Idiosyncratic momentum in commodity futures

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Abstract

This paper provides novel findings on idiosyncratic momentum in commodity futures. Momentum strategy that forms portfolios on the basis of commodity-specific returns delivers compelling investment returns which are substantially more robust and superior to total return momentum on an absolute and risk-adjusted basis. Furthermore, idiosyncratic return momentum is materially more persistent than total return momentum in that it delivers statistically significant positive returns over longer term horizons including ranking periods of up to 24 months. A set of commodity specific and equity markets inspired factors are examined. Notably, the results corroborate that hedging pressure and term structure are sources of risk premium in commodity futures. The analysis in this chapter expose that momentum in commodity futures is fundamentally different to the momentum effect in equity markets. Specifically, momentum in commodity futures is entirely attributed to the momentum effect in long-only portfolios whilst none of the short-only strategies' returns are either profitable or statistically significant. Lastly, the two types of long-only momentum significantly outperform a passive investing into a broad market index such as S&P GSCI.

Keywords: momentum, risk premium, idiosyncratic return, commodity futures, equity markets, factor investing

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1. Introduction

Momentum effect, which is a tendency of recent winner stocks to continue to rise and the recent loser stocks to continue to fall, is the most puzzling anomaly in the asset pricing literature. Momentum strategy, first formally documented in the U.S. equity market by Jegadeesh and Titman (1993), implemented by buying past winners and selling past losers, is a bet on past returns predicting a cross-section of future returns. Fama and French (1996) posit that their three-factor model which includes market risk, size and value premiums cannot explain returns to momentum and call it a 'premier anomaly'. Two explanations have been provided in the literature as to what causes momentum effect - behavioural and risk-based. To date, however, there is no consensus on what exactly causes momentum effect in security prices. Since it was first documented in the literature the research on momentum investing has grown exponentially. Yet, the literature on momentum is dominated by the evidence from equity markets. With the phenomenal rise of factor investing across asset classes over the recent years, the research on momentum style and factor investing more generally outside equity markets is becoming ever more important for academics and practitioners alike. Commodity futures provide an interesting case for momentum style research. Firstly, empirical evidence suggests that unlike returns to equities, returns to commodity futures do not follow random walk (Stevenson and Bear 1970). This implies that investment strategies based on past performance patterns may lead to profitable outcomes. Secondly, there are strong implementation advantages of momentum in commodity futures over equity markets. Momentum investing in equity markets entails high portfolio turnover, and as a result, higher trading costs relative to other factor styles. In comparison to equity markets, trading costs in commodity futures are very low. Furthermore, in contrast to equity markets there are no constraints on short-selling in commodity futures.

We make several important contributions to the research on momentum style, systematic factors and active investing in commodity futures. Firstly, we provide novel findings on the idiosyncratic momentum effect in commodity futures. Conventional momentum strategy, as documented in the seminal work by Jegadeesh and Titman (1993), selects securities based on total returns over a ranking period. In contrast, idiosyncratic momentum strategy selects stocks based on its idiosyncratic returns over a ranking period. The rationale behind idiosyncratic returns momentum stems from the extensive empirical evidence on time-varying momentum exposure to systematic factors (Grundy and Martin 2001) and pronounced momentum crashes that a conventional momentum strategy occasionally suffers from (Daniel and Moskowitz 2016). Specifically, conventional momentum loads positively on systematic factors when these factors performed well in the ranking period and, conversely, it loads negatively on the factors that performed poorly in the ranking period. As a result, if the sign of a factor's returns that the momentum strategy has exposure to changes between a ranking and holding period, the conventional momentum suffers. Blitz et al. (2011) and Chaves (2016) document a robust performance of idiosyncratic momentum in the US and 23 international equity markets. To the best of our knowledge, this paper is the first to empirically examine idiosyncratic momentum in commodity futures. We find that momentum strategy that selects commodity futures contracts on the basis of idiosyncratic return over a ranking period is a substantially more robust strategy that consistently yields higher returns on absolute and risk-adjusted basis than total returns momentum.

Secondly, our analysis exposes that commodity futures momentum is starkly different to momentum in equity markets. Despite more than 20 years of research on momentum, by far the major part of the existing literature is focused on cross-sectional total return momentum in equity markets whilst the research on momentum in other asset classes remains underdeveloped. Notably, commodity futures have been included in studies on momentum alongside other classes (Moskowitz et al. 2012, Georgopoulou, A., and J. Wang. 2016). Commodity futures however have distinct features compared to equity markets. Specifically, commodity returns are driven by factors that are very different from those affecting stocks and bonds. Further, there are material differences in the market microstructure and trading between commodity futures and cash equities. We hypothesize that the momentum effect in commodity futures may have a different manifestation to the momentum effect in equity markets. Our empirical analysis corroborates this conjecture. Namely, momentum in commodity futures is entirely ascribed to long-only portfolios. This is in a stark contrast to equity markets where empirical studies document strong or dominating attribution to the strategy's profitability by short portfolios. Specifically, long-only momentum in commodity futures is a profitable and robust strategy across two types of momentum, total return and idiosyncratic, and a range of implementations whist none of the short portfolios deliver positive or statistically significant returns. Long-only portfolios consistently deliver a significant average annualized return of 10%. In contrast, short portfolios consistently detract value. Notably, the returns to portfolios that short losers are consistently negative which, in the presence of statistical significance, would be indicative of short term reversal patterns. As a result, a total return long-short momentum strategy yields statistically significant returns in only 4 out of 144 implementations with an average annualized returns of 7% across statistically significant strategies. Idiosyncratic momentum yields a substantially improved performance in the long-short implementation relative to a conventional total return momentum. Namely, the strategy is statistically significant in 21 out of 144 implementations with an average annualized return of 12.3% across statistically significant strategies. Further, the idiosyncratic long-short momentum yields a Sharpe of 0.65 versus 0.36 for total return long-short momentum.

Our findings with respect to long-only momentum are consistent across both total return and idiosyncratic return momentum. Whilst only 4 out of 144 total return long-short strategies are statistically significant with an average annualized return of 7%, long-only total return momentum yields an average annualized return of 10% and is statistically significant in 51 out of 144 implementations. Remarkably, the idiosyncratic return long-only momentum generates 10% annualized average return and is statistically significant in 126 out of 144 implementations. Furthermore, idiosyncratic returns momentum is also highly persistent in that it holds also across long horizons including 24 months ranking periods. Overall our findings show that a commodity futures investor would have benefited from implementing long-only momentum, especially an idiosyncratic long-only momentum which is a strikingly robust and profitable strategy, as opposed to momentum in its traditional total return long-short format. Both type of long-only momentum substantially outperform a passive investing in S&P GSCI on absolute and risk-adjusted basis.

Our analysis of factor-mimicking portfolios provides important empirical evidence on the systematic factors in commodity futures. In contrast to equity markets, where there is virtually a universal evidence on the existence of several risk premia, the consensus on systematic factors in commodity futures is yet to be reached. In our analysis of systematic factors we turn to principal theories in commodity futures, that is the theory of normal backwardation, theory of storage and hedging pressure hypothesis, as well as equity markets inspired systematic risk premiums such market, size and value. We find strong evidence that term structure and hedging pressure are the sources of positive risk premia in commodity futures.

Further, our findings on momentum and factor mimicking portfolios have important practical implications to investors in commodity futures and future research avenues. The epic price run-up in commodity markets over 2003-2014 has triggered a lot institutional investors' appetite for the asset class. With the collapse in oil prices and subsequent bear market, long-only passive investing in commodities lost its lustre among institutional investors. Despite the unattractive risk-adjusted performance of a long-only passive investing, there is evidence in support of active investing in commodity futures. The empirical findings in this article corroborate the case for active investing strategies such as momentum in commodity futures.

The rest of this article is organized as follows, section 2 provides the theoretical framework on idiosyncratic momentum and systematic factors in commodity futures, section 3 and 4 lay out the methodology and data description, sector 5 provides empirical findings and section 6 concludes.

2. Theoretical Framework

2.1 Idiosyncratic return momentum in equity markets

This article is motivated by the recent findings on idiosyncratic momentum phenomenon in equity markets by Chaves (2016) and Blitz et al. (2011). The authors advance the seminal work of Grundy and Martin (2001) that demonstrates that momentum has dynamic exposures to Fama and French factors (1993). Grundy and Martin (2001) propose a hypothetical momentum strategy that dynamically hedges systematic factors' exposure. Despite significant improvement in performance that this hypothetical strategy yields ex-post, the dynamic factor hedging in momentum strategy is difficult to implement ex-ante. Gutierrez and Prinsky (2007) advance this strand of momentum research by distinguishing between traditional cross-sectional total returns momentum, as originally proposed by Jegadeesh and Titman (1993), and firm specific momentum. Gutierrez and Prinsky (2007) document that both types of momentum portfolios perform similarly in the first year upon portfolio formation; however, there is a striking difference beyond one year. Specifically, profits to the standard relative momentum portfolios in equity markets reverse in 2-5 years after formation which suggests overreaction to relative returns. In contrast, the abnormal firm-specific returns that follow corporate events such as earnings surprises, dividend changes, share repurchase, stock splits continues for years without reversing. The authors attribute the difference in performance between the two types of momentum to the reversal in systematic factors returns.

Blitz et al. (2011) document idiosyncratic returns momentum anomaly in the US Equity market. The authors propose an implementable idiosyncratic return momentum strategy that yields substantially improved performance relative to conventional total returns momentum. Specifically, their idiosyncratic returns momentum strategy ranks stocks cross-sectionally on the basis of residual returns which are obtained by neutralizing Fama and French (1993) market, size and value factors. Since idiosyncratic returns momentum selects securities based on the performance of an idiosyncratic component in the formation period, the strategy by construction is not impacted by systematic factors' performance reversals. The authors document that the idiosyncratic momentum strategy earns risk-adjusted returns that are about twice as large as those of a conventional momentum. Blitz, Huij, and Martens (2011) argue that apart from substantially higher risk-adjusted returns, the idiosyncratic equity returns momentum strategy improves performance in several other ways. The returns of the idiosyncratic momentum appear to be more consistent over time and less concentrated in the extremes of cross-section of stocks such as small cap, high beta or illiquid stocks.

Chaves (2016) corroborates this finding and documents an evidence in support of idiosyncratic momentum in 21 international equity markets in addition to the U.S equity. Similar to Blitz et al. (2011), the strategy he proposes selects stocks based on the idiosyncratic return ranking relative to the cross-section. Methodologically the strategies of Blitz et al. (2011) and Chaves (2016) differ in that the latter extracts residual return from a regression of total returns on market portfolio whilst Blitz et al. (2011) also include size and value factors. Chaves (2016) argues that the vast majority of improvements in idiosyncratic momentum strategy of Blitz et al. (2011) can be attributed to the market portfolio. In essence, the improvements that the idiosyncratic strategy achieves by neutralizing size and value factors are limited. The author reports that the idiosyncratic momentum strategy delivers superior investment outcomes in all international equity markets. Notably, the profitability of the idiosyncratic returns momentum persists far beyond the 12 months holding period.

2.2 Systematic factors in commodity futures

The rationale behind idiosyncratic returns momentum is predicated on the decomposition of a security's total returns into returns attributed to a security's exposure to systematic factors and an idiosyncratic component. The literature on systematic risk factors in traditional asset classes such as equity market is well established. The empirical evidence is virtually universal on the existence of at least three systematic factors in equity markets, that is market, size, and value (Fama and French 1993). Unlike in equity markets, there is no strong consensus thus far as to what determines the cross-sectional variation in commodity futures returns. Several approaches, which can be broadly categorized into equity inspired, namely those derived from traditional asset pricing models, and commodity-specific have been proposed in the commodity markets literature.

For traditional asset classes, market risk premium, or the market factor, corresponds to the market capitalization-weighted return of a broadly diversified portfolio. For instance, the S&P 500 and JP Morgan US Government Bond Index are conventionally used as market factor proxies of the US equity and US bond markets respectively. In a similar vein, S&P GSCI or an equally-weighted basket of commodities has been used as a proxy of market risk premium in commodity futures. The theoretical and empirical support on S&P GSCI or an equally-weighted portfolio being a systematic risk premium in commodity futures is however mixed. For instance, Basu and Miffre (2013) document that price risk associated with S&P GSCI is zero both statistically and economically. In a different line of research, Blitz et al. (2014) point that the commodity market premium, as proxied by S&P GSCI, has provided Sharpe ratio of merely 0.06 compared to 0.35 for Equity Market Premium and 0.49 for Government Bond Premium.

Value and size factors have become virtually the most popular investment styles in traditional asset classes. Value factor stems from the mean reversion literature of De Bondt and Thaler (1985) and Jegadeesh and Titman (2001). In equity markets the commonly used measure of value factor is the ratio of the book value of equity to market value of equity

(Fama and French 1992, Lakonishok et al.1994). For the size premium, the theoretical construct predicts that stocks with low market capitalizations can be expected to earn higher returns than stocks with higher market capitalizations. There are no commonly accepted measures of value nor size in commodity futures thus far. To examine value effect in commodity futures, Asness et al. (2013) propose the log of the spot price 5 years ago divided by the most recent spot price, which effectively is the negative of the spot return over the last 5 years, as a measure of value factor.

Commodity specific factors are intended to capture risk premia specific to the shape of a commodity's term structure and risk transfer dynamics between hedgers and speculators. Two key factors, hedging pressure and term structure, have been proposed and substantiated in theoretical and empirical literature. The existence of hedging pressure premium stems from the two principal theories in commodities literature, namely the hedging pressure hypothesis and the theory of storage. The hedging pressure hypothesis was first proposed by Keynes (1930) and Hicks (1939) who argue that a commodity futures risk premium is a premium provided to speculators as a reward for accepting the price risk that the hedgers seek to transfer. In essence, this theory predicts that the commodity futures premium is positive only in backwardated markets. On the other hand, the theory of storage (Working 1949, Brennan 1958) suggests that the variation in futures prices is related to storage and inventories rather than hedging pressure. Hirschleifer (1990) solves this divergence by proposing the generalized-equilibrium hedging pressure hypothesis which reconciles the theory of Keynes (1930) and Working (1949). In effect, the theory of Hirschleifer postulates that risk premiums are present in both backwardated and contangoed markets. The theory states that the net long (short) speculators demand a risk premium for taking on the risk of price decline (increase) that the net short (long) hedgers aim to mitigate. Basu and Miffre (2013) provide a strong empirical support of hedging pressure being a systematic factor in determining the commodity futures returns. They also document that hedging pressure risk premium explains the performance of active commodity strategies substantially better as compared to S&P GSCI or an equally-weighted basket of commodities.

The term structure factor stems from the theory of storage. Fama and French (1987), Erb and Harvey (2006) or Gorton and Rouwenhorst (2006) empirically validate that term structure of commodity futures has been historically awarded with above average returns. Term structure underpins the relation between futures prices and the maturity of futures contracts. The theory of storage connects the shape of the term structure to the levels of inventory, costs and benefits of holding a physical commodity. In effect, term structure factor captures the risk premium earned when buying commodities in scarce supply and shorting commodities in abundant supply. More specifically, an excess return of a commodity future consists of a spot return, which is a change in spot price, and roll return which is a return an investor gets by periodically selling an expiring contract and buying the next to expiry contract. It is thus evident that the shape of a term structure drives the roll return. If term structure of a commodity is upward-sloping, namely a contangoed market, this implies negative roll return. In contract, a downward sloping term structure, which is a backwardated market, implies a positive roll return. Term structure (or Roll return) factor has been extensively substantiated in the empirical literature. Erb and Harvey (2006) note that roll returns explain 91% of the long run cross-sectional variation of commodity futures returns.

3. Data

To carry out the analysis in this chapter we collect data for monthly futures prices for 28 commodities from Bloomberg. The cross section of commodity futures includes several sectors covering agriculture (corn, soybean, sugar, wheat, soybean oil, soybean meal, live cattle, wheat hard winter, lean hogs, coffee, cotton, cocoa, wheat red sping and feeder cattle); energy (WTI, Brent, natural gas, gasoline, heating oil and gasoil), and metals (aluminium, copper, zinc, nickel, lead, gold, silver, platinum). All contracts are traded in the US dollars on the major futures exchanges, namely CME, LME, ICE which are the largest and most liquid markets for derivatives trading. We filter out futures contracts with average trading volume below 1000 contracts. Such choice of contracts and exchanges where these contracts are traded minimizes issues related to practical implementation, particularly liquidity and transaction costs. The data sample is from August 1997 to July 2017. We follow methods used in existing literature in designing the futures price series by holding the closest to maturity contracts until three trading days prior to expiry, then we roll the series to the returns of the next contract and so forth. This method allows us to obtain data for the three closest to expiry contracts in the term structure for any given commodity on any given day. The majority of commodities trade with monthly expiries, however certain commodities roll more infrequently or irregularly, for this reason we do not roll into a new contract if there is greater open interest in a contract with a longer expiry. This methodology provides us with two separate datasets. One contains daily returns, which are used for measuring momentum, portfolio returns and any calculations relating to a historical price. The second dataset takes the price, which does not adjust for rolling, but merely appends the series with the price of the new contract. This data is used for term structure calculations, which the former data cannot provide due to the adjustments.

In order to construct factor mimicking portfolios in addition to the price series of commodity futures we use the data on open interest for each contract, S&P GSCI index and the data on position of hedgers and speculators. The data on the positions of hedgers and speculators is obtained from the CFTC Commitment of Traders report and is available from 2006. We do not consider the position of non-reportable traders as this category cannot be identified as hedgers or speculators. The positions of hedgers and speculators are reported every Friday at a weekly frequency. Hedging pressure (HP) for a category (speculators or hedgers) is defined as the number of long contracts in that category divided by the total number of contracts in the category. For example, a hedging pressure of 0.3 for hedgers means that over the previous week 30% of hedgers were long, a clear sign of a backwardated market. Vice versa, a hedging pressure of 0.3 for speculators means that over the previous week 30% of speculators were long, which implies contangoed market.

4. Methodology

The analysis of a conventional total return momentum follows the common approach in the literature. In essence, momentum strategy involves a set of rules for security selection, asset allocation and investment holding. Security selection process for a momentum strategy consists in specifying ranking periods and cut-off rules, for a security to be considered a winner or a loser. A conventional momentum strategy selects a security based on a security's cumulative raw return over a ranking period. The length of a ranking period for a momentum strategy should be long enough to identify an establishment of a true trend in the market but not too long so that the entry into a position occurs at the end of a security's trend. Academic literature on cross-sectional total returns momentum in equity markets typically applies 2 to 12 months formation period:

$$Mom_{i,t}=\prod_{j=2}^{12}(1+r_{i,t-j})\ -1 \tag{1}$$

where r_{it} is the return on a security i in month t. Importantly, the studies in equity markets momentum skip the last month before portfolio formation due to the short-term reversal and bid-ask bounce effects. Since commodity futures do not suffer this problem, skipping the first month may lead inferior results. We analyse ranking and holding periods of 1 to 24 months.

As to cut-off rules, total returns momentum strategy ranks stocks on the basis of their relative performance over a ranking period. The winners are identified as those securities that rank in the top X% of the distribution and as losers those securities that rank in the bottom X% of the distribution. Momentum literature conventionally applies a decile or quintile rules. Since the commodity futures market has a substantially smaller number of securities as compared to equity market, a quartile rule may be more suitable for a momentum strategy in commodity futures. That is, 7 futures which rank highest (lowest) are selected for winner (loser) portfolios. Increasing the number of futures in the winner and loser portfolio leads to increased diversification, however, comes at a cost of a reduced dispersion of returns between winner and loser portfolios and thus reduces the profitability.

The next pillar of a momentum strategy is the portfolio construction process which consists of decisions regarding asset allocation and rebalancing. Consistent with most of the literature, we assign equal weights to the constituents in long and short momentum portfolios. We adopt overlapping portfolios approach of Jegadeesh and Titman (1993; 2001). With this approach, the strategies hold a series of portfolios, in any given month, that are selected in the current month as well as in the previous *K*-1 months, where *K* is the holding period.

To design commodity futures idiosyncratic momentum strategy we draw upon the principal papers in equity markets. Idiosyncratic momentum strategy in equity markets constructs long-short momentum portfolios on the basis of residual returns momentum over a ranking period. Gutierrez and Prinsky (2007), Blitz et al. (2011) and Chaves (2016) define idiosyncratic returns on the basis of regression inspired by the CAPM model of Sharpe (1964) and Lintner (1965):

$$r_{i,t}\text{-}r_t^f=\alpha+\beta(R_t^M\text{-}r_t^f)+\varepsilon_{i,t} \tag{2}$$

where r_{it} is the return on security i in month t, r_{Mt} is the return on the market portfolio in month t, α and β are parameters to be estimated. Based on the estimated parameters, a residual return, $\hat{\boldsymbol{\varepsilon}}_{it}$, is calculated in month t using the following specification:

$$\hat{\varepsilon}_{it}=r_{it}\text{--}\hat{a}_i\text{ -}\hat{\beta}_i*r_{Mt} \tag{3}$$

Following the literature we do not include the estimated alpha (intercept) in the calculation of the residual return because alpha serves as a general control for the misspecification in the model.

The idiosyncratic momentum winners and losers are identified by cumulating monthly residual returns of each security over the ranking period. Since we are deploying several systematic factors, an idiosyncratic return for commodity futures contract is estimated each month on the basis of the following model:

$$r_{i,t}=a_i+\beta_i X_{jt}+e_{i,t} \quad (4)$$

where $r_{i,t}$ is the return on a commodity future i in month t, X_{jt} is a return on the factor mimicking portfolio j at time t. Parameters α are β are estimated by the OLS regression and $e_{i,t}$ is the residual return on a contract i in month t. In essence, the only difference between in the implementation of an idiosyncratic momentum strategy and a total return momentum is that the former selects winners and losers on the basis of residual return as opposed to total return.

To construct factor premiums in commodity futures we apply Fama & French (1993) approach to constructing factor mimicking portfolios, specifically High minus Low (or Low-High). We design factor mimicking portfolios using hedging pressure, roll-yield, size, value measures. Hedging pressure (HP) is defined as long open interest divided by total open interest in a category (hedgers or speculators). Hedgers and Speculators are two separate categories therefore a factor can be obtained by constructing a 'Low minus High' portfolio in either (or both categories). As a first step, the cross-section of commodity futures is sorted based on the average (HP) of either category over a ranking period. In this analysis we implement speculator's category hedging pressure. To construct a speculator –category HP factor portfolio, one goes long 15% of the cross-section with the highest average HP and short 15% of futures with the lowest average HP. To construct a term structure factor (High roll yield – low roll yield) we rank the cross section of commodity futures on their roll yield over a previous month. Roll yield is defined as F1/F2 (next to delivery contract divided by 2nd next to delivery). We go long 15% of the cross section with the highest average roll yield (corresponds to backwardated market) and short 15% of the cross-section with the lowest roll yield (corresponds to contangoed market). We adopt the approach of Asness et al. (2013) to construct a value premium. We define value factor in the following way. We take a log of spot price 5 years ago (the average spot price from 4.5 to 5.5 years ago) divided by the most recent spot price, which effectively is the negative of the spot return over the last 5 years. To construct a size factor we follow the equity markets approach. We approximate the size of a futures contract for a commodity by multiplying its open interest by its contract value[2]. The contract value and open interest therefore provide a proxy for market capitalisation, which when ranked cross-sectionally, determines the selection of a size factor portfolio. Open interest is used rather than volume as it gives an indication of the size of the market as opposed to its turnover.

5. Empirical results

5.1 Performance of total returns momentum

We start our empirical analysis by examining total returns momentum. Table 1 reports the performance of 144 momentum strategies over different ranking and holding periods ranging from 1 to 12 months. All 144 strategies yield positive returns that vary between 2% to 13% across different combinations. Yet, on exception of four combinations, that is 11 / 1 (stands for 11 months ranking period and 1 month holding period), 1/11, 2/11, 2/10, none of the momentum strategies' returns are significantly different from zero. A strategy that applies

[2] The contract value is the price multiplied by the specific multiplier.

11 months ranking period and 1 month holding period yields a statistically significant 13% annualized return. The other three strategies produce positive statistically significant return, albeit much lower in magnitude, of 5 % per annum in an average.

Table 1 Long-short total return momentum returns

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.047	0.042	0.038	0.037	0.034	0.029	0.021	0.015	0.008	0.023	**0.042**	0.03
	'(0.80)'	'(0.92)'	'(1.04)'	'(1.24)'	'(1.25)'	'(1.22)'	'(0.91)'	'(0.69)'	'(0.38)'	'(1.22)'	**'(2.34)**'**	'(1.79)'
2	0.099	0.098	0.069	0.044	0.066	0.047	0.03	0.023	0.021	**0.05**	**0.052**	0.039
	'(1.55)'	'(1.80)'	'(1.59)'	'(1.16)'	'(1.87)'	'(1.45)'	'(1.03)'	'(0.85)'	'(0.80)'	**'(2.03)*'**	**'(2.35)**'**	'(1.76)'
3	0.107	0.09	0.069	0.054	0.058	0.036	0.018	0.019	0.038	0.052	0.046	0.037
	'(1.82)'	'(1.69)'	'(1.45)'	'(1.24)'	'(1.44)'	'(0.96)'	'(0.52)'	'(0.59)'	'(1.22)'	'(1.82)'	'(1.67)'	'(1.40)'
4	0.102	0.07	0.057	0.04	0.034	0.013	0.013	0.023	0.031	0.037	0.04	0.02
	'(1.75)'	'(1.27)'	'(1.16)'	'(0.87)'	'(0.79)'	'(0.33)'	'(0.37)'	'(0.68)'	'(0.95)'	'(1.22)'	'(1.37)'	'(0.73)'
5	0.095	0.067	0.047	0.027	0.014	0.013	0.03	0.037	0.031	0.042	0.035	0.021
	'(1.58)'	'(1.21)'	'(0.93)'	'(0.57)'	'(0.31)'	'(0.32)'	'(0.76)'	'(1.00)'	'(0.89)'	'(1.26)'	'(1.08)'	'(0.66)'
6	0.095	0.056	0.03	0.008	0.013	0.026	0.037	0.036	0.042	0.042	0.036	0.03
	'(1.63)'	'(1.03)'	'(0.60)'	'(0.17)'	'(0.29)'	'(0.62)'	'(0.93)'	'(0.95)'	'(1.17)'	'(1.22)'	'(1.09)'	'(0.90)'
7	0.049	0.012	-0.007	-0.005	0.022	0.031	0.034	0.033	0.032	0.035	0.032	0.018
	'(0.85)'	'(0.22)'	'(-0.14)'	'(-0.11)'	'(0.49)'	'(0.72)'	'(0.82)'	'(0.84)'	'(0.86)'	'(0.98)'	'(0.91)'	'(0.53)'
8	0.048	0.024	0.016	0.029	0.04	0.043	0.049	0.041	0.043	0.048	0.05	0.031
	'(0.87)'	'(0.46)'	'(0.31)'	'(0.61)'	'(0.87)'	'(0.99)'	'(1.15)'	'(1.02)'	'(1.11)'	'(1.29)'	'(1.39)'	'(0.86)'
9	0.038	0.04	0.06	0.054	0.048	0.046	0.043	0.046	0.046	0.05	0.049	0.039
	'(0.69)'	'(0.77)'	'(1.20)'	'(1.11)'	'(1.04)'	'(1.04)'	'(1.01)'	'(1.10)'	'(1.14)'	'(1.29)'	'(1.32)'	'(1.05)'
10	0.064	0.079	0.07	0.059	0.046	0.038	0.034	0.036	0.041	0.047	0.044	0.047
	'(1.10)'	'(1.44)'	'(1.34)'	'(1.20)'	'(0.96)'	'(0.84)'	'(0.79)'	'(0.86)'	'(1.00)'	'(1.19)'	'(1.18)'	'(1.20)'
11	**0.132**	0.097	0.07	0.058	0.042	0.033	0.029	0.027	0.03	0.036	0.041	0.04
	'(2.37)'**	'(1.81)'	'(1.37)'	'(1.18)'	'(0.89)'	'(0.72)'	'(0.66)'	'(0.63)'	'(0.74)'	'(0.89)'	'(1.05)'	'(1.00)'
12	0.095	0.06	0.049	0.028	0.027	0.02	0.021	0.022	0.027	0.031	0.039	0.039
	'(1.67)'	'(1.11)'	'(0.97)'	'(0.59)'	'(0.57)'	'(0.43)'	'(0.49)'	'(0.52)'	'(0.65)'	'(0.75)'	'(0.99)'	'(0.98)'

The table reports annualized average returns of long-short total return momentum strategies. The holding period is indicated in the rows; the ranking period is indicated in the columns. T statistics in parentheses. ***, **, * indicates statistical significance at 1%, 5%, 10% levels.

Next we turn to the analysis of long (winners) and short (losers) sides of momentum strategy. Understanding the dynamics of winner and loser portfolios is important not only from the theoretical perspective but even more so in a practical context. The empirical evidence from the equity markets momentum research suggests that momentum profits are dominated by short momentum portfolios. In a different line of research, short leg of momentum has been ascribed to momentum crashes (Daniel 2016). Further, despite compelling returns of a winner minus loser equity momentum strategy documented in the literature, a practical implementation of short portfolios has several caveats. Firstly, many investors are restricted to long-only exposures. Secondly, empirical backtests of long-short equity strategies have to be taken with a pinch of salt. That is, there are number of short selling restrictions across equity markets exchanges and time periods. For example, in order to be representative, a long-short momentum backtest in equity markets that captures the period over the Global Financial Crisis (GFC) would require to exclude a large number of financial stocks which were not available for short-selling during the GFC. Aside from a prominent example of short-selling restrictions during the GFC, there are regular restrictions imposed on individual stocks that take place across countries and exchanges. In practice many empirical papers omit such important exclusions.

We find a stark difference in economic and statistical significance between long and short portfolios. Table 2 reports returns to long only total return momentum strategies. Notably, out of 36 strategies, a combination of strategies across 1 to 6 months ranking and holding periods, 29 long-only strategies deliver statistically significant positive annualized return of 11.2%. Extending the ranking and holding horizons to 12 months, 51 out of 144 long-only momentum portfolios are statistically significant and economically profitable. On average, the annualized return of statistically significant long-only momentum portfolio is 10%. In contrast, none of the short portfolios' returns, reported in Table 3, are statistically different from zero. Moreover, the sign of the returns across portfolios that short losers is consistently negative indicating that shorting losers in commodity futures is a strategy that consistently delivers negative returns. In fact, if the returns were statistically significant, this finding would have been indicative of a reversal effect in loser portfolios. We also examine returns of long-short, long-only and short-only portfolios over longer ranking and holding periods, up to 24 months. For brevity we report the main results for 1 to 12 months ranking and holding periods however the results over longer horizons are available from the authors on request. Notably, we also find a strong evidence of statistically significant positive returns in long-only portfolios also over longer ranking periods. We do not find any evidence of momentum effect in long-short nor short-only portfolios over longer ranking and holding periods.

This novel finding exposes that momentum effect in commodity futures is exclusively driven by long-only portfolios whilst short-only portfolios detract value in the long-short momentum strategy. This finding also has an important practical implication for investors with respect to costs. That is, implementing long-only momentum requires trading only one portfolio instead of two portfolios which implies lower trading costs.

Table 2 Long-only total return momentum returns

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.095	**0.097**	**0.099**	**0.093**	**0.095**	**0.09**	0.084	0.082	0.076	0.076	**0.092**	0.078
	'(1.77)'	**'(1.98)*'**	**'(2.11)*'**	**'(2.08)*'**	**'(2.17)*'**	**'(2.08)*'**	'(1.94)'	'(1.93)'	'(1.82)'	'(1.85)'	**'(2.21)*'**	'(1.89)'
2	**0.119**	**0.136**	**0.115**	**0.106**	**0.116**	**0.101**	**0.089**	0.082	0.079	**0.089**	**0.093**	**0.085**
	'(2.14)*'	**'(2.55)**'**	**'(2.31)**'**	**'(2.28)**'**	**'(2.51)**'**	**'(2.24)*'**	**'(2.02)*'**	'(1.90)'	'(1.85)'	**'(2.09)*'**	**'(2.21)*'**	**'(2.01)*'**
3	**0.151**	**0.128**	**0.123**	**0.115**	**0.119**	**0.1**	**0.092**	0.087	**0.097**	**0.1**	**0.099**	**0.089**
	'(2.68)*'**	**'(2.43)**'**	**'(2.43)**'**	**'(2.34)**'**	**'(2.46)**'**	**'(2.13)*'**	**'(2.03)*'**	'(1.93)'	**'(2.20)*'**	**'(2.26)**'**	**'(2.23)*'**	**'(2.06)*'**
4	**0.122**	**0.113**	**0.11**	**0.106**	**0.099**	0.085	0.082	0.083	0.086	**0.088**	**0.092**	0.077
	'(2.25)*'	**'(2.14)*'**	**'(2.18)*'**	**'(2.16)*'**	**'(2.06)*'**	'(1.82)'	'(1.81)'	'(1.84)'	'(1.95)'	**'(2.00)*'**	**'(2.08)*'**	'(1.77)'
5	**0.145**	**0.13**	**0.11**	**0.104**	0.092	0.086	**0.092**	**0.092**	**0.091**	**0.094**	**0.093**	0.081
	'(2.57)'**	**'(2.42)**'**	**'(2.13)*'**	**'(2.10)*'**	'(1.90)'	'(1.83)'	**'(1.97)*'**	**'(2.03)*'**	**'(2.04)*'**	**'(2.11)*'**	**'(2.08)*'**	'(1.83)'
6	**0.139**	**0.113**	**0.097**	0.085	0.088	**0.094**	**0.097**	0.088	**0.095**	**0.092**	**0.092**	0.084
	'(2.50)'**	**'(2.12)*'**	'(1.88)'	'(1.73)'	'(1.83)'	**'(1.97)*'**	**'(2.05)*'**	'(1.90)'	**'(2.09)*'**	**'(2.03)*'**	**'(2.04)*'**	'(1.85)'
7	0.091	0.082	0.072	0.069	0.084	0.085	0.084	0.08	0.083	0.082	0.081	0.072
	'(1.63)'	'(1.53)'	'(1.41)'	'(1.40)'	'(1.71)'	'(1.77)'	'(1.76)'	'(1.70)'	'(1.79)'	'(1.78)'	'(1.78)'	'(1.58)'
8	0.089	0.077	0.071	0.084	0.088	0.089	0.09	0.086	0.088	0.087	0.09	0.082
	'(1.65)'	'(1.49)'	'(1.44)'	'(1.72)'	'(1.83)'	'(1.85)'	'(1.89)'	'(1.83)'	'(1.88)'	'(1.88)'	'(1.94)'	'(1.77)'
9	0.07	0.077	0.092	0.091	0.088	0.09	0.086	0.088	0.086	0.086	0.085	0.08
	'(1.35)'	'(1.55)'	'(1.86)'	'(1.88)'	'(1.82)'	'(1.89)'	'(1.80)'	'(1.84)'	'(1.83)'	'(1.84)'	'(1.85)'	'(1.72)'
10	0.098	**0.109**	**0.104**	0.094	0.09	0.086	0.079	0.081	0.082	0.083	0.079	0.084
	'(1.81)'	**'(2.08)*'**	**'(2.05)*'**	'(1.90)'	'(1.83)'	'(1.77)'	'(1.64)'	'(1.69)'	'(1.75)'	'(1.77)'	'(1.72)'	'(1.77)'
11	**0.147**	**0.131**	**0.111**	**0.102**	0.093	0.085	0.08	0.078	0.077	0.078	0.076	0.077
	'(2.74)*'**	**'(2.49)**'**	**'(2.17)*'**	**'(2.05)*'**	'(1.89)'	'(1.75)'	'(1.66)'	'(1.62)'	'(1.63)'	'(1.66)'	'(1.64)'	'(1.63)'
12	**0.127**	**0.108**	**0.102**	0.089	0.088	0.083	0.08	0.076	0.077	0.078	0.076	0.078
	'(2.33)'**	**'(2.04)*'**	**'(1.98)*'**	'(1.77)'	'(1.78)'	'(1.68)'	'(1.64)'	'(1.56)'	'(1.62)'	'(1.63)'	'(1.61)'	'(1.63)'

The table reports annualized average returns of long-only total return momentum strategies. The holding period is indicated in the rows; the ranking period is indicated in the columns. T statistics in parentheses. ***, **, * indicates statistical significance at 1%, 5%, 10% levels.

Table 3 Short-only total return momentum returns

	1	2	3	4	5	6	7	8	9	10	11	12
1	-0.044	-0.051	-0.057	-0.051	-0.057	-0.057	-0.059	-0.063	-0.064	-0.05	-0.046	-0.044
	'(-1.00)'	'(-1.29)'	'(-1.53)'	'(-1.34)'	'(-1.54)'	'(-1.53)'	'(-1.65)'	'(-1.78)'	'(-1.77)'	'(-1.41)'	'(-1.31)'	'(-1.25)'
2	-0.018	-0.034	-0.041	-0.056	-0.045	-0.05	-0.054	-0.054	-0.054	-0.036	-0.038	-0.043
	'(-0.41)'	'(-0.83)'	'(-1.02)'	'(-1.43)'	'(-1.17)'	'(-1.30)'	'(-1.48)'	'(-1.46)'	'(-1.43)'	'(-0.98)'	'(-1.04)'	'(-1.19)'
3	-0.038	-0.034	-0.048	-0.055	-0.054	-0.059	-0.069	-0.062	-0.055	-0.044	-0.048	-0.049
	'(-0.90)'	'(-0.81)'	'(-1.18)'	'(-1.33)'	'(-1.38)'	'(-1.51)'	'(-1.85)'	'(-1.65)'	'(-1.46)'	'(-1.22)'	'(-1.36)'	'(-1.36)'
4	-0.018	-0.039	-0.048	-0.06	-0.06	-0.067	-0.064	-0.055	-0.051	-0.047	-0.047	-0.053
	'(-0.39)'	'(-0.88)'	'(-1.11)'	'(-1.43)'	'(-1.45)'	'(-1.66)'	'(-1.63)'	'(-1.42)'	'(-1.32)'	'(-1.27)'	'(-1.29)'	'(-1.41)'
5	-0.044	-0.057	-0.058	-0.071	-0.072	-0.067	-0.057	-0.051	-0.055	-0.048	-0.054	-0.056
	'(-0.96)'	'(-1.27)'	'(-1.33)'	'(-1.66)'	'(-1.74)'	'(-1.65)'	'(-1.45)'	'(-1.33)'	'(-1.45)'	'(-1.29)'	'(-1.46)'	'(-1.48)'
6	-0.039	-0.052	-0.062	-0.072	-0.069	-0.062	-0.055	-0.049	-0.049	-0.046	-0.052	-0.05
	'(-0.86)'	'(-1.19)'	'(-1.45)'	'(-1.74)'	'(-1.68)'	'(-1.55)'	'(-1.40)'	'(-1.27)'	'(-1.30)'	'(-1.25)'	'(-1.41)'	'(-1.34)'

7	-0.039	-0.065	-0.074	-0.07	-0.057	-0.05	-0.047	-0.043	-0.047	-0.043	-0.046	-0.05
	'(-0.82)'	'(-1.46)'	'(-1.70)'	'(-1.62)'	'(-1.36)'	'(-1.24)'	'(-1.17)'	'(-1.10)'	'(-1.21)'	'(-1.13)'	'(-1.23)'	'(-1.31)'
8	-0.038	-0.049	-0.052	-0.051	-0.045	-0.042	-0.038	-0.042	-0.042	-0.036	-0.037	-0.048
	'(-0.84)'	'(-1.12)'	'(-1.19)'	'(-1.19)'	'(-1.07)'	'(-1.04)'	'(-0.96)'	'(-1.08)'	'(-1.09)'	'(-0.95)'	'(-0.99)'	'(-1.26)'
9	-0.03	-0.034	-0.029	-0.035	-0.036	-0.041	-0.04	-0.039	-0.037	-0.033	-0.034	-0.038
	'(-0.67)'	'(-0.77)'	'(-0.66)'	'(-0.81)'	'(-0.87)'	'(-1.01)'	'(-0.99)'	'(-0.97)'	'(-0.96)'	'(-0.86)'	'(-0.89)'	'(-1.02)'
10	-0.031	-0.028	-0.031	-0.032	-0.041	-0.044	-0.042	-0.041	-0.038	-0.033	-0.032	-0.035
	'(-0.66)'	'(-0.62)'	'(-0.71)'	'(-0.76)'	'(-0.98)'	'(-1.08)'	'(-1.02)'	'(-1.03)'	'(-0.97)'	'(-0.86)'	'(-0.84)'	'(-0.91)'
11	-0.013	-0.03	-0.037	-0.041	-0.047	-0.048	-0.047	-0.047	-0.043	-0.039	-0.033	-0.035
	'(-0.28)'	'(-0.68)'	'(-0.86)'	'(-0.98)'	'(-1.14)'	'(-1.18)'	'(-1.17)'	'(-1.19)'	'(-1.10)'	'(-1.01)'	'(-0.85)'	'(-0.90)'
12	-0.028	-0.044	-0.048	-0.056	-0.057	-0.059	-0.055	-0.05	-0.047	-0.044	-0.035	-0.036
	'(-0.63)'	'(-1.01)'	'(-1.14)'	'(-1.36)'	'(-1.39)'	'(-1.44)'	'(-1.37)'	'(-1.26)'	'(-1.20)'	'(-1.16)'	'(-0.92)'	'(-0.95)'

The table reports annualized average returns of short-only total return momentum strategies. The holding period is indicated in the rows; the ranking period is indicated in the columns. T statistics in parentheses. ***, **, * indicates statistical significance at 1%, 5%, 10% levels.

5.2 Factor- mimicking portfolios

In order to implement idiosyncratic momentum we start with the analysis of systematic factors. Specifically, we construct and examine several factor mimicking portfolios on the basis of hedging pressure, term structure, size, value measures. On exception of market factor which is a long-only portfolio proxied by the S&P GSCI index, all other factors are constructed using Fama and French (1993) approach. Each factor mimicking portfolio systematically goes long (short) 15% of best (worst) performing securities in the cross-section.

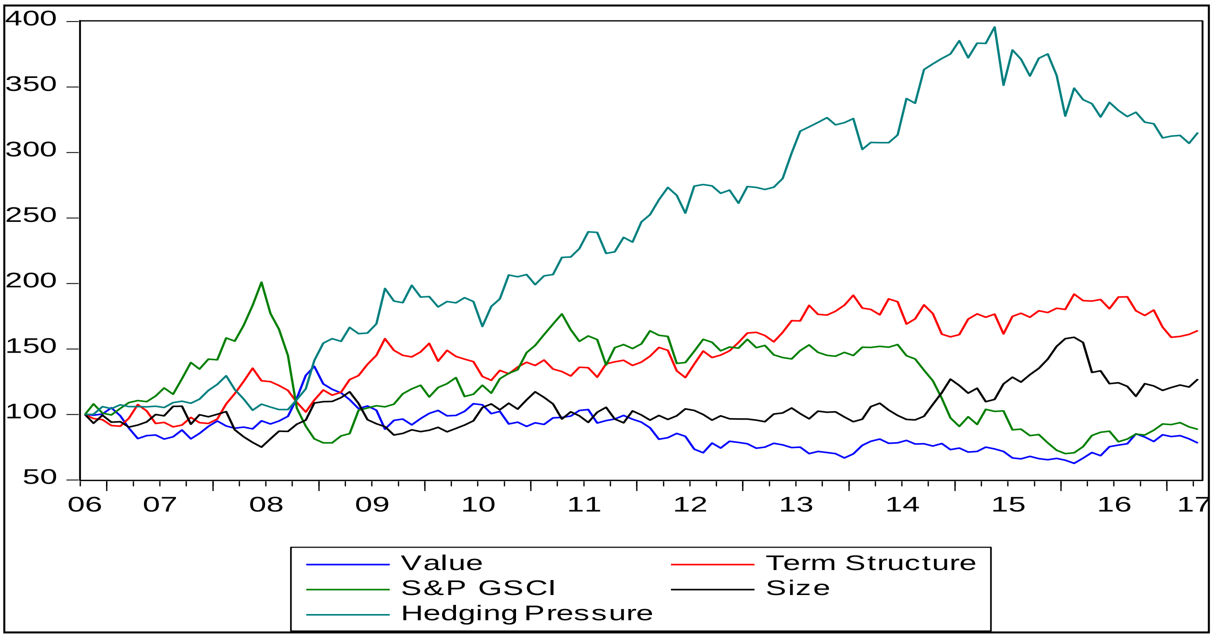
Table 4 exhibits annualized returns, volatilities, statistical significance and return to risk ratios of the five factor mimicking portfolios. A market factor yields statistically insignificant and relatively low annualized return. Remarkably, factor portfolios for term structure and hedging pressure are statistically significant and positive delivering annualized returns of 6.27% and 12.56% respectively. Not only these factors deliver positive return over the market portfolio they also do so with a lower volatility relative to S&P GSCI. In particular, there appears to be a sizable positive systematic risk premium in a factor mimicking portfolios constructed on the basis of a hedging pressure signal. Cumulative returns to five factor mimicking portfolios are reported in Figure 1. The hedging pressure factor portfolio also exhibits the lowest volatility among the five factors. This finding corroborates the results documented by Basu and Miffre (2012) who state that hedging pressure is a systematic risk premium in commodity futures. Further, this finding provides direct support to the theory of Hirschleifer (1990). The returns to factor portfolios constructed on the basis of size and value are insignificantly different from zero.

Table 4 Return and volatility of factor mimicking portfolios

	S&P GSCI	HP	Term Structure	Size	Value
Return (annualized)	1.64%	12.56%	6.27%	4.16%	0.07%
T-statistic	0.22	2.43*	2.17*	0.23	-1.38
Volatility (annualized)	23%	16%	17%	19%	18%
Return to risk ratio	0.07	0.79	0.38	0.22	0.00

The table reports mean annualized return and annualized volatility (standard deviation) of factor mimicking portfolios. The sample period is 2006M10-2017M4. Return to risk ratio can be construed as an analogue to Sharpe ratio. HP stands for hedging pressure.

Figure 1 Cumulative returns of factor mimicking portfolios



To determine whether any of the above factor mimicking portfolios can explain returns to momentum we regress returns to a total return momentum strategy on individual factors. Table 5 reports estimated coefficients and T statistics of simple and multiple regressions. Notably, the coefficients for term structure and hedging pressure are statistically significant and sizable across all regressions. Since the data for hedging pressure is available only from 2006 and given that in this paper longer ranking periods are examined for momentum, we exclude HP factor from the idiosyncratic returns momentum strategy in order not to compromise the length of data sample for momentum implementation. A marked difference is observed in the statistical significance of the S&P GSCI index in long-only and long-short momentum's sensitivity to this factor. Given that long-only strategies appear particularly promising in the context of commodity futures momentum, we include this factor in subsequent idiosyncratic momentum analysis. Both size and value fare relatively similarly with respect to their statistical significance, yet value factor by design comes with a shorter sample period i.e. the definition of value is a negative of a return 5 years ago. On that basis, not to compromise the sample length of momentum strategies, value is excluded from subsequent idiosyncratic momentum. We thus proceed with idiosyncratic momentum implementation using three factors: term structure, market and size.

Table 5 Total return momentum's sensitivity to factors

Panel A: Long-only momentum simple regressions' coefficients

	S&P GSCI	Hedging Pressure	Term Structure	Size	Value
Coefficient	0.65	0.39	0.39	-0.34	-0.32
T-statistic	10.49*	4.74*	4.15*	-3.82*	-4.38*

Panel B: long-only momentum multiple regression coefficients

	S&P GSCI	Term Structure	Size	Value
Coefficient	0.74	0.24	0.25	-0.05
T-statistic	8.90*	2.13*	2.52*	-0.88

Panel C: Long-short momentum simple regressions' coefficients

	S&P GSCI	Hedging Pressure	Term Structure	Size	Value
Coefficient	0.10	0.58	0.56	-0.19	-0.35
T-statistic	1.47	5.65*	7.45*	-2.66*	-4.93*

Panel D: Long-short momentum multiple regression coefficients

	S&P GSCI	Term Structure	Size	Value
Coefficient	-0.04	0.28	0.00	-0.27
T-statistic	-0.54	2.90*	0.02	-3.26*

The table reports regression coefficients of simple and multiple OLS regressions. Since the data for hedging pressure is available only from 2006, the HP factor is excluded from multiple regressions. Since value factor requires 5 years look-back window, all multiple regressions and simple regressions for value factor are carried out over the sample period covering 2002 to 2017. * indicates statistical significance at 5% or more.

5.3 Idiosyncratic returns momentum

This subsection presents the analysis of idiosyncratic returns momentum strategy. Table 6 reports returns and T statistics to long-short idiosyncratic momentum strategies. As hypothesized, idiosyncratic long-short momentum performs substantially better than total return long-short momentum. Specifically, the returns across all long-short strategies are positive and 21 strategies yield statistically significant returns. The average annualized return across statistically significant strategies is 12.3%.

Table 6 Long-short idiosyncratic momentum returns

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.061	0.054	0.061	**0.085**	0.059	**0.070**	0.049	**0.050**	0.036	**0.045**	**0.053**	0.040
	'(0.99)'	'(1.11)'	'(1.64)'	**'(2.48)**'**	'(1.84)'	**'(2.40)**'**	'(1.91)'	**'(2.08)*'**	'(1.54)'	**'(2.03)*'**	**'(2.64)***'**	'(1.96)'
2	0.120	**0.136**	**0.132**	**0.091**	**0.078**	0.059	0.048	0.034	0.038	0.046	0.047	0.031
	'(1.85)'	**'(2.40)**'**	**'(2.77)***'**	**'(2.10)*'**	**'(1.98)*'**	'(1.64)'	'(1.50)'	'(1.11)'	'(1.28)'	'(1.67)'	'(1.81)'	'(1.25)'
3	**0.175**	**0.154**	**0.134**	**0.113**	0.069	0.055	0.028	0.031	0.056	0.059	0.039	0.036
	'(2.66)*'**	**'(2.60)**'**	**'(2.44)**'**	**'(2.18)*'**	'(1.52)'	'(1.28)'	'(0.76)'	'(0.86)'	'(1.64)'	'(1.86)'	'(1.35)'	'(1.30)'
4	**0.131**	**0.119**	0.102	0.068	0.043	0.030	0.013	0.029	0.044	0.038	0.036	0.020
	'(2.02)*'	**'(2.03)*'**	'(1.85)'	'(1.31)'	'(0.91)'	'(0.69)'	'(0.33)'	'(0.75)'	'(1.20)'	'(1.17)'	'(1.17)'	'(0.68)'
5	0.131	**0.124**	0.110	0.076	0.035	0.036	0.032	0.043	0.056	0.046	0.035	0.032
	'(1.94)'	**'(2.02)*'**	'(1.93)'	'(1.42)'	'(0.71)'	'(0.77)'	'(0.75)'	'(1.03)'	'(1.45)'	'(1.34)'	'(1.05)'	'(1.01)'
6	**0.146**	0.093	0.069	0.033	0.028	0.031	0.031	0.025	0.032	0.028	0.024	0.016
	'(2.25)*'	'(1.51)'	'(1.23)'	'(0.65)'	'(0.58)'	'(0.67)'	'(0.71)'	'(0.62)'	'(0.83)'	'(0.79)'	'(0.70)'	'(0.52)'
7	0.091	0.072	0.060	0.043	0.049	0.039	0.031	0.035	0.031	0.030	0.024	0.010
	'(1.36)'	'(1.20)'	'(1.09)'	'(0.83)'	'(0.98)'	'(0.82)'	'(0.70)'	'(0.87)'	'(0.79)'	'(0.83)'	'(0.68)'	'(0.30)'
8	0.042	0.032	0.016	0.029	0.029	0.018	0.038	0.025	0.020	0.014	0.021	0.007
	'(0.64)'	'(0.56)'	'(0.29)'	'(0.57)'	'(0.59)'	'(0.38)'	'(0.87)'	'(0.60)'	'(0.50)'	'(0.38)'	'(0.60)'	'(0.20)'
9	0.044	0.040	0.052	0.044	0.044	0.045	0.033	0.032	0.020	0.023	0.025	0.010
	'(0.69)'	'(0.68)'	'(0.94)'	'(0.84)'	'(0.87)'	'(0.98)'	'(0.73)'	'(0.77)'	'(0.51)'	'(0.60)'	'(0.66)'	'(0.29)'
10	0.087	0.109	0.083	0.067	0.058	0.042	0.040	0.029	0.027	0.022	0.026	0.015
	'(1.30)'	'(1.78)'	'(1.45)'	'(1.24)'	'(1.14)'	'(0.89)'	'(0.85)'	'(0.67)'	'(0.63)'	'(0.54)'	'(0.65)'	'(0.40)'
11	**0.174**	**0.157**	**0.119**	0.097	0.077	0.057	0.048	0.036	0.034	0.027	0.031	0.024
	'(2.62)*'**	**'(2.56)**'**	**'(2.05)*'**	'(1.80)'	'(1.50)'	'(1.17)'	'(1.02)'	'(0.80)'	'(0.77)'	'(0.64)'	'(0.77)'	'(0.62)'
12	0.114	0.103	0.087	0.059	0.051	0.035	0.027	0.026	0.014	0.013	0.019	0.016
	'(1.69)'	'(1.74)'	'(1.55)'	'(1.10)'	'(1.00)'	'(0.73)'	'(0.59)'	'(0.57)'	'(0.31)'	'(0.31)'	'(0.47)'	'(0.38)'

The table reports annualized average returns of long-short idiosyncratic momentum strategies. The holding period is indicated in the rows; the ranking period is indicated in the columns. T statistics in parentheses. ***, **, * indicates statistical significance at 1%, 5%, 10% levels.

Next we separately examine long-only and short-only idiosyncratic momentum strategies. For brevity we do not include the tables with these results however they are available from authors on request. Long-only strategy delivers statistically significant and positive annualized returns of 12% on an average. The strategy is significant and positive across virtually all ranking periods for the holding periods of 1 and 2 months. For 3 and 4 months holding periods 8 and 7 out of 12 implementations respectively are significant and profitable. The profitability of a strategy ceases beyond 7th month holding period. We also examine the profitability of this strategy over longer horizons. Again, the strategy delivers statistically significant and positive average annualized return of 12% across virtually all ranking periods (13 to 24 months) for holding periods of 1 and 2 months. Long-only idiosyncratic momentum is a remarkably robust and profitable strategy across all ranking periods (1 to 24 months) and holding periods of up to 2 months. Similar to total returns momentum, none of the short-only idiosyncratic momentum strategies are statistically significant.

As a robustness test we also perform analysis of idiosyncratic momentum with a tighter cut-off threshold. This strategy (for simplicity referred to as 'concentrated' going forward) goes long (short) the best (worst) 4 contracts. In the long-short implementation the returns across strategies are positive and 26 strategies out of 144 yield statistically significant return. The average annualized return across statistically significant strategies is 8.5%. The long-only implementation of the strategy, Table 7, yields remarkably consistent positive statistically significant returns. Notably, the strategy provides a material improvement over the cut-off period of 7 contracts. Specifically, over the ranking and holding periods of 1 to 12 months the strategy delivers an average annualized returns of 9.7% across 88% of implementations. Furthermore, the profitability of the strategy does not cease after 12 months. The strategy works exceptionally well over longer ranking periods. Specifically, over the ranking periods from 1 to 24 months and holding periods for 1 to 12 months, which results in 288 different combinations, 198 combinations are statistically significant. In effect, 69% of implementations that include longer durations of up to 24 months are profitable and statistically significant. This reveals that long-only idiosyncratic momentum is a very persistent phenomenon. To ensure that both momentum strategies are compared adequately, the analysis of total return momentum with the same cut-off threshold was carried. In contrast to idiosyncratic momentum, a 'concentrated' version of a total return momentum performs substantially worse than a total return momentum with standard cut-off point of 7 securities.

Table 7 Long-only idiosyncratic momentum returns (concentrated)

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0956	0.1027	0.1131	0.1120	0.0990	0.1003	0.0923	0.0827	0.0802	0.0817	0.0855	0.0805
	'(1.97)*'	'(2.35)**'	'(2.66)***'	'(2.68)***'	'(2.41)**'	'(2.49)**'	'(2.30)**'	'(2.12)*'	'(2.05)*'	'(2.14)*'	'(2.18)*'	'(2.08)*'
2	0.1199	0.1321	0.1270	0.1147	0.1094	0.1017	0.0885	0.0794	0.0825	0.0849	0.0819	0.0771
	'(2.38)**'	'(2.82)***'	'(2.83)***'	'(2.64)***'	'(2.55)**'	'(2.46)**'	'(2.19)*'	'(2.00)*'	'(2.05)*'	'(2.15)*'	'(2.07)*'	'(1.97)*'
3	0.1454	0.1378	0.1323	0.1208	0.1022	0.1027	0.0792	0.0858	0.0978	0.0943	0.0928	0.0896
	'(2.85)***'	'(2.90)***'	'(2.83)***'	'(2.64)***'	'(2.27)**'	'(2.36)**'	'(1.88)'	'(2.05)*'	'(2.34)**'	'(2.29)**'	'(2.26)**'	'(2.23)*'
4	0.1264	0.1253	0.1111	0.1011	0.0917	0.0894	0.0783	0.0872	0.0871	0.0868	0.0886	0.0801
	'(2.50)**'	'(2.52)**'	'(2.35)**'	'(2.19)*'	'(2.05)*'	'(2.05)*'	'(1.87)'	'(2.08)*'	'(2.11)*'	'(2.14)*'	'(2.17)*'	'(2.00)*'
5	0.1170	0.1097	0.1009	0.0903	0.0768	0.0773	0.0800	0.0834	0.0826	0.0845	0.0851	0.0803
	'(2.29)**'	'(2.22)*'	'(2.14)*'	'(1.95)'	'(1.73)'	'(1.80)'	'(1.89)'	'(2.00)*'	'(2.00)*'	'(2.06)*'	'(2.09)*'	'(1.98)*'
6	0.1268	0.1114	0.0973	0.0843	0.0787	0.0828	0.0836	0.0835	0.0864	0.0871	0.0861	0.0804
	'(2.47)**'	'(2.30)**'	'(2.10)*'	'(1.87)'	'(1.80)'	'(1.93)'	'(1.98)*'	'(2.02)*'	'(2.09)*'	'(2.13)*'	'(2.11)*'	'(1.99)*'
7	0.0821	0.0929	0.0792	0.0797	0.0825	0.0843	0.0883	0.0867	0.0859	0.0883	0.0882	0.0802
	'(1.65)'	'(1.96)'	'(1.75)'	'(1.79)'	'(1.87)'	'(1.95)'	'(2.07)*'	'(2.07)*'	'(2.08)*'	'(2.14)*'	'(2.13)*'	'(1.97)'
8	0.1111	0.1005	0.0912	0.0984	0.0957	0.0926	0.0963	0.0917	0.0918	0.0921	0.0915	0.0840
	'(2.29)**'	'(2.20)*'	'(2.05)*'	'(2.22)*'	'(2.18)*'	'(2.16)*'	'(2.26)**'	'(2.19)*'	'(2.21)*'	'(2.23)*'	'(2.20)*'	'(2.07)*'
9	0.0783	0.0945	0.1005	0.0979	0.0917	0.0961	0.0937	0.0908	0.0929	0.0920	0.0892	0.0829
	'(1.66)'	'(2.09)*'	'(2.25)*'	'(2.21)*'	'(2.10)*'	'(2.27)**'	'(2.22)*'	'(2.19)*'	'(2.24)*'	'(2.24)*'	'(2.15)*'	'(2.06)*'
10	0.1109	0.1230	0.1072	0.1048	0.0987	0.0977	0.0946	0.0941	0.0926	0.0926	0.0881	0.0844
	'(2.35)**'	'(2.64)***'	'(2.35)**'	'(2.34)**'	'(2.23)*'	'(2.24)*'	'(2.17)*'	'(2.19)*'	'(2.16)*'	'(2.18)*'	'(2.08)*'	'(2.03)*'
11	0.1532	0.1328	0.1182	0.1168	0.1065	0.1004	0.0993	0.0931	0.0908	0.0890	0.0867	0.0813
	'(3.07)***'	'(2.73)***'	'(2.50)**'	'(2.51)**'	'(2.34)**'	'(2.25)*'	'(2.23)*'	'(2.13)*'	'(2.09)*'	'(2.07)*'	'(2.03)*'	'(1.93)'
12	0.1127	0.1056	0.1104	0.1044	0.1010	0.0975	0.0975	0.0935	0.0918	0.0934	0.0890	0.0863
	'(2.30)**'	'(2.23)*'	'(2.36)**'	'(2.26)**'	'(2.22)*'	'(2.18)*'	'(2.20)*'	'(2.14)*'	'(2.12)*'	'(2.16)*'	'(2.06)*'	'(2.03)*'

13	0.1068	0.1213	0.1098	0.1026	0.1020	0.0948	0.0941	0.0917	0.0901	0.0885	0.0886	0.0835
	'(2.22)*'	'(2.55)**'	'(2.34)**'	'(2.23)*'	'(2.24)*'	'(2.11)*'	'(2.13)*'	'(2.09)*'	'(2.07)*'	'(2.05)*'	'(2.05)*'	'(1.95)'
14	0.1277	0.1160	0.1086	0.1033	0.1002	0.0988	0.0958	0.0940	0.0937	0.0935	0.0923	0.0866
	'(2.52)**'	'(2.36)**'	'(2.26)**'	'(2.18)*'	'(2.16)*'	'(2.16)*'	'(2.12)*'	'(2.10)*'	'(2.12)*'	'(2.12)*'	'(2.10)*'	'(1.99)*'
15	0.1218	0.1160	0.1081	0.1017	0.0973	0.0945	0.0928	0.0941	0.0928	0.0903	0.0886	0.0873
	'(2.45)**'	'(2.38)**'	'(2.27)**'	'(2.17)*'	'(2.12)*'	'(2.10)*'	'(2.07)*'	'(2.11)*'	'(2.11)*'	'(2.05)*'	'(2.02)*'	'(2.00)*'
16	0.1357	0.1169	0.1036	0.0979	0.0946	0.0937	0.0932	0.0929	0.0906	0.0879	0.0877	0.0836
	'(2.69)***'	'(2.39)**'	'(2.20)*'	'(2.12)*'	'(2.08)*'	'(2.08)*'	'(2.09)*'	'(2.08)*'	'(2.05)*'	'(2.00)*'	'(1.99)*'	'(1.91)'
17	0.1344	0.1208	0.1080	0.0978	0.0961	0.0940	0.0927	0.0917	0.0895	0.0844	0.0868	0.0827
	'(2.67)***'	'(2.49)**'	'(2.29)**'	'(2.11)*'	'(2.10)*'	'(2.08)*'	'(2.07)*'	'(2.06)*'	'(2.02)*'	'(1.92)'	'(1.97)'	'(1.87)'
18	0.1185	0.1076	0.0949	0.0902	0.0892	0.0886	0.0879	0.0852	0.0842	0.0814	0.0824	0.0796
	'(2.38)**'	'(2.26)*'	'(2.07)*'	'(1.98)*'	'(1.98)*'	'(1.99)*'	'(1.98)*'	'(1.93)'	'(1.92)'	'(1.86)'	'(1.87)'	'(1.81)'
19	0.1097	0.0931	0.0903	0.0856	0.0841	0.0824	0.0815	0.0782	0.0796	0.0802	0.0800	0.0776
	'(2.24)*'	'(1.98)*'	'(1.96)'	'(1.88)'	'(1.87)'	'(1.84)'	'(1.83)'	'(1.77)'	'(1.80)'	'(1.81)'	'(1.80)'	'(1.75)'
20	0.0864	0.0960	0.0819	0.0767	0.0736	0.0727	0.0730	0.0724	0.0733	0.0748	0.0755	0.0715
	'(1.83)'	'(2.07)*'	'(1.81)'	'(1.72)'	'(1.67)'	'(1.66)'	'(1.66)'	'(1.66)'	'(1.68)'	'(1.70)'	'(1.72)'	'(1.62)'
21	0.0985	0.0935	0.0820	0.0835	0.0804	0.0795	0.0815	0.0802	0.0799	0.0814	0.0812	0.0763
	'(2.06)*'	'(2.04)*'	'(1.82)'	'(1.86)'	'(1.81)'	'(1.79)'	'(1.83)'	'(1.81)'	'(1.81)'	'(1.83)'	'(1.82)'	'(1.71)'
22	0.1001	0.0913	0.0830	0.0806	0.0806	0.0767	0.0763	0.0753	0.0770	0.0788	0.0772	0.0731
	'(2.12)*'	'(2.00)*'	'(1.84)'	'(1.78)'	'(1.79)'	'(1.72)'	'(1.71)'	'(1.70)'	'(1.73)'	'(1.76)'	'(1.73)'	'(1.63)'
23	0.0967	0.0917	0.0859	0.0812	0.0849	0.0792	0.0795	0.0785	0.0801	0.0833	0.0821	0.0774
	'(2.08)*'	'(2.02)*'	'(1.90)'	'(1.79)'	'(1.88)'	'(1.76)'	'(1.78)'	'(1.75)'	'(1.78)'	'(1.85)'	'(1.82)'	'(1.72)'
24	0.1002	0.0873	0.0875	0.0865	0.0829	0.0800	0.0790	0.0776	0.0806	0.0832	0.0827	0.0805
	'(2.15)*'	'(1.89)'	'(1.91)'	'(1.90)'	'(1.82)'	'(1.77)'	'(1.75)'	'(1.71)'	'(1.77)'	'(1.83)'	'(1.82)'	'(1.77)'

The table reports annualized average returns of long-only idiosyncratic momentum strategies. The holding period is indicated in the rows; the ranking period is indicated in the columns. T statistics in parentheses. ***, **, * indicates statistical significance at 1%, 5%, 10% levels. Concentrated implies a cut-off threshold as 4 securities.

The robust performance of idiosyncratic momentum implemented with tighter cut-off threshold substantiates the idiosyncratic returns momentum strategy in commodity futures. The findings suggest that a commodity specific momentum is a much more persistent phenomenon than total returns momentum. To assess whether the returns to idiosyncratic momentum are a compensation for a systematic risk factors we examine regression coefficients of idiosyncratic returns, both long-only and long-short, on returns to factor mimicking portfolios. Table 8 reports the coefficients of OLS regressions of momentum returns on factors. Long-short momentum returns are partially explained by returns to term structure factor. On the other hand, the market and size factors appear statistically significant in explaining long-only idiosyncratic returns. Notably, alphas are statistically significant in both long-only and long-short idiosyncratic momentum strategies.

Table 8 Idiosyncratic momentum's sensitivity to factors

Panel A: Long-short momentum multiple regressions' coefficients				
	Alpha	S&P GSCI	Term Structure	Size
Coefficient	0.01	-0.11	0.249	0.04
T-statistic	2.27*	-1.07	2.38*	0.69
Panel B: Long-only momentum multiple regression coefficients				
	Alpha	S&P GSCI	Term Structure	Size
Coefficient	0.01	0.65	0.06	0.30
T-statistic	2.15*	7.41*	0.07	3.02*

The table reports regression coefficients of multiple regressions. Alpha denotes intercept in an OLS regression.

5.4 Discussion of results

Table 9 compares the returns and robustness of a total return and idiosyncratic return momentum strategies. Firstly, the findings expose that momentum in commodity futures is almost exclusively driven by long-only portfolios. None of the short-only momentum strategies in either total return or idiosyncratic return implementation is statistically significant. The analysis reveals that idiosyncratic momentum is a substantially more robust and profitable strategy than a total return momentum. Specifically, ranking commodity futures on the basis of idiosyncratic returns improves the performance of momentum both in long-short and long-only implementations. Notably, a conventional long-short momentum is an inferior strategy in that it yields statistically significant returns in only 4 implementations out of 144 with an average annualized return across statistically significant strategies of 7%. In contrast, an idiosyncratic return long-short momentum yields statistically significant returns in 21 out of 144 implementations. Moreover, the average annualized return across statistically significant strategies is 12.3%, which is nearly double from that of a total return momentum. Idiosyncratic returns momentum yields a substantial improvement in long-only implementations. A long-only idiosyncratic momentum implemented with a cut-off of 7 futures contracts, yields an annualized return across statistically significant strategies of 12.3% whereas a long-only total return momentum yields an annualized return across statistically significant strategies of 10%. Further, idiosyncratic momentum returns comes with higher T- statistics on average and delivers statistically significant positive returns over the longer durations. Remarkably, a concentrated implementation provides positive returns of 10% per year in average across 126 implementations out of 144. The concentrated idiosyncratic momentum is statistically significant and positive also over longer ranking and holding periods.

Notably, both type of momentum deliver the highest return in an implementation that applies 11 months as a ranking period and 1 month as a holding period. This combination is consistent with the previous findings in the literature. In particular, this is the only strategy which is successful in the context of a total return long-short momentum with the other three statistically significant strategies producing an annualized return of just 5 percent. The 11/1 implementation yields 13.2% and 12.7% average annualized return in a total return long-short and long-only momentum respectively. The 11/1 momentum delivers an impressive 17.4% annualized average return in an idiosyncratic long-short implementation and 13% annualized average return in a long-only implementation. The concentrated strategy delivers 14.5% and 15.3 for long-short and long-only momentum respectively. The evidence on 11/1 combination is consistent with the autocorrelation patterns across commodity futures. In particular, 9 out of 28 commodity futures exhibit sizable and statistically significant autocorrelation at the 11^{th} month lag. All coefficients at the 11^{th} month lag are also positive. Therefore, a superior returns of 11/1 momentum strategies are partially explained by the 11^{th} month lag autocorrelation.

Table 10 reports return and volatility characteristics of different implementations of momentum. There is a marked improvement in both return and volatility profile of idiosyncratic momentum in a long-only and long-short implementation. As a result, idiosyncratic return momentum yield substantially higher risk adjusted return. Specifically, a return to risk ratio of an idiosyncratic long-short momentum is 0.65 versus 0.36 for a total return long-short momentum. The difference is less pronounced in the context of long-only implementation, that is an idiosyncratic return long-only momentum yields a return to risk ratio of 0.63 versus 0.55 for a total return long-only. Figure 2 exhibits the cumulative returns to a 100 USD investment in long-only idiosyncratic and total return momentum strategies as well as S&P GSCI. Both total return and idiosyncratic return materially outperform S&P GSCI. Evidently, an investor could have achieved substantially better returns by implementing an active long-only momentum strategy than by passively following a long-only SP GSCI index.

Table 9 Robustness of momentum strategies

		Long-short	Long-only
Total Return			
	Number of Successful Strategies	4	51
	% of statistically significant strategies	3%	35%
	Average Annualized Return	7%	10%
Idiosyncratic Return			
	Number of Successful Strategies	21	48
	% of statistically significant strategies	15%	33%
	Average Annualized Return	12.3%	12.3%
Idiosyncratic Return (concentrated)			
	Number of Successful Strategies	26	126
	% of statistically significant strategies	18%	88%
	Average Annualized Return	8.5%	9.7%

The table reports the summary of different momentum strategies. Average annualized return refers to the average across statistically significant strategies

Table 10 Return and volatility of momentum strategies

	Total Ret. Long-short	Total Ret. Long-only	Idiosyncratic long-short	Idiosyncratic long-only
Return (annualized)	7%	11%	13%	13%
Volatility (annualized)	21%	21%	19%	20%
Return to Risk ratio	0.36	0.55	0.65	0.63

This table reports risk and return characteristics of 4 momentum implementations over the common period of July 2002-April 2017. Return to risk ratio can be construed as an analogue to Sharpe ratio.

Figure 2 Cumulative returns of long-only momentum and S&P GSCI

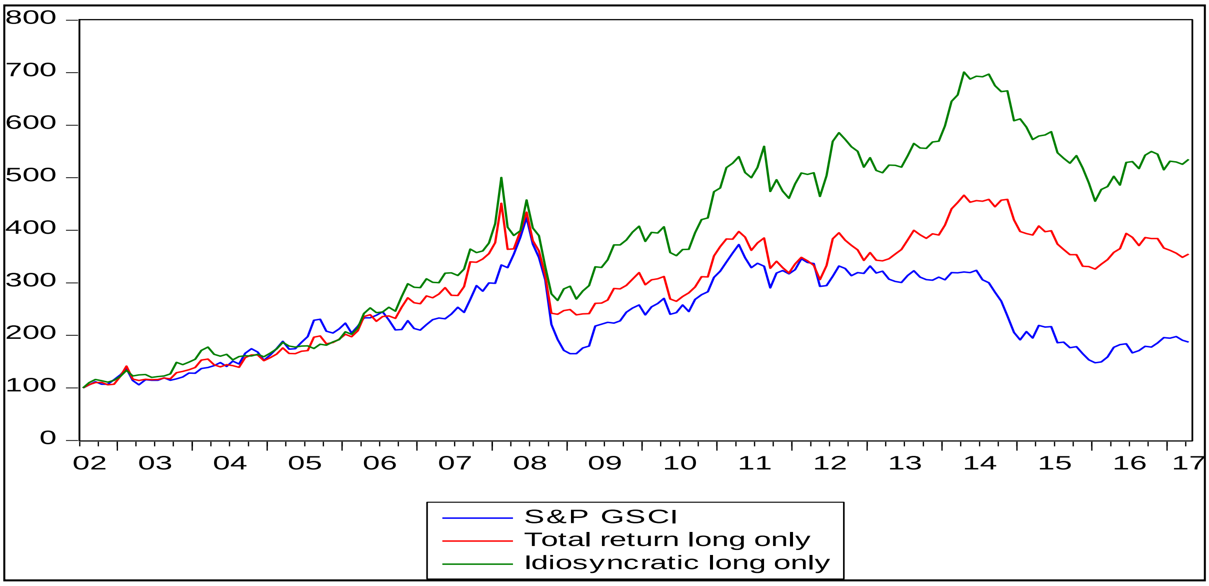


Table 11 reports correlation of momentum strategies and S&P GSCI. Long-only momentum strategies are positively and highly correlated with the S&P GSCI. Yet, a long-only idiosyncratic returns momentum exhibits a lower correlation compared to a total return momentum. Specifically, idiosyncratic long-only momentum's correlation with S&P GSCI is 0.57 whereas total return momentum's correlation with the passive index is 0.70. As to long short strategies, both type of momentum are uncorrelated to S&P GSCI. Specifically, total return long-short momentum exhibits a correlation of only 0.1 to S&P GSCI whilst the correlation between idiosyncratic long-short momentum and S&P GSCI is -0.1. Hence, the long-short momentum strategies provide a diversification with respect to S&P GSCI.

Table 11 Momentum strategies' correlations

	Total return long-only	Idiosyncratic long-only	S&P GSCI
Total return long-only	1.00	0.85	0.70
Idiosyncratic long-only	0.85	1.00	0.57
S&P GSCI	0.70	0.57	1.00
	Total return long-short	Idiosyncratic long-short	S&P GSCI
Total return long-short	1.00	0.66	0.10
Idiosyncratic long-short	0.66	1.00	-0.10
S&P GSCI	0.10	-0.10	1.00

The table reports correlations coefficients of momentum strategies and S&P GSCI. The period is 2002 to 2017

6. Concluding remarks

In this article we examine idiosyncratic return momentum in commodity futures. By doing so, we also revisit total returns momentum strategy and examine factor mimicking portfolios in commodity futures. Our analysis reveals that idiosyncratic momentum is a robust and profitable strategy. The findings in this paper show that momentum in commodity futures, both total return and idiosyncratic, is entirely driven by long-only portfolios. None of the short-only momentum strategies is statistically significant or positive. As a result a long-short momentum is an inferior strategy with respect to robustness and returns relative to long-only momentum. Notably, idiosyncratic momentum materially outperforms total return momentum in a long-short and long-only implementation on absolute and risk-adjusted basis. Idiosyncratic return momentum yields an attractive Sharpe ratio of 0.65 and 0.63 in a long-short and long-only implementation. This fares favourably to total return momentum which yields a Sharpe of 0.36 and 0.55 in a long-short and long-only implementations respectively and even more so to a passive investing in S&P GSCI which yields a Sharpe of just around 0.

The two key findings in this paper, namely on performance of long-only side of momentum and superior performance of idiosyncratic momentum, reconcile well with the theoretical foundations in the commodity markets literature and with earlier empirical research. The empirical evidence in this paper on the long side of a momentum strategy corroborates the research of Chaves and Visvanathan (2016). Specifically, the authors argue that momentum strategies in futures markets perform well because they have high positive basis. Positive basis means that spot price is higher than a futures price, i.e. backwardated term structure. For the basis of the overall momentum portfolio to be positive it implies that the long-only portfolios have to dominate the return. Positive basis is directly linked to the theory of normal backwardation which states that long-only position in commodity futures provides a positive risk premium.

The evidence on idiosyncratic momentum being more profitable than total return momentum in commodity futures is consistent with the extant literature on time-varying momentum performance. Further, it reconciles well with the research of Gutierez and Prinsky (2007) on an agency-based rational explanation of idiosyncratic and total returns momentum. The authors argue that institutions play a role in generating two types of momentum returns yet the under-reaction to idiosyncratic returns momentum is more pronounced and longer-lasting compared to total returns momentum.

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