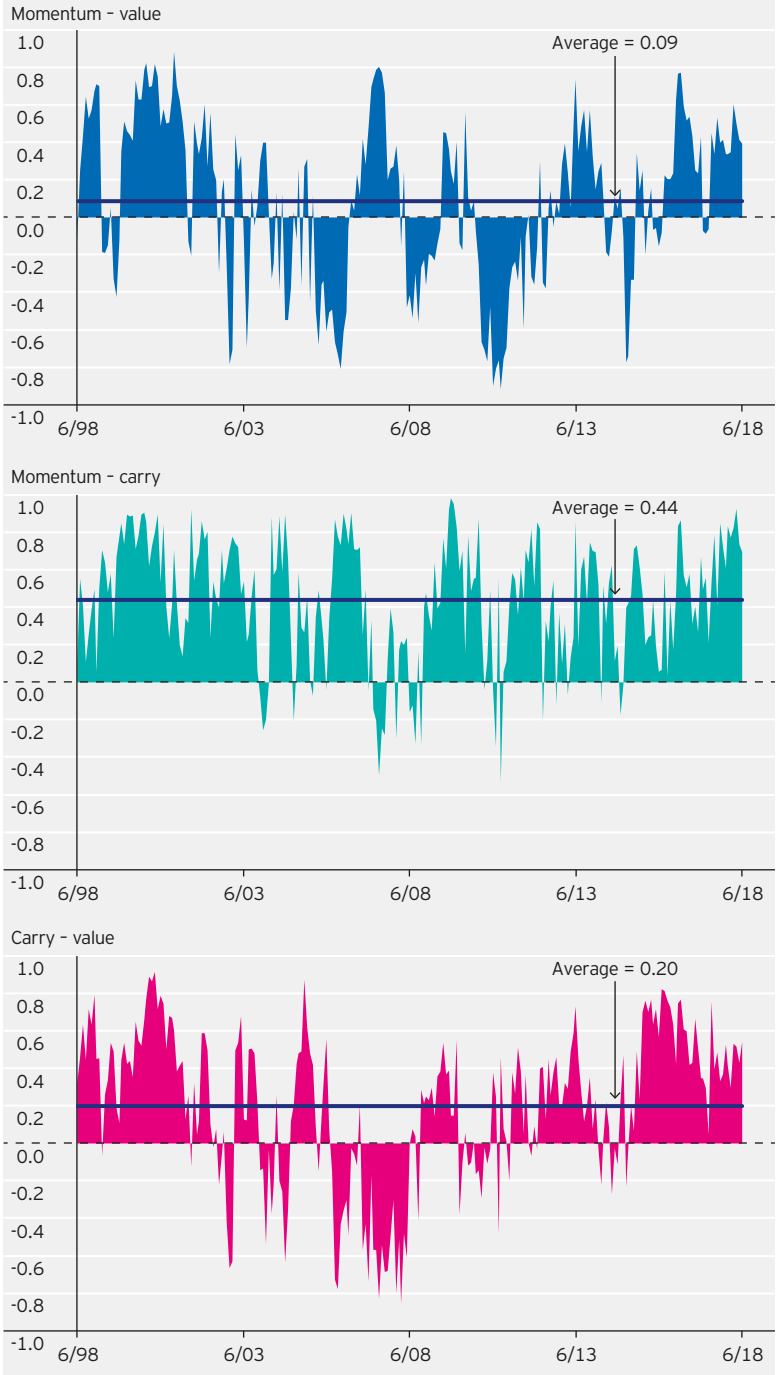
As a result, we use a risk parity framework for long/short factor construction. The process has two steps: First, we calculate the long-side asset weights, such that each individual asset has the same marginal risk contribution to the long-side portfolio. We apply the same process to create the short-side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

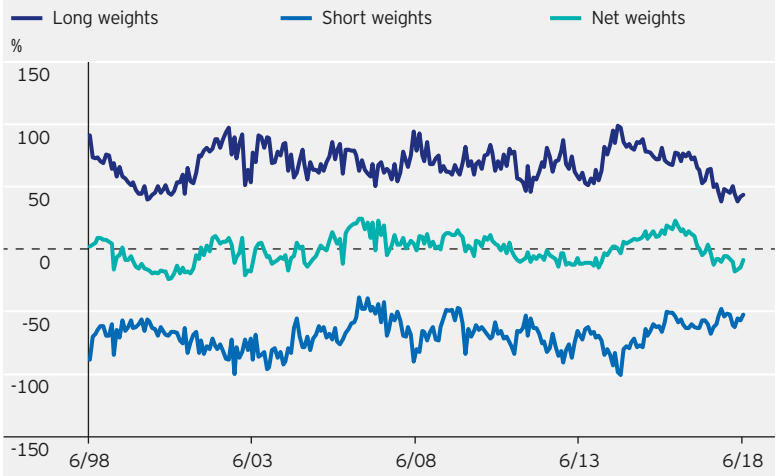
Of course, some turnover is simply noise. Changes of one or two percent in commodity weights in any given month may have very limited influence on results but still have a large cumulative effect on turnover and costs. Accordingly, we explored how limiting trades to only the most meaningful ones would 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.

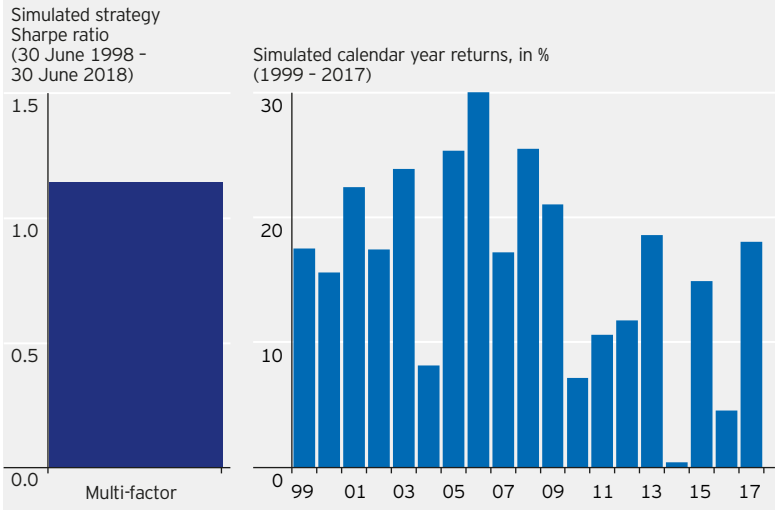
The historical performance of the strategy, even after imposing the constraints described above, lends strong support for factor investing in commodities. As shown below, the high Sharpe ratio for the full period studied is driven by consistent returns by calendar year (top right panel in figure 8). 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.

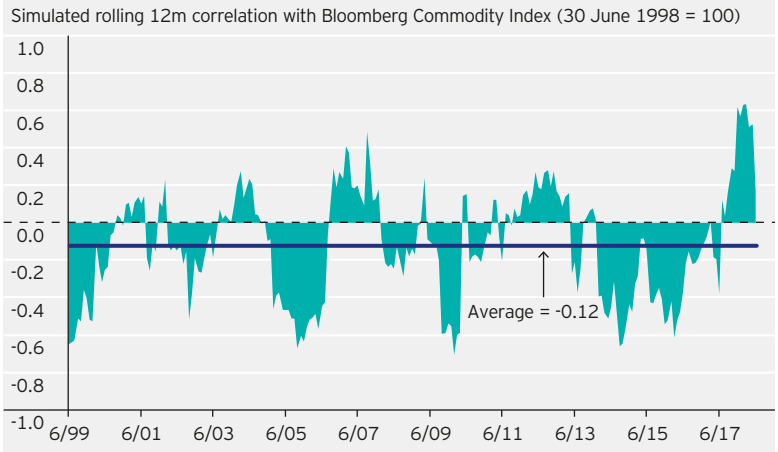
Figure 7
Simulated exposures



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

Figure 8
Returns and correlations





Sources: Bloomberg, Invesco analysis. Data as at 30 June 2018. **Figures refer to simulated past performance and past performance is not a reliable indicator of future performance.**

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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