An EDHEC-Risk Institute Publication

Long-Short Commodity Investing: Implications for Portfolio Risk and Market Regulation

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Foreword

This publication presents the results of the latest research on commodity futures investing done at EDHEC-Risk Institute with the support of CME Group and under the leadership of Joëlle Miffre, member of EDHEC-Risk Institute and professor of finance at EDHEC Business School.

The rise in commodity prices over the last ten years and their recent volatility has generated considerable interest on the part of investors, regulators and policy-makers.

Attracted by the prospect of robust returns, diversification benefits, and potential for hedging inflation and macroeconomic risks, investors have increased their allocations to commodities over the period, primarily via passive investment into long-only commodity futures indices. Recent market gyrations have contributed to reviving the debate on the role of commodities in strategic and tactical asset allocation and led to an increasing recognition of the relevance of long-short dynamic strategies to capture the commodities premium in the context of highly volatile markets.

The increased participation of financial investors on commodity markets has caused concerns about the latter's possible increased integration with traditional financial markets, which could have weakened the diversification and hedging benefits from commodity investment.

The high volatility in commodity prices has also led to contentious political pronouncements on the role of financial investment in commodity markets and to calls for further regulation.

This publication addresses these issues head on. It examines commodity futures investment over the last ten years to shed new academic evidence on the performance of passive as well as active commodity investment and their conditional volatility and conditional correlations with traditional assets. It also investigates whether the increased participation of index and long-short investors on commodity futures markets has had an impact on the volatility of prices or the traditional benefits of commodities as an asset class. The publication's in-depth consideration of long-short strategies is particularly notable as the extant academic literature has focused on long-only investments.

The research results presented in the following pages confirm the relevance of commodity futures investment and document the benefits of adopting long-short strategies in terms of risk-adjusted performance, diversification and extreme-risk hedging. They find no support for the hypothesis that long-short investors have destabilised commodity markets by increasing volatility or co-movements between the prices of commodity futures investments and those of traditional assets. This holds true whether investors are defined broadly or approached as non-commercial traders or professional money managers.

The results on the performance and risk characteristics of long-only and long-short commodity futures investing have important practical consequences for investors that are considering or have implemented commodity investment programmes.

The new found academic evidence on the impact of the financialisation of commodity

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futures market challenges the assumptions of a politically and sometimes emotionally charged debate and will be of relevance not only to regulators and industry associations but also to institutional investors whose investment committees need to factor social responsibility considerations into their investment decisions.

We would like to express our gratitude to our partners at CME Group for their support for our research.

Frédéric Ducoulombier
Director, EDHEC Risk Institute–Asia

Foreword

About the Author

Joelle Miffre is professor of finance at EDHEC Business School and a member of EDHEC-Risk Institute. Her work focuses on asset management, with special emphasis on commodities, active strategies and asset pricing. Her research has appeared in leading academic and practitioner-oriented scientific journals such as the *Journal of Banking and Finance*, the *Journal of Business Finance and Accounting* and the *Journal of Futures Markets.* She also acts as scientific advisor to a commodity trading advisor (CTA). She teaches portfolio management, fixed-income analysis, derivatives and commodities at postgraduate and executive levels. She is a seasoned presenter at international academic conferences and industry events. Before joining EDHEC Business School, she was associate professor of finance at Cass Business School, City University London. Her previous appointments include research and teaching positions at the University of Technology, Sydney and at the United Kingdom based International Capital Market Association Centre and Brunel University. She holds graduate degrees in management and finance and a Ph.D. in finance from Brunel University.

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The rise in commodity prices over the last ten years and their recent volatility has generated considerable interest on the part of investors, regulators and policy-makers.

Attracted by the prospect of robust returns, diversification benefits, and potential for hedging inflation and macroeconomic risks, investors have increased their allocations to commodities over the period, primarily via passive investment into commodity futures indices. While the potential for alpha generation through long-short dynamic trading in commodity futures markets has been recognised, the focus of the attention has been on passive portfolios of long positions in futures owing to the long-only nature of traditional market indices. Recent market gyrations have contributed to reviving the debate on the role of commodities in strategic and tactical asset allocation and led to an increasing recognition of the relevance of long-short strategies.

Some market participants and policy-makers have been quick to associate the strong inflows into commodity investments with the recent commodity spikes of 2007-2008 and 2009-2011. The increased participation of financial investors on commodity markets has also led to concerns about their possible increased integration with traditional financial markets which could have resulted in the weakening of the diversification benefits from commodity investments.

This publication sheds new academic evidence on these concerns with particular emphasis on long-short commodities futures investing.

Its first contribution is to study the performance and risk characteristics of long-only commodity portfolios and of long-short commodity strategies of the kind implemented by hedge fund managers with a focus on commodities, such as commodity trading advisors (CTAs) and commodity pool operators (CPOs).

It investigates the conditional volatility of these commodity futures investments and their conditional correlations with traditional assets. Indeed, the strategic decision to include commodity futures in a well-diversified portfolio does not solely depend on the risk premium of commodity futures viewed as an asset class but is also driven by a desire for risk diversification and thus depends on how the returns of commodity investments correlate with the rest of the investor's portfolio over time. This publication thus analyses the conditional volatility of long-only and long-short commodity portfolios and the conditional correlations of their returns with those of traditional assets in periods of high volatility in traditional asset markets. By doing so, the paper extends the literature which focused on the conditional correlations between long-only commodity portfolios and traditional assets[1].

The second contribution of this publication is to look at the possible impact that long-short trades may have had on the volatility of commodity prices and on their conditional correlation with traditional assets. This topic is of interest given the recent debate amongst politicians and policy makers surrounding the financialisation of commodity futures markets. The 2009 Staff Report by the U.S. Senate Permanent Subcommittee on

1 - See for example Büyükşahin, Haigh and Robe (2010) or Chong and Miffre (2010).

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Investigation argues that commodity index traders were disruptive forces, driving prices away from fundamentals. If established, this would support calls for an increase in transparency, position limits and margins to curb excessive speculation and, it is hoped, volatility. Since then the claim that the financialisation of commodity markets is responsible for the observed volatility in commodity prices has been the subject of an intense academic debate – the overwhelming conclusion of which has been that it is not possible to empirically link investments in commodity futures and commodity futures prices[2]. However, the debate has so far focused mainly on the potentially destabilising role of long-only, as opposed to long-short, investors. This paper fills the gap by studying the potentially unsettling role of long-short investors on price volatility and cross-market correlation.

To address these objectives, we first start by mimicking the trading behaviour of long-short participants in commodity futures markets over the period 1992-2011. This is done by implementing a battery of long-short strategies, where these strategies are based on a momentum signal[3], on the slope of the term structure[4], on a double-sort that combines momentum and term structure signals[5], or on the positions of hedgers and speculators[6]. The rule-based strategies that we implement specify minimum liquidity requirements for commodity contracts and then include in a long-short portfolio the commodities with the strongest momentum, the highest absolute roll-returns, or the most extreme hedging pressures.

The dataset spans 2 October 1992 – 25 March 2011 and includes Friday settlement prices for twenty-seven commodity futures as obtained from *Datastream International*. The frequency, time series and cross section are chosen based on the availability of the positions of commercial traders (also often termed "hedgers") and non-commercial traders (also often referred to as "speculators")[7] in the Commodity Futures Trading Commission (CFTC) Commitment of Traders Report (COT). The cross section includes twelve agricultural commodities (cocoa, coffee C, corn, cotton n°2, frozen concentrated orange juice, oats, rough rice, soybean meal, soybean oil, soybeans, sugar n°11, wheat), five energy commodities (blendstock RBOB gasoline, electricity, heating oil n°2, light sweet crude oil, natural gas), four livestock commodities (feeder cattle, frozen pork bellies, lean hogs, live cattle), five metal commodities (copper, gold, palladium, platinum, silver) and random length lumber. The positions of commercial and non-commercial traders are collected every Tuesday and made available to the public the following Friday.

Futures returns are calculated by assuming that investors hold the nearest contract up to one month before maturity and then roll their position to the second nearest contract, where the rolling takes place to avoid physical delivery of the underlying commodity.

All portfolios short-list the 75% most liquid contracts out of the universe of commodity futures that are available at the time of portfolio construction. The momentum portfolio is composed by buying the (remaining) 20% with the highest past performance and shorting the (remaining) 20% with the lowest past performance over a chosen observation period. Likewise,

2 - See for Irwin and Sanders (2011) for a recent review of the evidence.

3 - As in Erb and Harvey (2006) and Miffre and Rallis (2007).

4 - As in Erb and Harvey (2006) and Gorton and Rouwenhorst (2006). As in Fuertes, Miffre and Rallis (2010).

5 - As in Basu and Miffre (2011).

6 - The hedger/speculator distinction is not clear since commercial traders can hold views on the market and take speculative positions accordingly. Non-commercial traders are generally investors seeking exposure to commodities without holding the underlying; they may nonetheless be motivated by hedging motives.

7 - See for example Erb and Harvey (2006), Gorton and Rouwenhorst (2006), Miffre and Rallis (2007), Fuertes, Miffre and Rallis (2010), and Basu and Miffre (2011).

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out of the 75% of contracts that are the most liquid, the term structure portfolio buys the 20% with the highest roll returns (i.e., the most downward-sloping term structure) and sells the 20% with the lowest roll-returns (or the most upward-sloping term structure). Finally, the hedging pressure strategies use as signals for asset allocation the positions of commercial traders and non-commercial traders, as reported by the CFTC. To be more specific, the strategies take long positions in liquid backwardated commodities (for which commercial traders were net short and/or non-commercial traders were net long) and short positions in liquid contangoed commodities (for which commercial traders were net long and/or non-commercial traders were net short). The either single- or double-sort strategies we end up with thus aim at systematically taking long positions in the 15% of commodities whose prices are expected to appreciate and short positions in the 15% of commodities whose prices are expected to depreciate.

Having mimicked the returns that long-short commodity speculators earned over the period 1992-2011, we then move on to comparing the performance and risk characteristics of these long-short commodity portfolios with those of long-only index positions using both an equally-weighted portfolio of the aforementioned twenty-seven commodity futures and the Standard and Poor's Goldman Sachs Commodity Index (S&P-GSCI) as benchmarks.

We also analyse the conditional correlations of these long-short and long-only commodity portfolios with traditional asset classes, using the Standard & Poor's 500 Index (S&P500) for equities and the Barclays Capital U.S. Aggregate Bond Index for fixed income products

In terms of stand-alone performance and as previously reported in the literature[8], long-short commodity portfolios are found to dominate long-only commodity indices. The average mean excess return of the single-sort long-short portfolios equals 7.99% a year and that of the double-sort portfolios equals 9.03% a year. Over the same period, the mean excess return of the S&P-GSCI equals 0.64% a year and that of the long-only equally-weighted portfolio of the twenty seven commodities included in this study is at 4.28% a year[9]. The conclusion is similar once we adjust for risk. The Sharpe ratios of the long-short portfolios average out at 0.5093 with a range from 0.2711 (for the single-sort momentum strategy) to 0.6302 (for the single-sort hedger-based strategy). These Sharpe ratios always substantially exceed those of long-only benchmarks (0.0529 for the long-only equally-weighted portfolio and 0.1965 for the S&P-GSCI)[10].

In the context of multi-asset class investment, the relationship between the conditional volatility of commodity investments and that of traditional investments as well as the conditional correlations between commodity investments and traditional asset classes have important implications for risk management and diversification.

The averages of the conditional volatilities of the long-short commodity strategies studied here range from 15.09% to 17.61% a year and are less than the average of the conditional volatilities of the S&P-GSCI, which stands at 20.81% - these differences

8 - See for example Erb and Harvey (2006), Gorton and Rouwenhorst (2006), Miffre and Rallis (2007), Fuertes, Miffre and Rallis (2010), and Basu and Miffre (2011).

9 - The S&P500 and the Barclays Capital US Aggregate Bond Index returned 4.21% and 2.95% in excess return form, respectively.

10 - The S&P500 and the Barclays Capital US Aggregate Bond Index had Sharpe ratios of 0.2401 and 0.6631, respectively.

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are statistically significant. The equally-weighted portfolio of the twenty-seven commodities is found to have a conditional volatility of 11.28%.

The conditional volatilities of the long-short commodity strategies are also found to rise by less than that of the S&P-GSCI or the equally-weighted benchmark in periods of increased volatility in equity markets. Furthermore, they fall in periods of increased volatility in fixed income markets at a time when the conditional volatilities of the long-only commodity indices rise. Other things being equal, this is welcome news to long-short speculators as it indicates that they can reduce the total risk of their multi-class portfolios in a more effective way by being long-short commodities as opposed to being long-only.

Over the period, the conditional correlations of the S&P500 with the commodity investments studied are low, confirming their strategic role as risk diversifiers. The conditional correlations modeled relative to the long-short commodity portfolios (averaging 0.00 and statistically not different from zero) are lower than those modeled relative to the long-only commodity indices (averaging 0.19, positive and significant), suggesting that the risk diversification benefits of commodity futures are stronger within long-short portfolios. Focusing on the period following the demise of Lehman Brothers, we observe a sharp rise in the conditional correlations between the S&P500 and long-only commodity indices (to an average of 0.54) while those between the S&P500 and long-short commodity strategies remain very low (at an average of 0.01). This documents the much stronger diversification benefits associated with long-short strategies versus long-only indices, in the recent past.

The conditional correlations between the long-short and long-only commodity portfolios and the Barclays Capital US Aggregate Bond Index are also found to be low over the period. As previously reported in the literature[11], the correlations with the long-only commodity indices are particularly low (-0.0737 for the equally-weighted portfolio and -0.0267 for the S&P-GSCI). They are also low for the long-short portfolios (ranging from -0.0324 to 0.0320 and averaging 0.0006). Statistical test of differences between these correlations suggest that, other things being equal, bond investors are better off from a risk management perspective holding the S&P-GSCI than commodity portfolios based on past performance or on past roll-returns. The evidence is less clear-cut for strategies based on the positions of commercial and non-commercial traders.

We then focus on the behaviour of conditional correlations between traditional asset classes and commodity investments when the former are under stress.

In periods of high volatility in equity markets, the conditional correlations between the S&P500 index and the long-short commodity portfolios based on the positions of commercial and non-commercial traders are found to decrease. This is good news to equity investors as it is precisely when the volatility of equity markets is high that the benefits of diversification are most appreciated. In contrast, the conditional correlations between long-only commodity indices and equity indices rise with the volatility of the

11 - See Bodie and Rosansky (1980), Erb and Harvey (2006) and Gorton and Rouwenhorst (2006).

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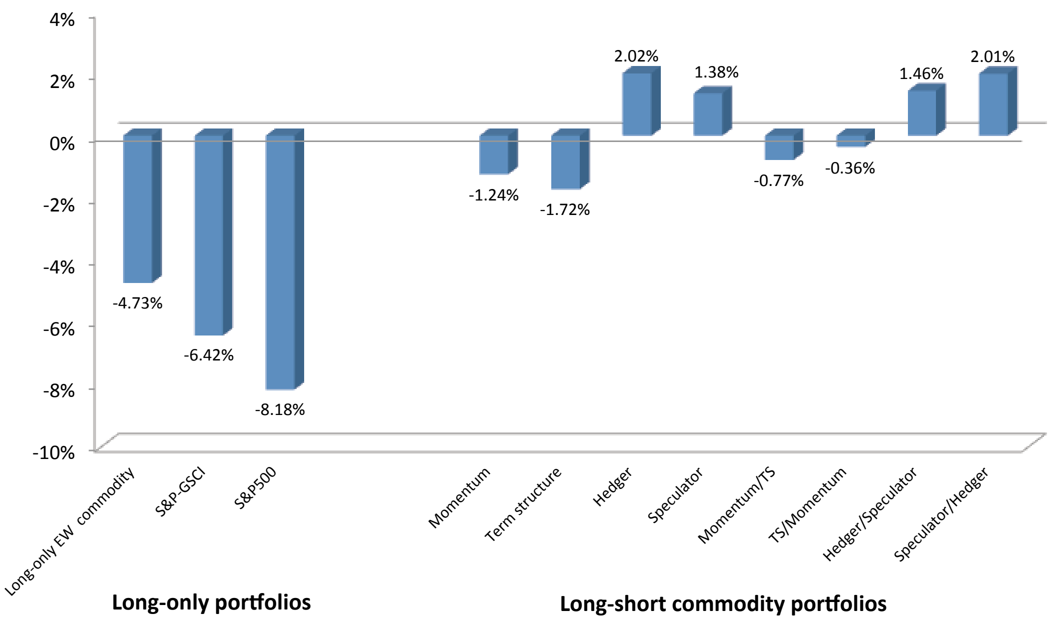
S&P500, suggesting that the risk reduction that comes from diversification prevails less when needed most. The four weeks that followed the demise of Lehman Brothers provide an acid test of these relationships. As depicted by the chart below, the S&P500 lost 8.18% a week, the long-only commodity portfolios retreated sharply (-4.73% for the equally-weighted portfolio and -6.42% for the S&P-GSCI), whereas the long-short commodity strategies studied here earned between -1.72% and 2.02% a week. These results suggest that, unlike long-only commodity portfolios, long-short commodity strategies can serve as partial hedge against extreme equity risk.

In periods of high volatility in fixed income markets, the conditional correlations between the Barclays Capital U.S. Aggregate Bond Index and the long-short commodity portfolios based on the positions of commercial and non-commercial traders are found to remain constant, whereas the conditional correlations measured relative to long-only commodity portfolios are found to rise sharply. This suggests that, other things being equal, long-short commodity portfolios based on the positions of hedgers and speculators can serve as better diversifiers than long-only commodity portfolios in periods of extreme risk in fixed income markets.

This publication thus confirms the relevance of commodity futures investment and presents reasons as to why long-short strategies should prevail over long-only investing: they provide superior risk-adjusted performance as reflected by higher Sharpe ratios; have lower conditional volatility than the leading long-only benchmark index; and they offer more effective diversification qualities for equity portfolios, especially in

Average Weekly Performance of the S&P500 Index, of Long-Only and Long-Short Commodity Portfolios Over the Four Weeks that Followed Lehman Brothers' Demise



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the recent period. Furthermore, long-short commodity portfolios based on the positions of commercial and non-commercial traders are found to have partial hedging characteristics providing protection against extreme-risk in the equity markets and to offer stable diversification properties in times of turbulence on the fixed income markets.

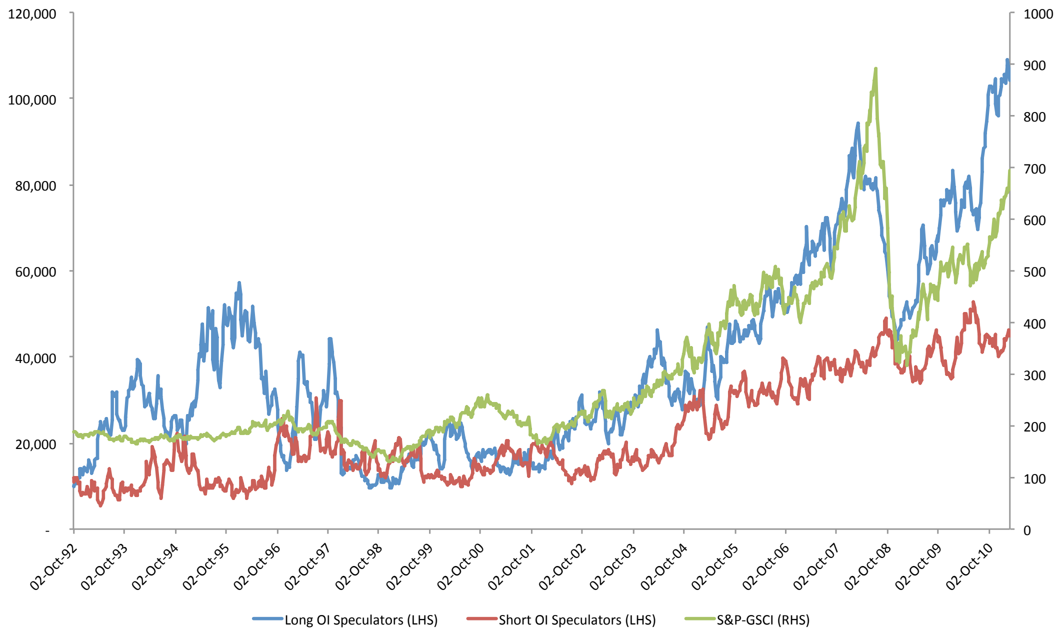
The second purpose of this publication is to present evidence on the financialisation of commodity futures markets and investigate the possible impact that long-short trades may have had on the volatility of commodity prices and on their conditional correlation with traditional assets.

The financialisation of the commodity futures market is portrayed in the graph below, which plots the long and short open interests of non-commercial traders across the cross-section of commodities studied (see number of contracts on the left-hand side) and the level of the S&P-GSCI (see index level on the right-hand side). Two points are worth noting. First, the dramatic changes in the long open interests of non commercial traders seem to parallel the dramatic ups and downs of the S&P-GSCI over the period 1992-2011. This gives credibility to the claim that changes in the long open interests of investors could have increased the volatility of the S&P-GSCI. Second, both the long and short positions of investors have risen sharply over the period 1992-2011, suggesting an increase in the financialisation of commodity futures markets.

We investigate whether the increased role of financial investors has been a disruptive force in commodity futures markets. This is done by testing whether the increase in the long, as well as short, interests of speculators caused[12] a change in the conditional volatility of long-short commodity portfolios or a change in the

12 - In the sense of Granger (1969).

Open Interests of Non-Commercial Traders (Speculators)



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conditional correlation between their returns and those of traditional assets. Our Granger-causality tests are tests of the null hypothesis that changes in the positions of long-short investors do not cause changes in the volatility of the long-short commodity portfolios or have no impact on their conditional correlation with traditional assets. A failure to reject the null hypothesis indicates a lack of causality.

We find no support for the hypothesis that long-short investors have destabilised commodity prices by increasing volatility or co-movements between commodity prices and those of traditional assets. Interestingly, this conclusion holds irrespective of whether investors are labelled as "non-commercial" in the CFTC Commitment of Traders report or "professional money managers" (i.e., CTAs, CPOs and hedge funds) in the CFTC disaggregated Commitment of Traders (DCOT) report. Thus the analysis presented here does not call for a change in the regulation in relation with the increased participation of professional money managers in commodity futures markets.

1. Introduction

1. Introduction

Academic research has made it clear that investors should take long, as well as short, positions in commodity futures markets. Strategies that buy backwardated contracts and sell contangoed ones have been shown to outperform long-only commodity indices on a risk-adjusted basis. For example, trading on momentum is a reliable source of alpha relative to long-only benchmarks (Erb and Harvey, 2006; Miffre and Rallis, 2007). Term structure signals can also be used to generate abnormal returns (Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006). Likewise, combining the information present in the term structure of commodity prices with that provided by trend following is highly profitable (Fuertes, Miffre and Rallis, 2010). Finally, inventory levels and hedgers' and speculators' (i.e. commercial traders' and non-commercial traders') positions can be used as long-short signals to model the risk premium present in commodity futures markets (Gorton, Hayashi and Rouwenhorst, 2008; Basu and Miffre, 2011).

The focus of this paper is twofold. The first contribution is with regards to the conditional volatility of these long-short commodity portfolios and their conditional correlations with traditional assets. It is well known that the strategic decision to include commodity futures in a well-diversified portfolio does not solely depend on the risk premium of these long-short portfolios. It is also driven by a desire for risk diversification and thus depends on how the returns of long-short commodity portfolios correlate with the rest of the investor's portfolio over time. The first purpose of the paper is to analyse precisely the conditional volatility of long-short commodity portfolios and the conditional correlations of their returns with those of traditional assets in periods of high volatility in traditional asset markets. By doing so, the paper extends the literature which focused on the conditional correlations between long-only commodity portfolios and traditional assets (Büyükşahin, Haigh, and Robe, 2010; Chong and Miffre, 2010).

We present five reasons as to why long-short (as opposed to long-only) trading should prevail in commodity futures markets. First, as previously reported, with Sharpe ratios that are on average four times as high, the performance of long-short portfolios by far exceeds that of long-only commodity indices (an equally-weighted portfolio of twenty-seven commodity futures and the Standard and Poor's Goldman Sachs Commodity Index (S&P-GSCI)). Second, the conditional volatility of long-short commodity portfolios is found to be lower than that of the S&P-GSCI. It is also found to rise by less than that of the S&P-GSCI in periods of increased volatility in equity markets and to fall in periods of increased volatility in fixed income markets (when that of long-only indices actually rises). Other things being equal, this is welcome news to long-short speculators as it indicates that they can reduce the total risk of their portfolio in a more effective way by being long-short commodities (as opposed to being long-only). Third, the conditional correlations of the Standard & Poor's 500 Composite Stock Price Index (S&P500) with long-short commodity portfolios are found to be lower than those measured relative to long-only commodity indices, suggesting that the risk diversification benefits of commodity futures are stronger within long-short portfolios. Fourth, in periods of high volatility in equity markets, the conditional correlations between the

1. Introduction

S&P500 index and the long-short commodity portfolios based on the positions of hedgers and speculators is found to decrease. This is good news to equity investors as it is precisely when the volatility of equity markets is high (e.g., following the demise of Lehman Brothers) that the benefits of diversification are most appreciated. In contrast, the conditional correlation between long-only commodity indices and equity indices rises with the volatility of the S&P500 index, suggesting that the risk reduction that comes from diversification prevails less when needed most; namely, during equity market downturns. Fifth, in periods of high volatility in fixed income markets, the conditional correlations between the Barclays Capital Aggregate Bond Index and the long-short commodity portfolios based on the positions of hedgers and speculators is found to remain constant, while the conditional correlations measured relative to long-only commodity portfolios rises sharply. This suggests that long-short commodity portfolios based on the positions of hedgers and speculators can serve as better diversifiers than long-only commodity portfolios in periods of extreme risk in fixed income markets.

The second contribution of the paper is with regards to the debate on the financialisation of commodity markets. The 2009 Staff Report by the U.S. Senate Permanent Subcommittee on Investigation argues that commodity traders were disruptive forces, driving prices away from fundamentals. This possibly calls for an increase in transparency, position limits and margins to curb speculation and, it is hoped, volatility. Since then the claim that the financialisation of commodity markets is responsible for the observed volatility in commodity prices has been the subject of an intense academic debate (see Irwin and Sanders, 2011, for a review). In particular, the literature has focused on supply and demand as drivers of commodity price changes[13], on tests for excessive speculation[14] and on the potential impact of commodity index traders (CIT) on price change, volatility and correlation[15]. Unlike these papers, we study the potentially destabilising role of long-short speculators on volatility and cross-market correlation.

The traditional view, as put forward by Friedman (1953), is that of speculators (or rational news traders) stabilising prices: by buying low and selling high, they bring prices closer to fundamentals. Yet, De Long, Shleifer, Summers and Waldmann (1990) bring forward a theoretical model that shows that rational news traders, by anticipating the price impact of trend followers (or positive feedback traders), actually end up destabilising markets. In their model, rational speculators, in anticipation of the forthcoming buy/sell orders of trend followers, increase their long-short positions today in the hope of earning higher returns tomorrow. As a result, far from stabilising prices, they end up setting price trends and deterring short-term prices away from fundamentals. It is thus not obvious from a theoretical standpoint whether long-short speculators stabilise markets. To test this in the context of commodity speculators, we first model the returns they earned using a battery of long-short strategies and then explicitly test whether their trading had any impact on volatility and cross-market correlations.

The extant literature concerning the impact of long-short trading on volatility and

13- Hamilton (2009) blames the stagnation in global supply, and the rapid growth in global demand, for the oil price shock of 2007-08. Korniotis (2009) relates the sharp rise in spot metal prices in 2003-04 to economic fundamentals such as rising demand and consumption or falling production and inventories.

14 - Till (2009) and Sanders, Irwin, and Merrin (2010) use Working's (1960) speculative *T* index to show that speculation in most commodity futures markets was not excessive compared to hedging demands. This suggests that the rise in speculative positions was altogether beneficial as long speculators provided liquidity and risk-sharing facility to short hedgers.

15 - Using a battery of experiments (among others, Granger causality tests), Irwin, Sanders and Merrin (2009) and Stoll and Whaley (2010) conclude that CIT had no impact on commodity price movements. Irwin and Sanders (2011) find no evidence that CIT and swap dealers have lead returns or increased volatility. On the other hand, Tang and Xiong (2011) blame CIT for the observed increase in the correlations across indexed commodity futures. In comparison, other factors (such as a weakening of the USD, an increase in the demand for indexed commodities from emerging countries, the financial crisis that followed Lehman Brothers' demise, a sudden rise in inflation or the widespread use of biofuel) are shown to be less instrumental.

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correlation in commodity futures markets is sparse. We are aware of only two papers. Brunetti, Büyükşahin and Harris (2011) test whether change in the net positions of hedge funds in three commodities (corn, crude oil and natural gas) have Granger-caused volatility and conclude that hedge funds, far from destabilising markets, actually decreased volatility. Büyükşahin and Robe (2010) hold hedge funds (and especially those that are active in both equity and commodity futures markets) responsible for the rise in the conditional correlations between commodity and stock indices observed since 2008.

Our results indicate that speculators had no impact on the volatility of long-short commodity portfolios or on their returns correlations with traditional assets. The conclusion holds irrespective of whether speculators are labelled as "non-commercial" in the CFTC Commitment of Traders report or "professional money managers" (i.e., commodity trading advisors (CTAs), commodity pool operators (CPOs) and hedge funds) in the CFTC Disaggregated Commitment of Traders report. It follows that calls for increased regulation of commodity money managers might be at this stage premature: they are unlikely to prevent the volatility of commodity futures prices from rising again in the future.

The remainder of the paper is structured as follows. Section II presents the dataset. Section III introduces the methodologies employed to capture the returns earned by long-short speculators in commodity futures markets, the conditional volatility of their portfolios and their return correlations with traditional assets. Section III also highlights the methodology used to test whether changes in speculators' positions have Granger caused changes in volatility or changes in correlation. Section IV discusses our results. Finally, section V concludes.

2. Data

2. Data

The dataset includes Friday settlement prices for twenty-seven commodity futures as obtained from *Datastream International*. The frequency, time series and cross section are chosen based on the availability of hedgers' and speculators' positions in the CFTC Commitment of Traders report. The cross section includes twelve agricultural commodities (cocoa, coffee C, corn, cotton n°2, frozen concentrated orange juice, oats, rough rice, soybean meal, soybean oil, soybeans, sugar n° 11, wheat), five energy commodities (blendstock RBOB gasoline, electricity, heating oil n° 2, light sweet crude oil, natural gas), four livestock commodities (feeder cattle, frozen pork bellies, lean hogs, live cattle), five metal commodities (copper, gold, palladium, platinum, silver) and random length lumber. The positions of hedgers and speculators are collected every Tuesday and made available to the public the following Friday. The dataset spans 2 October 1992 – 25 March 2011.

Futures returns are calculated by assuming that investors hold the nearest contract up to one month before maturity and then roll their position to the second nearest contract, where the rolling takes place to avoid physical delivery of the underlying commodity. Table 1 presents summary statistics for the twenty-seven commodity futures contracts included in this study (Panel A), for the S&P-GSCI and a long-only weekly-rebalanced portfolio that equally-weights these twenty-seven commodities (Panel B). As previously reported (Erb and Harvey, 2006), commodity futures are poor stand-alone investments: Over the period 30 October 1992 to 25 March 2011, annualised mean excess returns range from -25.69% (electricity) to 10.87% (soybean meal) with a cross-sectional average at 0%. In spite of poor performance, the cross-sectional standard deviations of excess returns are high, standing at 29.48% a year on average. Sharpe ratios range from -0.5738 (electricity) to 0.4373 (platinum) with a cross-sectional average at merely 0.0292. Table 1, Panel B shows that long-only indices perform poorly too: the mean excess returns of long-only commodity indices do not differ from zero at even the 10% level, the Sharpe ratio of the equally-weighted portfolio and that of the S&P-GSCI merely stand at 0.0529 and 0.1965, respectively.

Table 1 also presents the average open interests over the period 30 October 1992 – 25 March 2011 of the contracts considered in this analysis. It is obvious that lack of liquidity is a problem for commodities such as electricity, pork bellies, random length lumber or rough rice. This issue might in turn have an impact on the performance of the long-short portfolios[16] and on speculators' ability to implement their strategies. The problem is all the more severe within our setting that, following the literature (e.g., Erb and Harvey, 2006; Gorton and Rouwenhorst, 2007, among others) and to avoid portfolio concentration in any specific commodity, the constituents of the long-short portfolios are equally-weighted. The methodology we adopt to account for potential illiquidity problems consists in systematically excluding the 25% of the contracts (or cross section) with the lowest average open interests over the *R* weeks preceding portfolio formation[17]. Thus, to ease taking and liquidating positions, the rule-based strategies explained in Section III first and foremost specifies minimum liquidity requirements for commodity contracts.

16 - Investors are deemed to demand higher returns as a compensation for lack of liquidity (Amihud, 2002; Pastor and Stambaugh, 2003).

17 - As explained in Section III, *R* refers to the ranking period (expressed in weeks) of the long-short commodity portfolios.

2. Data

Table 1: Summary Statistics

The table presents summary statistics for the excess returns of individual commodity futures (Panel A), long-only commodity indices (Panel B) and traditional assets (Panel C). When it comes to excess returns, Mean is the annualised mean excess returns, *t*(Mean) stands for the associated *t*-statistic in parentheses, SD is the annualised standard deviation of excess returns, Sharpe is the ratio of the annualised mean to the annualised SD.

	Excess returns				Open Interest	
	Mean	*t*(Mean)	SD	Sharpe	Mean	SD
Panel A: Individual Commodity Futures						
Cocoa	0.0158	(0.22)	0.3053	0.0519	29,233	22,647
Coffee C	0.0101	(0.11)	0.3825	0.0264	33,633	28,018
Copper grade # 1	0.0878	(1.39)	0.2712	0.3238	13,319	16,594
Corn	-0.0577	(-0.91)	0.2714	-0.2125	217,261	167,378
Cotton # 2	-0.0137	(-0.22)	0.2705	-0.0508	33,191	35,958
Crude oil (light sweet)	0.0918	(1.18)	0.3343	0.2746	161,460	91,763
Electricity	-0.2569	(-1.52)	0.4477	-0.5738	2,235	888
Feeder cattle	0.0298	(0.88)	0.1447	0.2058	7,898	4,446
Frozen concentrated orange juice	-0.0621	(-0.84)	0.3191	-0.1946	12,823	6,479
Gasoline (Blendstock RBOB)	0.0452	(0.27)	0.3847	0.1175	54,401	28,559
Gold	0.0427	(1.13)	0.1631	0.2617	108,846	91,539
Heating oil # 2	0.0744	(1.00)	0.3207	0.2321	43,491	18,784
Lean hogs	-0.0602	(-0.99)	0.2615	-0.2302	27,765	24,873
Live cattle	0.0066	(0.19)	0.1517	0.0433	56,973	36,524
Natural gas	-0.1618	(-1.48)	0.4686	-0.3452	59,756	43,832
Oats	-0.0199	(-0.27)	0.3187	-0.0624	5,955	3,090
Palladium	0.0986	(1.22)	0.3483	0.2830	7,007	6,140
Platinum	0.0940	(1.88)	0.2149	0.4373	11,821	7,484
Pork bellies	0.0279	(0.35)	0.3439	0.0812	2,555	1,956
Random length lumber	-0.1255	(-1.67)	0.3232	-0.3884	2,709	1,664
Rough rice	-0.0918	(-1.13)	0.2723	-0.3372	4,618	3,211
Silver	0.0855	(1.27)	0.2894	0.2954	51,021	23,392
Soybean meal	0.1087	(1.71)	0.2731	0.3979	38,963	21,858
Soybean oil	0.0065	(0.12)	0.2367	0.0275	48,655	38,297
Soybeans	0.0550	(0.98)	0.2407	0.2287	86,780	67,679
Sugar # 11	0.0539	(0.74)	0.3151	0.1711	142,656	108,928
Wheat	-0.0789	(-1.19)	0.2850	-0.2767	81,120	67,494
Average	0.0002		0.2948	0.0292		
Panel B: Long-Only Commodity Indices						
Equally-weighted long-only portfolio	0.0064	(0.23)	0.1208	0.0529	50,552	25,281
S&P-GSCI	0.0428	(0.84)	0.2178	0.1965	12,587	9,738
Panel C: Traditional Asset Classes						
S&P-500 composite index	0.0421	(1.03)	0.1755	0.2401		
Barclays Capital US aggregate bond index	0.0295	(2.85)	0.0444	0.6631		

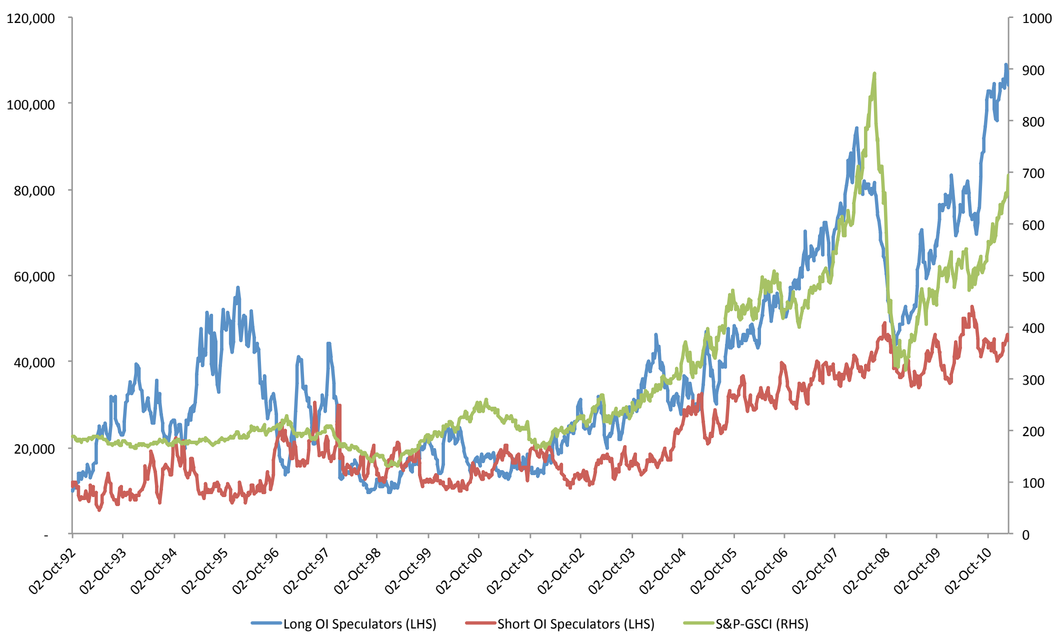
2. Data

The paper analyses the evolution in the conditional correlations between long-short commodity portfolios and the returns of traditional asset classes. To represent the later, we choose the Standard & Poor's 500 Composite Stock Price Index and Barclays Capital US Aggregate Bond Index. These two indices are considered as the main equity and fixed income benchmarks and are likely to represent the two traditional asset classes that investors hold. Table 1, Panel C shows that the risk-return characteristics of traditional asset classes rank favourably relative to those of long-only positions in commodity futures markets. Indeed, the Sharpe ratio of Barclays Capital bond index (at 0.6631) systematically exceeds the Sharpe ratios of long-only commodities and those of long-only commodity indices. The Sharpe ratio of the S&P500 index (at 0.2401) exceeds that of 22 long-only commodities and that of both long-only commodity indices.

The CFTC classifies traders based on the size of their positions into reportable and non-reportable. Reportable traders constitute 70% to 90% of the open interest in any given futures markets and are further recorded as commercial or non-commercial. Commercial traders[18] use commodity derivatives to hedge price risk. Non-commercial traders (also termed speculators) have no position in the underlying asset; they either take a long-only approach speculating on upcoming rises in commodity futures prices or adopt a long-short framework to speculate on both expected rises and falls. Aside from declaring whether they are commercial (hedgers) or non-commercial (speculators), traders also have to report whether they are long or short. The evolution in the long and short positions of speculators (i.e., non-commercial traders) is pictured in Figure 1, where the plot is for the open interests of both long and short speculators averaged across our twenty-

18 - Commercial traders include 1. producers, processors, merchants and users of the underlying commodity (who use derivatives to hedge their price risk) and 2. swap dealers (who hedge their short over-the-counter positions by taking long futures positions).

Figure 1: Open Interests of Non-Commercial Traders (Speculators)



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seven commodities (on the left-hand side) and for the futures prices of the S&P-GSCI (on the right-hand side). Two points are worth noting. First, the dramatic changes in the open interests of long speculators seem to parallel the dramatic ups and downs of the S&P-GSCI over the period 1992-2011. This somewhat gives credibility to the claim that changes in the open interests of long speculators could have increased the volatility of the S&P-GSCI. Second, both the long and short positions of speculators have risen sharply over the period 1992-2011, suggesting an increase in the financialisation of commodity futures markets.

We use the market participants' declarations as aggregated in the Commitment of Traders report to calculate two measures, called hedging pressure, one for the hedgers and one for the speculators. The hedging pressure of, say, speculators is calculated as the number of long positions divided by the total number of positions taken by non-commercial traders over the previous week. Similarly, the hedging pressure of hedgers is defined as the number of long positions divided by the total number of positions taken by commercial traders over the previous week. For example, a hedging pressure of 0.2 for hedgers means that over the previous week 20% of hedgers were long and thus 80% were short, a sign of a backwardated market[19]. Vice versa, a hedging pressure of 0.2 for speculators means that over the previous week 20% of speculators were long and thus 80% were short, a sign of a contango market[20].

The hedging pressure measures thus defined are used in two ways. First, as in Basu and Miffre (2011), we use them as signals for sorting commodity futures into portfolios, where the returns of portfolios that buy backwardated commodities and sell contangoed commodities is deemed to replicate the returns that speculators have earned over the period 1992-2011 for taking on the price risk that hedgers wanted to get rid of. Second, we use the hedging pressure measures to test whether commodity markets have become more volatile and asset markets more integrated under the actions of speculators. The idea here is to test whether changes in the hedging pressure of speculators have Granger caused 1. changes in the volatility of long-short commodity portfolios and 2. changes in the conditional return correlations between long-short commodity portfolios and traditional assets.

19 - Backwardation occurs when commodity producers are more prone to hedge than commodity consumers and processors. The then net short positions of hedgers lead to the intervention of net long speculators and thus to the rising price pattern typically associated with backwardation. In our setting, backwardation translates into low hedging pressure for hedgers and high hedging pressure for speculators.

20 - Contango arises when consumers and processors of a commodity outnumber producers. The then net long positions of hedgers lead to the intervention of net short speculators and to the falling price pattern typically linked to contango. In our setting, contango translates into high hedging pressure for hedgers and low hedging pressure for speculators.

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To mimic the trading behaviour of long-short market participants, we implement a battery of long-short strategies that hedge fund managers are known to follow (Bhardwaj, Gorton, and Rouwenhorst, 2008), where these strategies are based on momentum and term structure signals. We also replicate their trading behaviour by looking at the positions they took (Basu and Miffre, 2011). In total we have four single-sort strategies and four double-sort strategies that are based on performance, roll-returns, the positions of hedgers or/and the positions of speculators. These rule-based strategies aim at systematically taking long positions in the commodities whose prices are expected to appreciate and short positions in the commodities whose prices are expected to depreciate. Sections III. A. and III. B. briefly summarise the methodologies used to implement these strategies. Section III. C. then presents the methodologies employed to model the conditional volatility of commodity portfolios and their conditional return correlations with traditional assets. Finally, Section III. D. introduces the methodology employed to test whether changes in speculators' positions have Granger caused changes in volatility or changes in correlation.

III. A. Single-Sort Strategies

At this stage, it is important to note that the strategies, whether they be single-sort or double-sort, are implemented on the 75% of the cross section that has the highest average open interest at the time of portfolio formation. This is to ease taking and liquidating positions and thus to limit transaction costs.

The single-sort momentum portfolios then consist of long positions in the 20% of commodity futures with the best mean returns over the previous R weeks (winners) and short positions in the 20% of commodity futures with the worst mean returns over the previous R weeks (losers). The positions are held over the next H weeks, when a new set of winner, loser and momentum portfolios is formed (Erb and Harvey, 2006; Miffre and Rallis, 2007). Portfolio rebalancing thus takes place every H weeks. R stands for the ranking period of the positions and H for the holding period of the portfolio, both are expressed in weeks.

The single-sort term structure portfolios consist of long positions in the 20% of commodity futures with the highest average roll-returns over the previous R weeks and short positions in the 20% of commodity futures with the lowest average roll-returns over the previous R weeks, where roll-returns are measured as the difference in the log of the prices of the nearest and second nearest contracts. The positions are held over the next H weeks, when a new set of long, short and term structure portfolios is formed (see Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006; or Basu and Miffre, 2011).

The single-sort long-short portfolio based on the positions of hedgers consist of long positions on the 20% backwardated contracts for which hedgers were net short (i.e. had low average hedging pressure) over the previous R weeks and short positions on the 20% contangoed contracts for which hedgers were net long (namely had high average hedging pressure) over the previous R weeks. The positions are held over the next H weeks, when a new set of backwardated, contangoed and long-short portfolios is

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formed. It is hoped that the long-short risk premium thus modeled mimics the returns that speculators have earned over the period 1992-2011 for taking the price risk hedgers were willing to get rid of.

The single-sort long-short portfolio based on the positions of speculators consist of long positions on the 20% backwardated contracts for which speculators were net long (i.e. had high average hedging pressure) over the previous *R* weeks and short positions on the 20% contangoed contracts for which speculators were net short (i.e. had low average hedging pressure) over the previous *R* weeks. The positions are held over the next *H* weeks, when a new set of backwardated, contangoed and long-short portfolios is formed. For more on the long-short portfolios based on the positions of hedgers and speculators, please refer to Basu and Miffre (2011).

Note that the theory of storage as put forward by Kaldor (1939) and Working (1948) could also be used to model the long-short positions of speculators in commodity futures markets. Indeed, Gorton, Hayashi and Rouwenhorst (2008) show that investors can earn sizable returns by taking long futures positions in backwardated contracts with low inventory and short futures positions in contangoed contracts with high inventory[21]. However, due to the difficulty of collecting inventory data, we decided not to follow this lead. It is hoped that the long-short portfolios based on momentum, term structure, the positions of hedgers and the positions of speculators will be capable of mimicking the returns that long-short speculators have earned over the period 1992-2011.

III. B. Double-Sort Strategies

The double-sort strategies maintain the liquidity requirement of the single-sort strategies mentioned above. They then combine momentum and term structure signals in a manner that follows from Fuertes, Miffre and Rallis (2010). The available cross section of futures contracts is first split into *Winner* and *Loser* portfolios based on mean returns over the previous *R* weeks using the 50% of the available cross section or the median as breakpoint. This first signal is thus similar in spirit to the single-sort momentum strategy mentioned above. That signal is then combined with the term structure signal as follows: instead of buying the *Winner* portfolio, we only buy the 40% of its constituents that have the highest average roll-returns over the previous *R* weeks. Similarly, instead of shorting the *Loser* portfolio (as would the single-sort momentum strategy), we only short the 40% of its constituents that have the lowest average roll-returns over the previous *R* weeks. The long-short positions are held over the next *H* weeks. As it was arbitrary to sort on, first, performance and, second, roll-returns, we also reverse the sorting order, buying the portfolio with high roll-returns and best past performance and shorting the portfolio with low roll-returns and worst past performance.

The double-sort strategy that combines the positions of hedgers and speculators follows from Basu and Miffre (2011). The available cross section is first split using the 50% breakpoint into a backwardated portfolio (called Low_{Hedg}) and a contangoed portfolio (called $High_{Hedg}$) based on the mean hedging pressure of hedgers over the previous *R* weeks. As before with the single-sort portfolios, Low_{Hedg} is presumably

21 - The theory of storage explains the shape of the term structure of commodity prices by means of the incentive that inventory holders have in owning the spot commodity. When inventories are high, the term structure is upward-sloping to give incentive to inventory holders to buy the commodity spot (at a cheap price) and sell it forward at a profit that exceeds the cost of storage and the cost of financing the purchase of the commodity in the spot market. A contangoed market (with an upward-sloping term structure) is thus characteristic of abundant inventories. Applying the same argument to a backwardated market (with a downward-sloping term structure) might at first sight seem counterintuitive: the return from holding the commodity spot and selling it forward is apparently negative. This apparent inconsistency can be solved by considering the *benefits* earned from owning the commodity spot (called convenience yield). These benefits (which come in the form of, for example, merchandising profits) are higher when inventories are low. They could easily exceed the *cost* of storage and the *cost* of financing the purchase of the commodity, thus giving incentive to inventory holders to own the commodity spot when markets are in backwardation. A backwardated market (with a downward-sloping term structure) is thus characteristic of scarce inventories.

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made of backwardated commodities whose prices are expected to appreciate and $High_{Hedg}$ is presumably made of contangoed commodities whose prices are expected to depreciate. We then combine the positions of hedgers with those of speculators by buying the 40% of Low_{Hedg} for which speculators have high hedging pressure and selling the 40% of $High_{Hedg}$ for which speculators have low hedging pressure over the previous R weeks. The double-sort portfolio holds the long-short positions over the next H weeks. We also reverse the sorting order as it was arbitrary to sort on first, the average hedging pressure of hedgers and second, the average hedging pressure of speculators.

The single- and double-sort strategies implemented to mimic the trading behaviour of long-short speculators differ with regards to one characteristic only: the sorting criterion used for asset allocation. In all other respects, the strategies use the same following three principles. First, the ranking period (R) over which the sorting criterion is averaged and the holding period (H) over which the long-short portfolios are held are always set to either four, thirteen, twenty-six or fifty-two weeks. So we end up with sixteen long, sixteen short and sixteen long-short portfolios for each of the strategies mentioned above, where these sixteen series come from the permutation of the four ranking and four holding periods. To ease presentation, the average performance across these sixteen combinations is used in the remainder of the paper. Second, in line with, among others, Erb and Harvey (2006) or Miffre and Rallis (2007), the constituents of the long and short portfolios are equally-weighted. This is to avoid concentration in any commodity and preserve diversification. Third, as already mentioned the long-short strategies are implemented on the 75% of the cross section that is the most liquid, taking long positions in the 75% × 20% = 15% commodities whose prices are expected to appreciate and short positions in the 75% × 20% = 15% commodities whose prices are expected to decline. This is to ensure that issues related to lack of liquidity are kept to a minimum.

III. C. Modelling Conditional Volatility and Conditional Correlation

The most successful volatility model is the generalised autoregressive conditional heteroskedasticity GARCH(1,1) model of Bollerslev (1986). The GARCH(1,1) variance, h_t, describes the volatility dynamics of a given return series as follows

$$\begin{aligned} R_{C,t} &= \mu + \varepsilon_{C,t} \\ h_{C,t} &= \gamma + \alpha\varepsilon^2_{C,t-1} + \beta h_{C,t-1} \end{aligned} \tag{1}$$

$R_{C,t}$ is the time t return of the (long, short, long-short or long-only) commodity portfolio modelled in Sections III. A. and III. B., $\varepsilon_{C,t}$ are residuals distributed as $N(0, h_{C,t})$, μ is the mean return of $R_{C,t}$, α, β and γ are such that $\gamma > 0$, $\alpha \geq 0$, $\beta \geq 0$, and $\alpha + \beta < 1$.

When it comes to modelling the return co-movements between commodities C and traditional assets T, we use the dynamic conditional correlation (DCC) model of Engle (2002)[22]. DCC time-varying correlations are estimated in two steps. The first step estimates time-varying variances as GARCH(1,1) processes and the second step models a time-varying correlation matrix using the standardised residuals from the first-stage estimation. More specifically, the covariance matrix

22 - See also Büyükşahin and Robe (2010), Büyükşahin, Haigh, and Robe (2010), Chong and Miffre (2010) for an analysis of conditional correlations between traditional assets and long-only commodity futures positions.

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is expressed as $H_t \equiv D_t R_t D_t$, where $D_t = diag(\sqrt{h_{C,t}}, \sqrt{h_{T,t}})$ is a diagonal matrix of univariate GARCH(1,1) volatilities and $R_t = Q_t^{*-1} Q_t Q_t^{*-1}$ is the time varying correlation matrix, with

- $Q_t = (q_{C,T,t})$ as described by $Q_t = (1-a-b)\overline{Q} + a(\varepsilon_{C,t-1}\varepsilon_{T,t-1}) + bQ_{t-1}$, where $\varepsilon_{C,t} = R_{C,t} / \sqrt{h_{C,t}}$ and $\varepsilon_{T,t} = R_{T,t} / \sqrt{h_{T,t}}$ are standardized residuals modelled from the first stage. $\overline{Q}$ is the N×N unconditional covariance matrix of standardised residuals, a and b are non-negative coefficients satisfying a + b < 1,

- and $Q_t^* = (q_{ii,t}^*) = (\sqrt{q_{ii,t}})$ is a diagonal matrix composed of the square root of the i^{th} diagonal elements of Q_t, where *i* stands for *C* or *T*.

Rewriting $R_t = Q_t^{*-1} Q_t Q_t^{*-1}$, the time *t* conditional return correlation between commodity and traditional asset can then be expressed as

$$\rho_{C,T,t} = \frac{q_{C,T,t}}{\sqrt{q_{C,t}}\sqrt{q_{T,t}}} \tag{2}$$

The framework presented above is useful to study the evolution in the conditional volatility of commodity portfolios and the evolution of their conditional correlations with traditional assets. In particular, we will try and answer the following questions: Are the volatility of the long-only and long-short commodity portfolios of the same magnitude? Are the conditional correlations of traditional assets with long-only commodity portfolios equal to those measured relative to long-short commodity portfolios? Do these volatilities and correlations evolve in the same way in periods of high volatility in traditional asset markets? Bearing this last question in mind, regressions (3) and (4) are estimated

$$\sqrt{h_{C,t}} = \beta_0 + \beta_T \sqrt{h_{T,t}} + \varepsilon_t \tag{3}$$

$$\rho_{C,T,t} = \beta_0 + \beta_T \sqrt{h_{T,t}} + \varepsilon_t \tag{4}$$

which regress the annualised conditional volatility of long-short and long-only commodity portfolios or their conditional correlation with traditional assets on the annualised conditional volatility of traditional indices (S&P500 composite index or Barclays Capital Aggregate US bond index). A positive and significant β_T coefficient in (3) indicates concomitant increases in volatility across traditional and alternative asset markets, which is disappointing news to risk-adverse investors. Vice versa, a negative and significant β_T coefficient in (3) suggests that in periods of high volatility in traditional asset markets investors can – other things being equal – decrease the overall volatility of their portfolio by treating commodities as part of their strategic asset allocation.

Similarly, a positive and significant β_T coefficient in (4) indicates that conditional correlations rise with the volatility of traditional assets. If so, the evidence of increased integration of international stock markets in periods of high equity volatility (Solnik, Boucrelle, and Le Fur, 1996; Longin and Solnik, 2001) will be extrapolated to commodity and traditional asset markets. On the other hand, a negative and significant β_T coefficient in (4) indicates increased segmentation between commodity and traditional asset markets in periods of high volatility in traditional asset markets. This result will be treated as welcome news to

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investors in traditional assets as it implies that the usefulness of commodity futures as diversification tool increases in periods of high volatility in traditional asset markets; namely, when investors need diversification the most.

III. D. Testing for Granger Causality

Our analysis focuses on the hedging pressure (*HP*) of speculators, which measures the propensity of speculators to be net long or net short. Basically, a high *HP* (e.g., 0.8) translates into large speculators being net long (e.g., 80% are long and 20% are short), while a low *HP* (e.g., 0.2) translates into large speculators being net short (e.g., 20% are long and 80% are short). We measure for the commodities included in a given (long, short or long-short) commodity portfolio *C* the average hedging pressure of speculators over the holding period. We denote this quantity $\overline{HP}_{C,t}$ and use $\Delta\overline{HP}_{C,t}$ as a measure of the propensity of speculators to change their commodity exposure. In the case of a long portfolio, a positive $\Delta\overline{HP}_{C,t}$ means that long speculators increased their long exposure. In the case of a short portfolio, a negative $\Delta\overline{HP}_{C,t}$ means that short speculators decreased their long exposure and thus increased their short exposure.

To test whether the increased financialisation of commodity markets lead to change in volatility, we run tests of the null hypothesis that changes in speculators' hedging pressure did not Granger (1969) cause changes in the volatility of the long, short and long-short commodity portfolio returns. Namely, regression (5) is estimated

$$\Delta\sqrt{h_{C,t}} = \delta_0 + \delta_1 \Delta\overline{HP}_{C,t-1} + \delta_2 \Delta\sqrt{h_{C,t-1}} + \upsilon_{C,t} \qquad (5)$$

$\Delta\sqrt{h_{C,t}}$ measures the change in the annualized conditional volatility of the long (respectively short, respectively long-short) commodity portfolio, $\Delta\overline{HP}_{C,t-1}$ represents the first lag in the change in the average hedging pressure of speculators for the assets included in the long (respectively short, respectively long-short) commodity portfolio *C* over the holding period, $\upsilon_{C,t}$ are residuals, δ_0, δ_1 and δ_2 are parameters to estimate. The null hypothesis that $\delta_1 = 0$ is then tested using a Granger causality test, where a rejection of the null indicates that speculators through their long (respectively short, respectively long-short) positions had an impact on volatility. If δ_1 is positive and significant for a given long portfolio, then increases in the long positions of speculators (namely, $\Delta\overline{HP}_{C,t-1} > 0$) destabilise commodity markets by increasing the volatility of that long portfolio returns. Similarly, if δ_1 is negative and significant for a given short portfolio, then increases in the short positions of speculators (namely, $\Delta\overline{HP}_{C,t-1} < 0$) destabilise commodity markets by increasing the volatility of that short portfolio returns.

Granger causality tests are also used to investigate whether the financialisation of commodity markets had an impact on conditional correlation. The following regression is estimated for the conditional returns correlations between the long, short and long-short commodity portfolios *C* and the traditional asset class *T*

$$\Delta\rho_{C,T,t} = \delta_0 + \delta_1 \Delta\overline{HP}_{C,t-1} + \delta_2 \Delta\rho_{C,T,t} + \nu_{C,P,t} \qquad (6)$$

The null hypothesis is that change in the speculators' hedging pressure for the constituents of the long (respectively short, respectively long-short) portfolios

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in (6) did not Granger cause a change in the conditional correlation between the returns of the long (respectively short, respectively long-short) commodity index and the returns of the traditional asset. As in equation (5), a positive and significant δ_1 in (6) indicates increased integration driven by speculators increasing their long positions. A negative and significant δ_1 in (6) indicates increased integration driven by speculators increasing their short positions. Since data are at a quarterly frequency, we also test for the joint significance of the lags up to order 4 in equations (5) and (6).

Finally, we test the robustness of the results to three different specifications of equations (5) and (6). Following Irwin and Sanders (2011), Brunetti, Büyükşahin and Harris (2011) and Büyükşahin and Robe (2010), the first robustness test uses conditional volatility and conditional correlation as dependent and independent variables in (5) and (6) instead of their changes. As conditional correlations do not solely depend on traders' positions, the second robustness test augments equations (5) and (6) with the first lag in two business cycle variables[23] (in a way similar to Büyükşahin and Robe, 2010). Finally, the third robustness test uses the Disaggregated (instead of aggregated) Commitment of Traders report to test the null hypothesis that professional money managers (i.e., CTAs, CPOs and hedge funds) had no destabilising effect on conditional volatility and correlation.

23 - The business cycle variables considered are default spread (modelled as the difference in yields between BAA and AAA-rated bonds) and term spread (modelled as the difference between 10-year constant maturity T-bond yields and 3-month T-bill rate), where the data are downloaded from the Federal Reserve of St Louis.

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4. Empirical Results

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IV. A. Performance of Long-Short Commodity Portfolios

Panels A and B of Table 2 present summary statistics for the returns of the four single-sort and four double-sort portfolios, where the decision to include a commodity in (or to exclude it out of) the long-short portfolios is based on performance, the slope of the term structure, the positions of hedgers and/or the positions of speculators over the previous *R* weeks. To facilitate presentation and conserve space, a portfolio that equally weights all sixteen combinations of four ranking and four holding periods is formed for each of the single- and double-sorts[24]. The performance of long-only portfolios such as the S&P-GSCI or an equally-weighted portfolio of all twenty-seven commodities is reported in Table 2, Panel C.

24 - The details of the performance of the individual strategies are available upon request.

Altogether, the results of Table 2 highlight the importance of taking a long-short approach to commodity investing. With the exception of the single-sort momentum strategy in Panel A, the long-short portfolios in Panels A and B outperform the long-only benchmarks in Panel C. The average mean return of the single-sort long-short portfolios equals 7.99% a year and that of the double-sort portfolios equals 9.03% a year. These results compare favourably to the performance of long-only benchmarks such as the S&P-GSCI and a long-only equally-weighted portfolio of commodities that stand at 0.64% and 4.28% a year, respectively.

The conclusion is similar once we adjust for risk. The Sharpe ratios of the long-short portfolios average out at 0.5093 with a range from 0.2711 (for the single-sort momentum strategy) to 0.6302 (for the single-sort hedger-based strategy). These Sharpe ratios always substantially exceed those of long-only benchmarks (0.0529 for the long-only equally-weighted portfolio and 0.1965 for the S&P-GSCI). As previously reported (Miffre and Rallis, 2007; Fuertes, Miffre and Rallis, 2010; Basu and Miffre, 2011), these results confirm the importance of taking backwardation and contango into account while designing dynamic strategies in commodity futures contracts.

Table 2 also presents slope coefficients of regressions of the hedging pressure of speculators on a time trend for each of the single- and double-sort commodity strategies presented in Section III, where the hedging pressure of speculators is measured as $\overline{HP}_{C,t}$, namely, as the cross-sectional average of the *HP* of speculators for the constituents of the long (respectively, short, respectively, long-short) portfolios over the holding period of the strategy. The idea is to investigate how the average hedging pressure of speculators for the commodity futures included in the long (respectively, short, respectively, long-short) portfolio has changed over time. An increased level of financialisation of commodity markets would translate into an increase in the hedging pressure of speculators for the long and long-short portfolios over time and a decrease in the hedging pressure of speculators for the short portfolios over time. Indeed this result would be consistent with the idea that speculators took more long, more short and more long-short positions at the end of the sample than they did at the beginning of the sample, a sign of increased financialisation.

The slope coefficients on the time trend reported in Table 2 are for the most part in line with this conclusion. They are positive

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Table 2: Performance of Single- and Double-Sort Commodity Portfolios

The table presents summary statistics for long, short, long-short and long-only commodity portfolios. Four single-sort strategies (in Panel A) and four double-sort strategies (in Panel B) are considered, where these are based on momentum and/or term structure (TS) signals and on the average positions of hedgers and/or speculators over four ranking periods *R* of four, thirteen, twenty-six and fifty-two weeks. The long, short and long-short commodity portfolios are then held over four holding periods *H* of four, thirteen, twenty-six and fifty-two weeks.. Instead of reporting summary statistics for each of the sixteen combinations that results from permutations of these *R* and *H*, an equally-weighted portfolio that combines all sixteen permutations is formed for each strategy. The table presents summary statistics for the excess returns of these equally-weighted portfolios. Mean has been annualised, SD is the annualised standard deviation of the portfolio excess returns, Sharpe is the ratio of the annualised mean to the annualised SD, Trend (×100) is 100 × the slope coefficient of a regression of the portfolio excess returns on a time trend. *t*(.) in parentheses stands for the associated *t*-statistic. EW represents an equally-weighted portfolio that includes all twenty-seven commodities. TS stands for term structure.

	Long Portfolio						Short Portfolio						Long-Short Portfolio					
	Mean	t(Mean)	SD	Sharpe	Trend (*100)	t(Trend)	Mean	t(Mean)	SD	Sharpe	Trend (*100)	t(Trend)	Mean	t(Mean)	SD	Sharpe	Trend (*100)	t(Trend)
Panel A: Single-Sort Portfolios																		
Momentum	0.0328	(0.78)	0.1803	0.1822	0.0005	(0.46)	-0.0088	(-0.24)	0.1546	-0.0569	0.0006	(0.51)	0.0416	(1.17)	0.1536	0.2711	-0.0001	(-0.09)
TS	0.0553	(1.38)	0.1717	0.3220	0.0063	(5.20)	-0.0251	(-0.68)	0.1585	-0.1581	-0.0108	(-11.11)	0.0803	(2.02)	0.1712	0.4693	0.0170	(14.87)
Hedgers	0.0872	(2.08)	0.1800	0.4841	0.0101	(9.38)	-0.0269	(-0.82)	0.1410	-0.1906	-0.0034	(-3.02)	0.1140	(2.71)	0.1809	0.6302	0.0134	(11.13)
Speculators	0.0391	(0.98)	0.1712	0.2282	0.0111	(10.29)	-0.0444	(-1.18)	0.1618	-0.2746	-0.0031	(-2.61)	0.0835	(2.09)	0.1717	0.4863	0.0141	(12.54)
Average	0.0536		0.1758	0.3041			-0.0263		0.1540	-0.1700			0.0799		0.1694	0.4642		
Panel B: Double-Sort Portfolios																		
Momentum-TS	0.0693	(1.79)	0.1666	0.4159	0.0069	(6.61)	-0.0150	(-0.45)	0.1445	-0.1040	-0.0025	(-2.54)	0.0843	(2.39)	0.1518	0.5556	0.0094	(9.87)
TS-Momentum	0.0674	(1.67)	0.1733	0.3887	0.0059	(5.65)	-0.0224	(-0.65)	0.1484	-0.1509	-0.0019	(-1.89)	0.0898	(2.44)	0.1584	0.5666	0.0079	(7.72)
Hedgers-Speculators	0.0383	(0.98)	0.1683	0.2273	0.0105	(9.86)	-0.0401	(-1.10)	0.1573	-0.2550	-0.0025	(-2.12)	0.0784	(2.05)	0.1647	0.4759	0.0130	(11.44)
Speculators-Hedgers	0.0798	(1.95)	0.1759	0.4538	0.0118	(11.99)	-0.0288	(-0.86)	0.1437	-0.2002	-0.0023	(-2.01)	0.1086	(2.66)	0.1753	0.6197	0.0141	(11.99)
Average	0.0637		0.1710	0.3714			-0.0266		0.1485	-0.1775			0.0903		0.1625	0.5544		
Panel C: Long-Only Portfolios																		
EW	0.0064	(0.23)	0.1208	0.0529														
S&P-GSCI	0.0428	(0.84)	0.2178	0.1965														

and significant at the 1% level for seven out of eight long portfolios, meaning that speculators increased their long positions over time. They are negative and significant at the 5% level for six out of eight short portfolios, meaning that the average hedging pressure of speculators has decreased over time for the constituents of the short portfolios, a sign that speculators have increased their short positions. Finally, the slope coefficients are positive and significant at the 1% level for seven out of eight long-short portfolios, confirming the evidence from the perspective of the long-short portfolios of an increased financialisation of commodity markets. The question remains: Did this observed increase in financialisation of commodity futures markets by long-short investors lead to an increase in the volatility of commodity markets and to an increase in their conditional correlation with traditional assets? We will turn our attention to these questions shortly.

IV. B. Conditional Volatility

Table 3 presents summary statistics for the conditional volatilities of long-short and long-only commodity portfolios as modelled in (1). Interestingly, the averages of the conditional volatilities of the long-short commodity portfolios in Panels A and B range from 15.09% to 17.61% a year and are less than the average of the conditional

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Table 3: Conditional Volatility of Commodity Portfolios

The table presents summary statistics for the annualised conditional volatility of long-short and long-only commodity portfolios. SD stands for standard deviation. The column labelled H_0: $SD_{L-S} - SD_{S\&P-GSCI} = 0$ reports *t*-statistics for the null hypothesis that the difference in the conditional standard deviation of the long-short portfolio and the conditional standard deviation of the S&P-GSCI equals zero. $\beta_{S\&P500}$ is the slope coefficient of a regression of the volatility of the long-short and long-only commodity portfolios on the volatility of the S&P500 index. $\beta_{Barclays}$ is the slope coefficient of a regression of the volatility of the long-short and long-only commodity portfolios on the volatility of Barclays Capital US Aggregate Bond index. *t*(.) in parentheses stands for the associated *t*-statistic. EW represents an equally-weighted portfolio that includes all twenty-seven commodities.

	Summary statistics			Regression on S&P500 volatility		Regression on bond volatility	
	Mean	SD	H_0: $SD_{L-S} - SD_{S\&P-GSCI} = 0$	$\beta_{S\&P500}$	$t(\beta_{S\&P500})$	$\beta_{Barclays}$	$t(\beta_{Barclays})$
Panel A: Single-Sort Long-Short Portfolios							
Momentum	0.1532	0.0162	(-17.74)	0.0237	(3.55)	-0.2792	(-3.61)
Term Structure	0.1700	0.0237	(-15.93)	0.1012	(10.93)	-0.1003	(-0.88)
Hedgers	0.1761	0.0501	(-11.74)	0.2297	(11.87)	-0.9048	(-3.80)
Speculators	0.1691	0.0325	(-19.43)	0.1158	(8.95)	-0.2451	(-1.57)
Panel B: Double-Sort Long-Short Portfolios							
Momentum-Term Structure	0.1509	0.0273	(-19.14)	0.1063	(9.86)	-0.4333	(-3.32)
Term Structure-Momentum	0.1574	0.0291	(-16.13)	0.0670	(5.66)	-0.5095	(-3.68)
Hedgers-Speculators	0.1618	0.0342	(-21.44)	0.1262	(9.31)	-0.5593	(-3.43)
Speculators-Hedgers	0.1710	0.0451	(-11.12)	0.2088	(11.98)	-1.0840	(-5.07)
Panel C: Long-Only Portfolios							
EW	0.1128	0.0415		0.3330	(24.81)	1.1454	(5.85)
S&P-GSCI	0.2081	0.0801		0.6471	(25.15)	0.7621	(1.99)

volatilities of the S&P-GSCI (20.81% in Panel C). *t*-statistics reported in parentheses under the label H_0: $SD_{L-S} - SD_{S\&P-GSCI} = 0$ suggest rejection of the null hypothesis that the two conditional volatilities are equal at the 1% level. This confirms the importance of taking a long-short approach to commodity investing. Not only is the annualised mean returns of the long-short portfolios 4.23% higher than the annualised mean returns of the S&P-GSCI (Table 2), but also the annualised volatility of the long-short portfolios returns is 4.44% lower than the annualised volatility of the S&P-GSCI returns.

Table 3 also studies how the conditional volatility of long-short and long-only commodity portfolios evolves with the volatility of equity and fixed income markets. Namely, the question we are trying to answer is the following: does the conditional volatility of long-short portfolios rise / fall when the volatility of traditional asset markets rises as modelled in equation (3)? The second set of columns of Table 3 presents slope coefficients from regressions of the annualised conditional volatility of commodity portfolios on the annualised conditional volatility of the S&P500 index. Irrespective of the panel considered, the slope coefficients are always positive and significant at the 1% level, indicating that a rise in equity volatility goes hand-in-hand with a rise in commodity volatility. This is disappointing news to risk-averse investors[25]. Yet, the slope coefficients stand at 0.6471 for the

25 - The results presented here indicate concomitant rises in volatility for both asset classes. This does not necessarily mean that the overall volatility of a portfolio combining equities and commodities will rise as the conditional return correlation between the two asset classes could simultaneously sharply fall, thereby decreasing the overall volatility. We will turn our attention to this matter shortly.

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S&P-GSCI in Panel C and at an average of 0.1223 for the long-short single- and double-sort commodity portfolios in Panels A and B. This indicates that the long-short commodity portfolios become substantially less volatile than the S&P-GSCI when the volatility of equity markets rises. This again confirms the claim put forward earlier of the importance of taking backwardation and contango into account while designing active strategies in commodity futures markets.

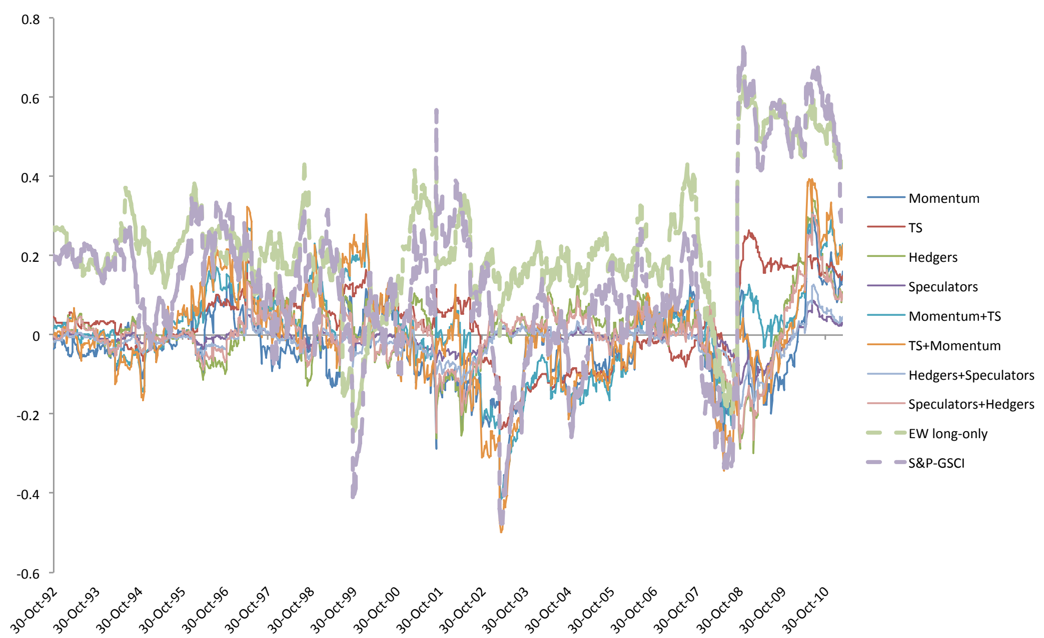
The last set of columns of Table 3 analyses how the conditional volatility of commodity portfolios evolves as the conditional volatility of the bond market rises. The slope coefficient on the conditional volatility of Barclays Capital bond index in (3) are positive at the 5% level or better for the long-only commodity portfolios and negative at the 1% level for six of the eight long-short commodity portfolios. This again is welcome news to long-short commodity traders: by taking short commodity positions, long-short commodity investors reduce the volatility of their overall portfolio when fixed income markets become more volatile. To state this another way, long-short commodity portfolios can be used to partially hedge fixed income risk.

IV. C. Conditional Correlation with the S&P500 Composite Index

Notwithstanding the importance of conditional volatility, it is important from a risk management perspective to also look at cross-market linkage and at how the conditional correlations of the long-short and long-only commodity portfolios with traditional assets have evolved in periods

Figure 2: Conditional correlations between the returns of long-short and long-only commodity portfolios and the returns of the S&P500 index

The full narrower lines represent the conditional correlations between the long-short commodity portfolios and the S&P500 index. The dashed wider lines represent the conditional returns correlations between the long-only commodity portfolios (long-only equally-weighted and S&P-GSCI) and the S&P500 index.



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of high volatility in equity and fixed income markets. Focusing first on the conditional correlation with the S&P500 index, Figure 2 plots the evolution over time in the conditional correlations of equity returns with either one of the commodity portfolios, where the focus here is both on the eight long-short commodity portfolios and on the two long-only indices (equally-weighted portfolio and S&P-GSCI). A casual look at Figure 2 indicates that the conditional correlations of the S&P500 index with the long-short commodity portfolios (full narrow lines) are lower than those with the long-only portfolios (dash wide lines). While this phenomenon applies across the whole sample, it seems more pronounced since 2008.

The left-hand side of Table 4 presents means for the conditional correlations as modelled in (2) between the S&P500 index and the long-short or long-only commodity portfolios. The means of the conditional correlations (μ, μ_1 and μ_2) are presented over the whole sample and over two sub-samples that span the periods, 30 October 1992 – 3 October 2008 and 10 October 2008 – 25 March 2011, respectively. Three points are worth noting. First, as previously reported (see, Bodie and Rosansky, 1980, amongst others), the

Table 4: Conditional Return Correlations between Commodity Portfolios and the S&P-500 Index

The table presents the means and associated *t*-statistics (in parentheses) for the conditional correlations between the S&P500 returns and the returns of the long-short and long-only commodity portfolios. μ is the mean over the whole sample, μ_1 and μ_2 are the mean correlations over the two following sub-samples: 30 October 1992 – 3 October 2008 and 10 October 2008 – 25 March 2011. The column labelled $H_0\colon \rho_{L-S} - \rho_{S\&P-GSCI} = 0$ reports *t*-statistics for the null hypothesis that the difference in conditional correlations for the long-short portfolio and the S&P-GSCI equals zero. $\beta_{S\&P500}$ is the slope coefficient of a regression of these conditional correlations on the volatility of the S&P500 index. EW represents an equally-weighted portfolio that includes all twenty-seven commodities. TS stands for term structure.

	Mean Correlation							Regression on S&P500 volatility	
	μ	$t(\mu)$	$H_0\colon \rho_{L-S} - \rho_{S\&P-GSCI} = 0$	μ_1	$t(\mu_1)$	μ_2	$t(\mu_2)$	$\beta_{S\&P500}$	$t(\beta_{S\&P500})$
Panel A: Single-Sort Long-Short Portfolios									
Momentum	-0.0351	(-1.09)	(-17.74)	-0.0435	(-1.26)	0.0193	(0.22)	-0.0865	(-2.10)
TS	0.0289	(0.90)	(-15.93)	0.0050	(0.14)	0.1836	(2.10)	0.5677	(15.70)
Hedgers	0.0058	(0.18)	(-11.74)	0.0003	(0.01)	0.0411	(0.46)	-0.4222	(-12.82)
Speculators	-0.0084	(-0.26)	(-19.43)	-0.0075	(-0.22)	-0.0140	(-0.16)	-0.1818	(-18.62)
Panel B: Double-Sort Long-Short Portfolios									
Momentum-TS	0.0088	(0.27)	(-19.14)	-0.0086	(-0.25)	0.1206	(1.37)	0.2490	(5.07)
TS-Momentum	-0.0001	(-0.00)	(-16.13)	-0.0136	(-0.39)	0.0870	(0.98)	-0.0192	(-0.34)
Hedgers-Speculators	-0.0167	(-0.52)	(-21.44)	-0.0160	(-0.46)	-0.0214	(-0.24)	-0.2600	(-18.17)
Speculators-Hedgers	0.0025	(0.08)	(-11.12)	-0.0020	(-0.06)	0.0309	(0.35)	-0.3899	(-13.78)
Panel C: Long-Only Portfolios									
EW	0.2275	(7.24)		0.1804	(5.28)	0.5313	(7.07)	0.4813	(7.45)
S&P-GSCI	0.1461	(4.57)		0.0836	(2.42)	0.5490	(7.40)	0.7875	(9.07)

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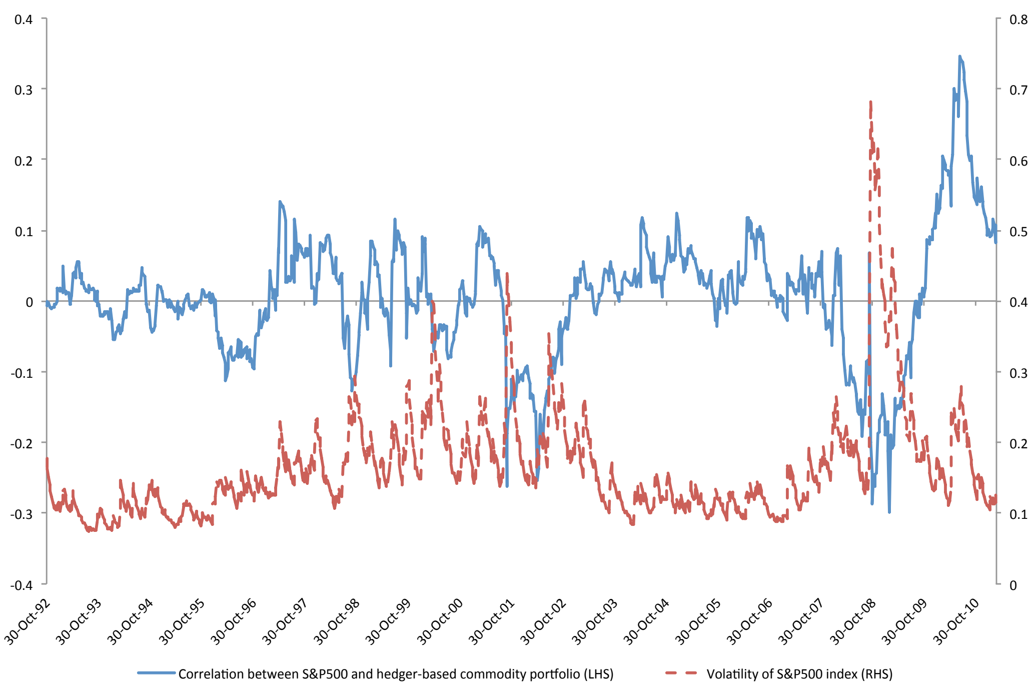
means of the conditional correlations are low, confirming the strategic role as risk diversifiers of commodity portfolios. Second, the means of the conditional correlations relative to the long-short indices (-0.0018 on average in Panels A and B) are clearly lower than those reported for the long-only indices (0.2275 for the long-only equally-weighted portfolio and 0.1461 for the S&P-GSCI in Panel C). While the former are not significantly different from zero at even the 10% level, the latter are positive and significant at the 1% level[26]. *t*-statistics reported in parentheses under the label H_0: $\rho_{L-S} - \rho_{S\&P-GSCI} = 0$ suggest rejection at the 1% level of the null hypothesis that the conditional correlations modelled relative to the long-short portfolios equal those modelled relative to the S&P-GSCI. Third, the observed pattern is stronger since 10 October 2008: over the second period the mean in the average conditional correlations of the S&P500 index relative to long-short indices stands at a mere 0.0559, while that relative to long-only indices equals 0.5402. This result highlights once more the importance of taking both long and short positions in commodity futures markets as opposed to being long-only: the benefits of diversification are then much stronger.

This result confirms that of Büyükşahin and Robe (2010) and Tang and Xiong (2011) who had shown before us that the conditional correlations between commodity and equity portfolios rose following the downfall of Lehman Brothers. Yet, Table 4 and Figure 2 show that the rise in conditional correlations and the subsequent drop

26 - The observed difference is driven by the negative and significant correlations between the S&P500 and the short commodity portfolios. These results are not reported here to conserve space but are available upon request.

Figure 3: The Negative Relationship between Conditional Correlation and Conditional S&P500 Volatility – The Case of a Long-Short Hedger-Based Commodity Portfolio

The correlation between the two series is -0.38 and is significant at the 1% level.



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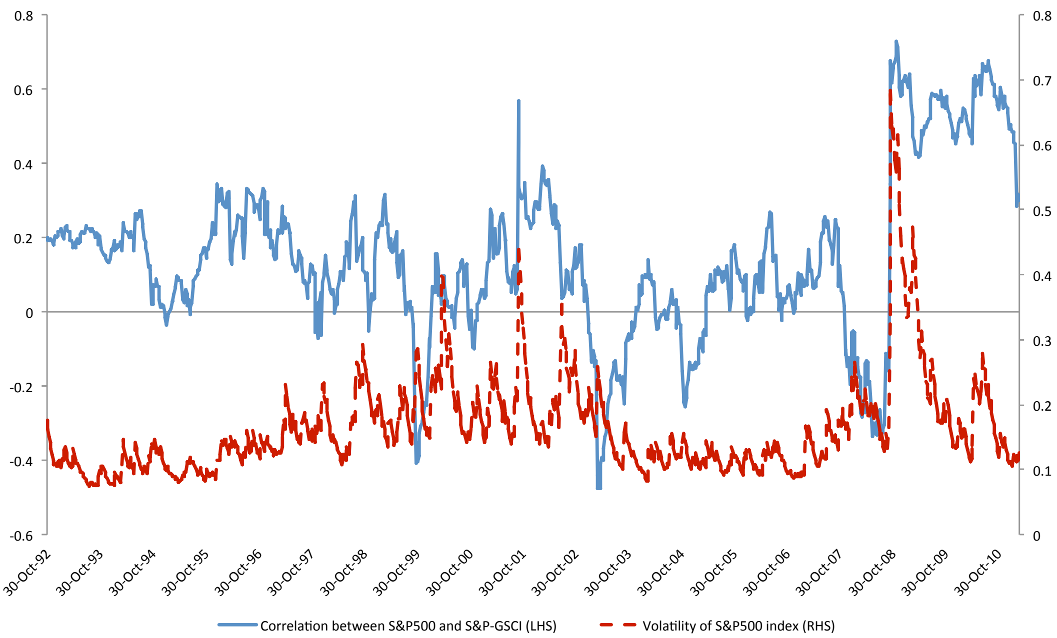
in diversification benefits matter much more to long-only commodity investors. While the average conditional correlations between equities and long-only commodity portfolios rose from 0.1320 to 0.5402 over the two sub-samples, those with long-short commodity portfolios rose much less (from -0.0107 to 0.0559) and remain close to zero.

Figure 3 plots on the left-hand side the conditional return correlations between the hedger-based commodity portfolio and the S&P500 index and on the right-hand side the annualised conditional volatility of the S&P500 index returns. Figure 4 reports the same information for a long-only commodity portfolio (the S&P-GSCI index) in place of the long-short hedger-based commodity portfolio. It is interesting to note that in Figure 3 the conditional correlations between the long-short commodity index and the S&P500 index tend to fall when the conditional volatility of the S&P500 index rises. In fact, the correlation between the two series plotted in Figure 3 is as low as -0.38 and is significantly different from zero at the 1% level. On the other hand, the conditional correlations plotted in Figure 4 vis-à-vis a long-only commodity index tend to rise with the conditional volatility of the S&P500 index: the correlation between the two series in Figure 4 stands indeed at 0.28 and is significantly different from zero at the 1% level. This suggests that investors following a long-short (as opposed to long-only) approach to commodity

Figure 4: The Positive Relationship between Conditional Correlation and Conditional S&P500 Volatility – The Case of a Long-Only Commodity Portfolio such as the S&P-GSCI

The correlation between the two series is 0.28 and is significant at the 1% level.



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investing get better diversification when it is most needed; namely, in periods of high volatility in equity markets.

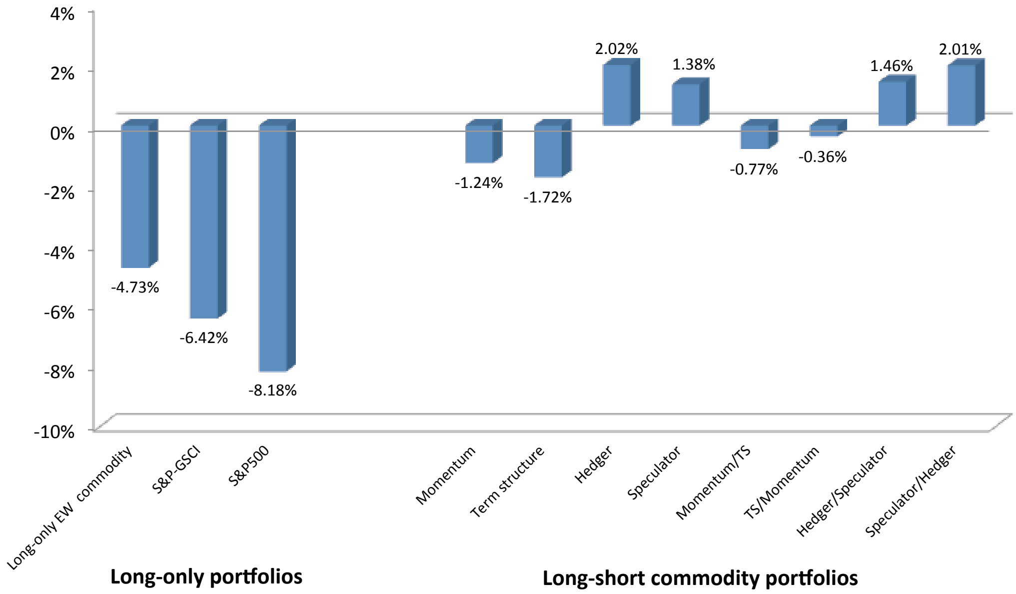
Take, for example, periods in which the volatility of the S&P500 index exceeded 50% on an annualised basis (namely, during the financial crisis that followed the demise of Lehman Brothers). The average of the conditional correlations between the long-short hedger-based commodity portfolio and the S&P-500 index was then particularly low at -0.23 (versus a long-term mean at 0.006). Vice versa, in periods when the volatility of the S&P500 index was less than 10% a year, the average of the conditional correlations between the long-short hedger-based commodity portfolio and the S&P500 index was rather high at 0.00. The opposite conclusion arises when we replace the long-short hedger-based commodity portfolio by a more traditional long-only commodity index such as the S&P-GSCI. Then the correlations with the S&P500 index are higher (at 0.67 on average) when the volatility of the S&P500 index exceeded 50% a year (after Lehman Brothers' bankruptcy) and lower (at 0.13 on average) when the volatility of the S&P500 was less than 10% a year. This shows that the benefits of diversification are stronger in periods of high equity volatility within a long-short approach to commodity investing. To put it differently, long-short commodity portfolios serve as partial hedge against extreme risks in equity markets.

This insight is confirmed analytically on the right-hand side of Table 4 where we report slope coefficients $\beta_{S\&P500}$ and associated *t*-statistics from equation (4). The estimated coefficients in Panel C indicate that a rise of 1% in the annualised volatility of the S&P500 index comes hand-in-hand with an increase by 0.79% (0.48%) in the conditional correlations between the S&P500 index and the S&P-GSCI (EW long-only commodity portfolio). Conversely, Table 4, Panels A and B show that a rise in 1% in the volatility of the S&P500 index *decreases* (by an average of 0.31%) the conditional correlations between the S&P500 index and the single- and double-sort long-short commodity strategies based on the positions of speculators and/or hedgers. Note, however, that the conclusion of a negative relationship between conditional correlation and S&P500 volatility does not hold for all of the long-short commodity portfolios in Panels A and B. In fact, we find negative, zero and positive relationships between conditional correlation and S&P500 volatility for the single- and double-sort commodity portfolios based on momentum and/or term structure. It follows that equity investors worried about diversification in periods of high volatility in equity markets should use the positions of hedgers and speculators over the recent past as long-short signals for asset allocation rather than past performance or past roll-returns.

Figure 5 presents the weekly performance of the S&P500 index, of long-only and long-short commodity portfolios in the four weeks that followed Lehman Brothers' demise (dated 15 September 2008). Over that period, the S&P500 composite index lost an average of 8.18% a week, the S&P-GSCI lost 6.42% and the long-only equally-weighted portfolio of all commodities lost 4.73%. Over the same period, the long and short commodity portfolios experienced large losses too (of a magnitude of -4.36% for the long portfolios and -4.71% for

4. Empirical Results

Figure 5: Average Weekly Performance of the S&P500 Index, of Long-Only and Long-Short Commodity Portfolios Over the 4 Weeks that Followed Lehman Brothers' Demise



the short portfolios). Consequently, the long-short commodity portfolios performed remarkably well in relative term, suggesting that the long-short strategies do act as partial hedges against extreme risk in equity markets. With an average weekly return of 1.72%, the performance of the single- and double-sort portfolios based on the positions of hedgers and/or speculators stands out for being particularly noteworthy.

IV. D. Conditional Correlation with Barclays Capital US Aggregate Bond Index

Table 5 reports averages of the conditional correlations between the long-short and long-only commodity portfolios and Barclays Capital US Aggregate bond index. As previously reported (Bodie and Rosansky, 1980; Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006), the correlations with the long-only commodity indices reported in Panel C are particularly low (-0.0737 for the equally-weighted portfolio and -0.0267 for the S&P-GSCI). They are also low for the long-short portfolios in Panels A and B, ranging from -0.0324 to 0.0320 with an average at 0.0006. The column labelled H_0: $\rho_{L-S} - \rho_{S\&P500-GSCI} = 0$ reports t-statistics for the null hypothesis that the conditional correlations between Barclays Capital bond index and the long-short commodity portfolios in Panels A and B equal the conditional correlations between Barclays Capital bond index and the S&P-GSCI in Panel C. The latter are lower than the former for momentum- and/or term structure-based portfolios. This suggests that, other things being equal, bond investors are better off from a risk management perspective holding the S&P-GSCI than commodity portfolios based on past performance or on

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Table 5: Conditional Return Correlations between Commodity Portfolios and Barclays Capital US Aggregate Bond Index

The table presents the means and associated t-statistics (in parentheses) for the conditional correlations between Barclays Capital US Aggregate bond index returns and the returns of the long-short and long-only commodity portfolios. μ is the mean over the whole sample: 30 October 1992 – 25 March 2011. $\beta_{Barclays}$ is the slope coefficient of a regression of these conditional correlations on the volatility of Barclays Capital US Aggregate Bond index. The column labelled H_0: $\rho_{L-S} - \rho_{S\&P-GSCI} = 0$ reports *t*-statistics for the null hypothesis that the difference in conditional correlations for the long-short portfolio and the S&P-GSCI equals zero. EW represents an equally-weighted portfolio that includes all twenty-seven commodities.

	Mean Correlation			Regression on bond volatility	
	μ	$t(\mu)$	H_0: $\rho_{L-S} - \rho_{S\&P-GSCI} = 0$	$\beta_{Barclays}$	$t(\beta_{Barclays})$
Panel A: Single-Sort Long-Short Portfolios					
Momentum	0.0320	(0.99)	(19.11)	1.4149	(10.65)
Term Structure	0.0169	(0.52)	(13.64)	0.1718	(0.97)
Hedgers	-0.0193	(-0.60)	(2.28)	0.0415	(1.80)
Speculators	-0.0303	(-0.94)	(-1.00)	0.3719	(1.62)
Panel B: Double-Sort Long-Short Portfolios					
Momentum-Term Structure	0.0298	(0.92)	(19.64)	1.4722	(7.21)
Term Structure-Momentum	0.0346	(1.07)	(20.60)	1.2091	(8.63)
Hedgers-Speculators	-0.0324	(-1.00)	(-1.75)	0.0556	(1.58)
Speculators-Hedgers	-0.0266	(-0.82)	(0.04)	0.1663	(3.03)
Panel C: Long-Only Portfolios					
EW	-0.0737	(-2.29)		1.7508	(7.01)
S&P-GSCI	-0.0267	(-0.83)		1.4344	(2.99)

past roll-returns. The evidence is less clear-cut from the perspective of a commodity investor who tracks the positions of hedgers and speculators: then the conditional correlations of his/her commodity portfolio with Barclays Capital bond index are often found to be of a similar magnitude to those modelled vis-à-vis the S&P-GSCI.

The right-hand side of Table 5 presents slope coefficients from regressions of these conditional correlations on the conditional volatility of Barclays Capital bond index as in (4). The slope coefficients are positive and significant at the 1% level in Panel C, suggesting that conditional correlations with long-only commodity indices rise in periods of high volatility in fixed income markets. The evidence is less clear-cut in Panels A and B where we find that only four out of eight $\beta_{Barclays}$ coefficients are positive at the 5% level. $\beta_{Barclays}$ equals 0.6129 on average in Panels A and B and solely 0.1588 for the hedger- and/or speculator-based portfolios. These averages compare favourably to those for the long-only portfolios in Panel C (1.5926). Thus, while correlations tend to rise in periods of high volatility in fixed income markets, fixed income investors are better off holding long-short portfolios based on hedgers' and/or speculators' positions than any other commodity portfolios as they are comparatively better diversifiers in periods of increased uncertainty in fixed income markets.

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IV. E. Granger Causality Tests

We now turn our attention to the issue of the financialisation of commodity markets. In particular, we test whether long-short speculators have been destabilising commodity markets by increasing volatility and cross-market linkage. The results are reported in Table 6 for the long portfolios (Panel A), the short portfolios (Panel B) and the long-short portfolios (Panel C), where we present estimates and associated *t*-statistics for δ_1 in (5) and (6) and *p*-values for the null hypothesis that change in hedging pressure of speculators did not Granger cause change in either conditional volatility or conditional correlation. Since the frequency of the data is weekly, we report *p*-values from Granger causality tests with four lags, as well as one.

Regardless of the dependent variable used (conditional volatility in (5) or conditional correlation in (6)) and of the panel considered, δ_1 is never significant at the 5% level. This indicates that speculators neither increased, nor decreased conditional volatility and conditional correlation. The *p*-values indicate a failure to reject the null hypothesis of no-causality for all the long, all the short, and all the long-short portfolios. The conclusion holds irrespective of the number of lags considered in the Granger causality tests. This indicates that the increased participation of speculators did not increase the volatility of commodity markets or their integration with traditional assets. These results go against the idea that speculators have destabilised commodity markets or have increased asset correlations by treating commodities as part of their strategic and tactical asset allocations.

Two robustness checks are implemented. Following Brunetti, Büyükşahin and Harris (2011) and Büyükşahin and Robe (2010), we test whether the results on the financialisation of commodity markets are any different, first, if we use the level (instead of the change) in conditional volatility and in conditional correlation in (5) and (6) and second, if we include as explanatory variables the first lag in two business cycle variables (default spread and term spread). The results, not reported here to conserve space, are consistent with those reported in Table 6.

The analysis conducted thus far focuses on the positions of commercial market participants (hedgers) and non-commercial market participants (speculators) as reported in the Commitment of Traders report. According to the CFTC website, the "commercial" category includes 1. producers, processors, merchants and users of the underlying commodity (who use commodity derivatives to hedge price risk) and 2. swap dealers (who hedge their short OTC positions by taking long futures positions). The "non-commercial" category include 1. professional money managers (CTAs, CPOs and hedge funds) and 2. a wide array of other non-commercial traders not classified as professional money managers (e.g., pension funds with long-only positions). Strictly speaking, swap dealers are not pure hedgers in the sense of Keynes (1930) since they do not have a position in the underlying commodity. Similarly, pension funds and long-only indexers are not pure Keynesian speculators since they merely seek passive exposure to commodity markets as part of their strategic asset allocation.

Bearing these distinctions in mind, the

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Table 6: Granger Causality Tests

The table tests whether changes in the positions of speculators have Granger caused changes in the volatility of commodity portfolios (first set of columns) or changes in the conditional correlation between commodity returns and traditional asset returns (second and third sets of columns). δ_1 is the slope coefficient of a regression of the change in these conditional volatilities (correlations) on the first lag of the change in speculators' hedging pressure for the constituents of that specific commodity portfolio. t(.) stands for the associated t-statistic. p(n lags) is the p-value associated with test of the null hypothesis that change in the positions of speculators did not Granger cause change in volatility (correlation) when n lags are considered in the Granger causality test.

	Conditional volatility of commodity portfolios				Conditional correlation with the S&P500 index				Conditional correlation with Barclays US Aggregate Bond index			
	δ_1	$t(\delta_1)$	p(1 lag)	p(4 lags)	δ_1	$t(\delta_1)$	p(1 lag)	p(4 lags)	δ_1	$t(\delta_1)$	p(1 lag)	p(4 lags)
Panel A: Long Portfolios												
Momentum	0.0036	(0.21)	0.83	0.58	-0.0270	(-0.64)	0.52	0.52	0.0033	(0.26)	0.79	0.26
Term Structure	-0.0132	(-0.78)	0.43	0.94	-0.0043	(-0.19)	0.85	0.06	-0.0094	(-0.20)	0.84	0.61
Hedgers	-0.0066	(-0.62)	0.54	0.62	0.0437	(1.25)	0.21	0.60	0.0116	(0.60)	0.55	0.89
Speculators	-0.0097	(-0.65)	0.52	0.68	0.0180	(0.57)	0.57	0.81	0.0040	(0.20)	0.85	0.99
Momentum-Term Structure	-0.0125	(-0.77)	0.44	0.71	-0.0144	(-0.32)	0.75	0.06	-0.0077	(-0.18)	0.86	0.86
Term Structure-Momentum	0.0055	(0.35)	0.72	0.81	-0.0187	(-0.42)	0.67	0.26	-0.0055	(-0.24)	0.81	0.76
Hedgers-Speculators	-0.0074	(-0.59)	0.55	0.60	0.0331	(0.96)	0.34	0.58	0.0040	(0.18)	0.86	0.87
Speculators-Hedgers	-0.0117	(-0.87)	0.39	0.64	0.0688	(1.62)	0.11	0.49	0.0212	(0.82)	0.41	0.80
Panel B: Short Portfolios												
Momentum	-0.0087	(-0.78)	0.44	0.90	0.0071	(0.40)	0.69	0.04	-0.0043	(-0.45)	0.65	0.89
Term Structure	-0.0054	(-0.72)	0.47	0.43	0.0248	(0.80)	0.43	0.88	-0.0034	(-0.35)	0.72	0.92
Hedgers	0.0036	(0.58)	0.56	0.76	0.0290	(1.17)	0.24	0.51	0.0055	(0.70)	0.48	0.84
Speculators	0.0033	(0.39)	0.70	0.65	0.0059	(0.21)	0.83	0.23	0.0071	(0.62)	0.54	0.97
Momentum-Term Structure	-0.0077	(-0.99)	0.32	0.79	0.0352	(1.41)	0.16	0.09	-0.0001	(-0.02)	0.98	0.93
Term Structure-Momentum	-0.0003	(-0.03)	0.98	1.00	0.0195	(0.85)	0.40	0.08	-0.0033	(-0.75)	0.45	0.84
Hedgers-Speculators	0.0059	(0.70)	0.48	0.84	0.0118	(0.43)	0.67	0.42	0.0060	(0.23)	0.82	0.94
Speculators-Hedgers	0.0071	(1.16)	0.25	0.66	0.0149	(0.60)	0.55	0.12	0.0042	(0.57)	0.57	0.97
Panel C: Long-Short Portfolios												
Momentum	0.0074	(1.55)	0.12	0.43	-0.0188	(-0.79)	0.43	0.59	-0.0034	(-0.37)	0.71	0.95
Term Structure	0.0005	(0.07)	0.95	0.82	0.0183	(1.68)	0.09	0.09	0.0162	(0.44)	0.66	0.95
Hedgers	-0.0004	(-0.04)	0.97	0.97	-0.0137	(-0.63)	0.53	0.32	-0.0034	(-0.74)	0.46	0.71
Speculators	-0.0030	(-0.40)	0.69	0.80	0.0063	(1.07)	0.28	0.70	-0.0361	(-0.76)	0.45	0.83
Momentum-Term Structure	0.0079	(0.93)	0.35	0.79	0.0053	(0.26)	0.80	0.59	0.0046	(0.21)	0.83	0.87
Term Structure-Momentum	0.0115	(1.25)	0.21	0.46	0.0014	(0.05)	0.96	0.46	-0.0060	(-0.53)	0.60	0.74
Hedgers-Speculators	-0.0014	(-0.19)	0.85	0.99	0.0135	(1.58)	0.11	0.42	-0.0070	(-0.96)	0.33	0.55
Speculators-Hedgers	-0.0032	(-0.50)	0.61	0.93	-0.0001	(-0.01)	0.99	0.78	-0.0023	(-0.39)	0.69	0.54

Disaggregated Commitment of Traders report (also available from the CFTC website) splits the positions of market participants explicitly into four categories: 1. pure hedgers (producers, processors, merchants and users of the physical commodity), 2. swap dealers, 3. pure speculators (professional money managers such as CTAs, CPOs and hedge funds) and 4. other non-commercial traders. It is hoped that by omitting other non-commercial traders from the non-commercial category, we will get a better idea of the trades implemented by pure speculators (professional money managers). Similarly, by omitting swap dealers from the commercial category, we

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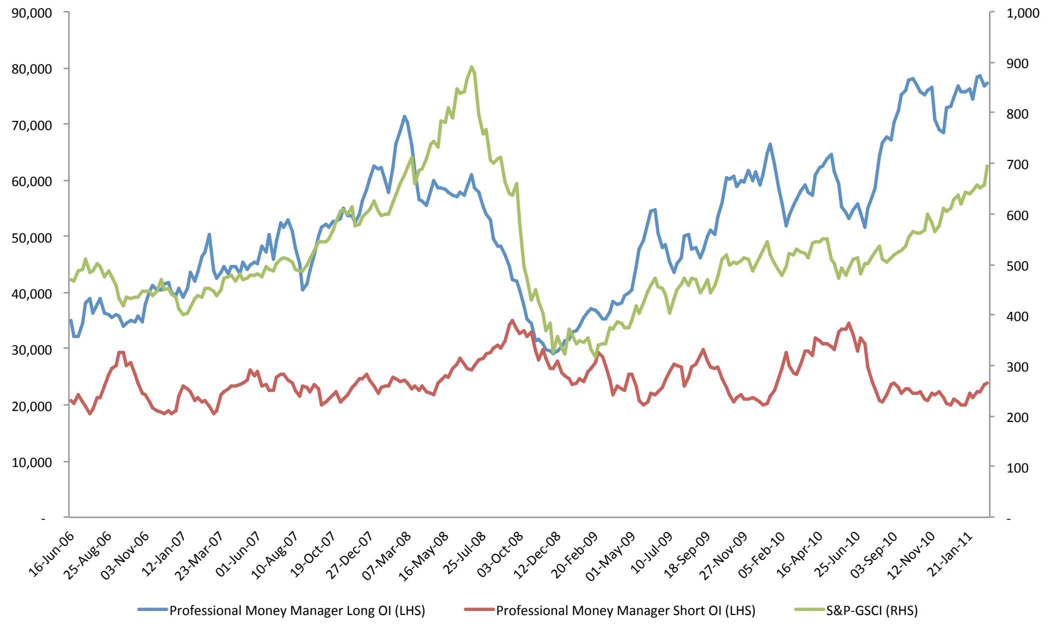
Figure 6: Open Interests of Professional Money Managers (CTAs, CPOs and Hedge Funds)



hope to get a better picture on pure hedging demand from those who have a commercial interest in the physical commodity. Disaggregated data on the positions of pure hedgers and pure speculators are only available since Tuesday, 13 June 2006. This restricts the ensuing analysis to the period 16 June 2006 – 25 March 2011.

Figure 6 plots the evolution in the S&P-GSCI (on the right-hand side) and the evolution in the long and short open interests of professional money managers averaged across our twenty-seven commodities (on the left-hand side). The long positions have risen sharply and seem to follow the ups and downs of the S&P-GSCI, legitimating the concern that change in the former could have increased volatility. On the other hand, the short positions look as if they had remained constant, hovering around 25,000 over the period 2006-2011. As the short positions of professional money managers pretty much remained constant, their change is unlikely to have increased volatility.

Table 7 presents summary statistics for the performance of the long-short and long-only commodity portfolios over the period 16 June 2006 – 25 March 2011. Unlike in Table 2, the asset allocation of the single and double-sort portfolios based on the positions of hedgers and/or speculators is based on the disaggregated hedging pressure of pure hedgers and pure speculators as opposed to the aggregated hedging pressure of commercial and non commercial traders. As in Table 2 before, the results of Table 7 highlight the importance of taking long, as well as short, positions in commodity futures markets. Over this shorter sample too, the Sharpe ratios of the long-short portfolios systematically

4. Empirical Results

and substantially exceed those of the long-only portfolios (which happen to be negative and as low as -0.1502 in the case of the S&P-GSCI). The best performance is achieved within the double-sort portfolio based on the positions of, first, hedgers and, second, speculators, whose equally-weighted portfolio of sixteen permutations of ranking and holding periods achieves a Sharpe ratio of 1.1903. With only one exception, the coefficient on the trend in Table 7 is positive and significant at the 5% level, indicating (as in Table 2 for the longer sample) an increase in the financialisation of commodity markets over the shorter period[27].

Instead of using the aggregated speculators' positions as in Table 6, the positions of pure speculators (i.e., CTAs, CPOs, and hedge funds) as disclosed in the CFTC disaggregated Commitment of Traders

Table 7: Performance of Long-Short Commodity Portfolios: Evidence from the Disaggregated Commitment of Traders Report

The positions of pure hedgers (i.e., producers, processors, merchants and users of the underlying commodity) and pure speculators (i.e., CTAs, CPOs, and hedge funds) as disclosed in the CFTC Disaggregated Commitment of Traders report are used to model the performance of the hedgers and speculators-based portfolios. The table presents summary statistics for long-short and long-only commodity portfolios over the period for which the Disaggregated Commitment of Traders report data are available: 14 July 2006 – 25 March 2011. Four single-sort strategies (in Panel A) and four double-sort strategies (in Panel B) are considered, where these are based on momentum and/or term structure (TS) signals and on the average positions of hedgers and/or speculators over four ranking periods *R* of four, thirteen, twenty-six and fifty-two weeks. The long-short commodity portfolios are then held over four holding periods *H* of four, thirteen, twenty-six and fifty-two weeks. Instead of reporting summary statistics for each of the sixteen combinations that results from permutations of these *R* and *H*, a equally-weighted portfolio that combines all sixteen permutations is formed for each strategy. The table presents summary statistics for the excess returns of these equally-weighted portfolios. Mean has been annualised, SD is the annualised standard deviation of the portfolio excess returns, Sharpe is the ratio of the annualised mean to the annualised SD, Trend (×100) is 100 × the slope coefficient of a regression of the portfolio excess returns on a time trend. t(.) in parentheses stands for the associated t-statistic. EW represents an equally-weighted portfolio that includes all twenty-seven commodities.

	Mean	t-stat	SD	Sharpe	Trend (*100)	t(Trend)
Panel A: Single-Sort Long-Short Portfolios						
Momentum	0.0529	(0.69)	0.1659	0.3190	0.0281	(5.00)
Term Structure	0.0488	(0.56)	0.1908	0.2556	0.0912	(16.02)
Hedgers	0.1129	(1.11)	0.2212	0.5104	0.0186	(2.25)
Speculators	0.1856	(2.23)	0.1813	1.0235	0.0229	(2.78)
Average	0.1000		0.1898	0.5271		
Panel B: Double-Sort Long-Short Portfolios						
Momentum-Term Structure	0.0910	(1.19)	0.1660	0.5483	0.0598	(10.72)
Term Structure-Momentum	0.0931	(1.19)	0.1707	0.5457	0.0558	(8.96)
Hedgers-Speculators	0.2210	(2.59)	0.1857	1.1903	-0.0065	(-1.00)
Speculators-Hedgers	0.2131	(2.45)	0.1888	1.1285	0.0122	(2.32)
Average	0.1546		0.1778	0.8532		
Panel C: Long-Only Portfolios						
EW	-0.0050	(-0.06)	0.1781	-0.0282		
S&P-GSCI	-0.0427	(-0.33)	0.2841	-0.1502		

27 - Further results over the shorter sample confirm the superiority of the long-short commodity portfolios relative to their long-only counterparts for risk management. For example, as in Table 3, the conditional volatilities of the long-short commodity portfolios are found to be statistically less than the conditional volatility of the S&P-GSCI. Similarly, as in Table 4, the conditional correlations between the S&P500 composite index and the long-short commodity portfolios are found to be statistically less than those calculated relative to the S&P-GSCI and to decrease in periods of high volatility in equity markets. These results, not reported here to conserve space, are available upon request.

4. Empirical Results

Table 8: Granger Causality Tests: Evidence from the Disaggregated Commitment of Traders Report

The positions of pure hedgers (i.e., producers, processors, merchants and users of the underlying commodity) and pure speculators (i.e., CTAs, CPOs, and hedge funds) as disclosed in the CFTC Disaggregated Commitment of Traders report are used to model the performance of the hedgers and speculators based portfolios and subsequently to test for Granger causality between changes in conditional volatility (correlation) and changes in the positions of pure speculators. δ_1 is the slope coefficient of regressions of the change in this conditional volatility (correlation) on the first lag of the change in the hedging pressure of the pure speculators for the constituents of that specific commodity portfolio. *p*(*n* lags) is the associated *p*-value when ***n*** lags are considered in the Granger causality tests. The sample covers the period: 14 July 2006 – 25 March 2011, for which data from the Disaggregated Commitment of Traders report are available.

	δ_1	$t(\delta_1)$	p(1 lag)	p(4 lags)
Panel A: Single-Sort Long-Short Portfolios				
Momentum	-0.0344	(-1.59)	0.11	0.26
Term Structure	-0.0011	(-0.03)	0.98	0.19
Hedgers	0.0032	(0.20)	0.84	0.42
Speculators	0.0057	(0.28)	0.78	0.30
Momentum-Term Structure	0.0117	(0.53)	0.60	0.74
Term Structure-Momentum	-0.0056	(-0.16)	0.87	1.00
Hedgers-Speculators	-0.0269	(-0.24)	0.81	0.45
Speculators-Hedgers	-0.0040	(-0.25)	0.80	0.01
Panel B: Conditional Correlation with the S&P-500 Index				
Momentum	-0.1508	(-1.15)	0.25	0.79
Term Structure	0.0941	(1.17)	0.24	0.81
Hedgers	-0.0435	(-0.31)	0.75	0.50
Speculators	-0.0759	(-0.89)	0.37	0.65
Momentum-Term Structure	-0.0176	(-0.20)	0.84	0.85
Term Structure-Momentum	-0.0445	(-0.42)	0.68	0.99
Hedgers-Speculators	-0.1560	(-1.28)	0.20	0.41
Speculators-Hedgers	-0.1240	(-1.15)	0.25	0.73
Panel C: Conditional Correlation with Barclays Aggregate Bond Index				
Momentum	0.0025	(0.94)	0.35	0.64
Term Structure	-0.1823	(-1.06)	0.29	0.69
Hedgers	0.0111	(0.56)	0.58	0.88
Speculators	0.0002	(0.57)	0.57	0.89
Momentum-Term Structure	0.0739	(0.70)	0.48	0.91
Term Structure-Momentum	0.0052	(0.34)	0.74	0.99
Hedgers-Speculators	-0.1212	(-0.60)	0.55	0.30
Speculators-Hedgers	-0.1223	(-0.77)	0.44	0.73

4. Empirical Results

report are tracked in the holding periods of the single- and double-sort strategies where the cross-sectional average of these hedging pressures are measured for the constituents of the long-short portfolios. The first lag in the change of these average hedging pressures is then used as regressors in equations (5) and (6) to test whether the change in the positions of pure speculators has Granger caused a change in the conditional volatility of the long-short portfolios or a change in their conditional correlation with traditional assets. Table 8 reports tests of these hypotheses for the conditional volatility of the long-short commodity portfolios in Panel A, for the conditional correlation with the S&P500 index in Panel B and for the conditional correlation with Barclays Capital bond index in Panel C. None of the δ_1 coefficients in (5) and (6) are significant even at the 10% level. With only one exception out of the 48 tests implemented, the *p*-values for the null hypothesis of no Granger causality are more than 10%, suggesting an almost systematic failure to reject the null. Altogether, the results from the Granger causality tests are robust to the definition of the non-commercial category: whether the non-commercial category focuses exclusively or not on professional money managers, we find very little to no evidence to suggest that speculators have destabilised commodity markets by increasing volatility or integration with traditional asset markets.

4. Empirical Results

5. Conclusions

5. Conclusions

This publication studies the performance of long-only and long-short commodity portfolios. It also analyses the conditional volatility of these commodity portfolios and their conditional correlations with traditional asset classes (using the S&P500 index for equities and the Barclays Capital US Aggregate bond index for fixed income). Altogether the results confirm the superiority of long-short strategies in commodity futures markets that offer better risk-adjusted performance than long-only benchmarks, present lower volatility than the S&P-GSCI and lower correlation with stock indices. For example, over the period 1992-2011, the Sharpe ratio of long-short commodity portfolios is at 0.51 on average, that of the S&P-GSCI stands at 0.20 and that of a long-only weekly-rebalanced equally-weighted portfolio of commodities equals 0.05. Along the same line, the conditional correlations of the S&P500 index with long-short commodity portfolios (at 0.00) are found to be lower than those measured relative to long-only commodity indices (at 0.19), suggesting that the risk diversification benefits of commodity futures are stronger within long-short portfolios.

The strategy based on speculators and hedgers positions stands further out for having decreasing conditional correlations with the S&P500 composite index in periods of high volatility in equity markets, suggesting that these long-short commodity portfolios become better tools for risk diversification when hedging is most needed. In contrast, the conditional correlation between long-only commodity indices and the S&P500 returns rises with the volatility of the S&P500 index, suggesting that the risk reduction that comes from diversification prevails less when needed most; namely, during equity market downturns. Finally, long-short commodity portfolios based on the positions of hedgers and speculators are found to serve as better diversifiers than long-only commodity portfolios in periods of extreme risk in fixed income markets.

The paper also studies whether the observed financialisation of commodity futures markets (as evidenced by the increase in the long, as well as short, positions of speculators over time) has led to change in the conditional volatility of commodity markets or to changes in their conditional correlations with traditional assets. Our results find no support for the hypothesis that speculators have destabilised commodity prices by increasing volatility or co-movements between commodity prices and those of traditional assets. Interestingly, this conclusion holds irrespective of whether speculators are labelled as "non-commercial" in the CFTC Commitment of Traders report or "professional money managers" (i.e., CTAs, CPOs and hedge funds) in the CFTC Disaggregated Commitment of Traders report. Thus the analysis presented here does not call for a change in the regulation relating to the participation of professional money managers in commodity futures markets.

Daskalaki and Skiadopoulos (2011) show that out-of-sample long-only positions in commodity futures markets do not improve the risk-return profile of investors' portfolios. To put this differently, commodities should not be part of the

5. Conclusions

optimal asset allocation of long-only investors. Our research presents strong reasons to believe that the conclusions drawn by Daskalaki and Skiadopoulos (2011) in a long-only framework might not necessarily extend to long-short commodity portfolios, which present higher mean returns, lower conditional volatility and lower conditional correlations with equities than those reported for the S&P-GSCI. Since these three features typically translate into higher asset allocation, it is likely that investors will increase their out-of-sample Sharpe ratios by adding long, as well as short, commodity positions to their traditional portfolios. We see this topic as an interesting avenue for future research.

5. Conclusions

6. References

6. References

- Amihud, Y., 2002, Illiquidity and stock returns: Cross-section and time-series effects, Journal of Financial Markets 5, 31–56
- Basu D., and J. Miffre, 2011, Capturing the risk premium of commodity futures: The role of hedging pressure, EDHEC-Risk Institute, Working paper
- Bhardwaj, G., G. Gorton, and K. G. Rouwenhorst, 2008, You can fool some of the people all of the time: The inefficient performance of commodity trading advisors, Yale ICF Working paper 08-21
- Bodie, Z., and V., Rosansky, 1980, Risk and returns in commodity futures, Financial Analysts Journal May/June, 27-39
- Bollerslev, T., 1986, Generalized autoregressive conditional heteroskedasticity, Journal of Econometrics 31, 3, 307-327
- Brunetti, C., B., Büyükşahin, and J. Harris, 2011, Speculators, prices and market volatility, John Hopkins University, Working paper
- Büyükşahin, B., and M., Robe, 2010, Speculators, commodities and cross-market linkages, American University, Working paper
- Büyükşahin, B., M. Haigh, and M., Robe, 2010, Commodities and equities: Ever a "market of one"?, Journal of Alternative Investments 12, 3, 76-95
- Chong, J., and J., Miffre, 2010, Conditional correlation and volatility in commodity futures and traditional asset markets, Journal of Alternative Investments 12, 3, 61-75
- Daskalaki, C., and G., Skiadopoulos, 2011, Should investors include commodities in their portfolios after all? New evidence, Journal of Banking and Finance, forthcoming
- De Long, B., A., Shleifer, L. Summers, and R., Waldmann, 1990, Positive feedback investment strategies and destabilizing rational speculation, Journal of Finance, 45, 2, 379-395
- Engle, R. F., 2002, Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models, Journal of Business and Economic Statistics 20, 3, 339-350
- Erb, C., and C. Harvey, 2006, The strategic and tactical value of commodity futures, Financial Analysts Journal 62, 2, 69-97
- Friedman, M., 1953, The case for flexible exchange rates, in Milton Friedman, ed.: Essays in Positive Economics (University of Chicago Press, Chicago, IL)
- Fuertes, A-M., J., Miffre, and G., Rallis, 2010, Tactical allocation in commodity futures markets: Combining momentum and term structure signals, Journal of Banking and Finance 34, 10, 2530–2548
- Gorton, G., Hayashi, F., and Rouwenhorst, G., 2008, The fundamentals of commodity futures returns, Working paper, Wharton School.
- Gorton, G., and G. Rouwenhorst, 2006, Facts and fantasies about commodity futures, Financial Analysts Journal, 62, 2, 47-68

6. References

• Granger, C. W. J., 1969, Investigating causal relations by econometric models, Econometrica 37, 424-438

• Hamilton, J., 2009, Causes and consequences of the oil shock of 2007-08, UCSD working paper

• Irwin, S., and D., Sanders, 2011, Index funds, financialization, and commodity futures markets, Applied Economic Perspectives and Policy, 1-31.

• Irwin, S., D., Sanders, and R., Merrin, 2009, Devil or angel? The role of speculation in the recent commodity price boom (and bust), Journal of Agricultural and Applied Economics, 377–391

• Kaldor, N., 1939, Speculation and economic stability, Review of Economic Studies 7, 1-27

• Keynes, M., 1930, A Treatise on Money, II: The Applied Theory of Money, Edition Macmillan and Co.

• Korniotis, G., 2009, Does speculation affect spot price levels? The case of metals with and without futures markets, Working paper, Federal Reserve Board, Washington, D.C.

• Longin, F., and B., Solnik, 2001, Extreme correlation in international equity markets, Journal of Finance 56, 649-676

• Miffre, J., and G., Rallis, 2007, Momentum strategies in commodity futures markets, Journal of Banking and Finance 31, 6, 1863-1886

• Pastor, L., and R. F., Stambaugh, 2003, Liquidity risk and expected stock returns, Journal of Political Economy 111, 642-685

• Sanders, D. R., H., Irwin, and R. Merrin, 2010, The adequacy of speculation in agricultural futures markets: Too much of a good thing? , Applied Economic Perspectives and Policy 32, 1, 77–94

• Solnik, B., C., Boucrelle, and Y., Le Fur, 1996, International market correlation and volatility, Financial Analysts Journal 52, 17-34

• Stoll, H. and R., Whaley, 2010, Commodity index investing and commodity futures prices, Journal of Applied Finance, 20, 7-46

• Tang, K., and W., Xiong, 2011, Index investment and financialization of commodities, NBER research paper

• Till, H., 2009, Has there been excessive speculation in the US oil futures markets? EDHEC-Risk Institute Position Paper

• Working, H., 1948, Theory of the inverse carrying charge in futures markets, Journal of Farm Economics 30, 1-28

• Working, H., 1960, Speculation on hedging markets, Stanford University Food Research Institute Studies 1, 185-220

6. References

About EDHEC-Risk Institute

About EDHEC-Risk Institute

Founded in 1906, EDHEC is one of the foremost French business schools. Accredited by the three main international academic organisations, EQUIS, AACSB, and Association of MBAs, EDHEC has for a number of years been pursuing a strategy for international excellence that led it to set up EDHEC-Risk in 2001. With sixty-six professors, research engineers, and research associates, EDHEC-Risk has the largest asset management research team in Europe.

The Choice of Asset Allocation and Risk Management

EDHEC-Risk structures all of its research work around asset allocation and risk management. This issue corresponds to a genuine expectation from the market.

On the one hand, the prevailing stock market situation in recent years has shown the limitations of diversification alone as a risk management technique and the usefulness of approaches based on dynamic portfolio allocation.

On the other, the appearance of new asset classes (hedge funds, private equity, real assets), with risk profiles that are very different from those of the traditional investment universe, constitutes a new opportunity and challenge for the implementation of allocation in an asset management or asset-liability management context.

This strategic choice is applied to all of the Institute's research programmes, whether they involve proposing new methods of strategic allocation, which integrate the alternative class; taking extreme risks into account in portfolio construction; studying the usefulness of derivatives in implementing asset-liability management approaches; or orienting the concept of dynamic "core-satellite" investment management in the framework of absolute return or target-date funds.

An Applied Research Approach

In an attempt to ensure that the research it carries out is truly applicable, EDHEC has implemented a dual validation system for the work of EDHEC-Risk. All research work must be part of a research programme, the relevance and goals of which have been validated from both an academic and a business viewpoint by the Institute's advisory board. This board is made up of internationally recognised researchers, the Institute's business partners, and representatives of major international institutional investors. Management of the research programmes respects a rigorous validation process, which guarantees the scientific quality and the operational usefulness of the programmes.

Six research programmes have been conducted by the centre to date:
- Asset allocation and alternative diversification
- Style and performance analysis
- Indices and benchmarking
- Operational risks and performance
- Asset allocation and derivative instruments
- ALM and asset management

These programmes receive the support of a large number of financial companies. The results of the research programmes are disseminated through the EDHEC-Risk locations in London, Nice, and Singapore.

In addition, EDHEC-Risk has developed a close partnership with a small number of sponsors within the framework of research chairs or major research projects:
- Regulation and Institutional Investment, *in partnership with AXA Investment Managers*
- Asset-Liability Management and Institutional Investment Management, *in partnership with BNP Paribas Investment Partners*
- Risk and Regulation in the European Fund Management Industry, *in partnership with CACEIS*

About EDHEC-Risk Institute

- Structured Products and Derivative Instruments,
sponsored by the French Banking Federation (FBF)
- Dynamic Allocation Models and New Forms of Target-Date Funds,
in partnership with UFG-LFP
- Advanced Modelling for Alternative Investments,
in partnership with Newedge Prime Brokerage
- Asset-Liability Management Techniques for Sovereign Wealth Fund Management,
in partnership with Deutsche Bank
- Core-Satellite and ETF Investment,
in partnership with Amundi ETF
- The Case for Inflation-Linked Corporate Bonds: Issuers' and Investors' Perspectives,
in partnership with Rothschild & Cie
- Advanced Investment Solutions for Liability Hedging for Inflation Risk,
in partnership with Ontario Teachers' Pension Plan
- Exploring the Commodity Futures Risk Premium: Implications for Asset Allocation and Regulation,
in partnership with CME Group
- Structured Equity Investment Strategies for Long-Term Asian Investors,
in partnership with Société Générale Corporate & Investment Banking
- The Benefits of Volatility Derivatives in Equity Portfolio Management,
in partnership with Eurex
- Solvency II Benchmarks,
in partnership with Russell Investments

The philosophy of the Institute is to validate its work by publication in international journals, as well as to make it available to the sector through its position papers, published studies, and conferences.

Each year, EDHEC-Risk organises a major international conference for institutional investors and investment management professionals with a view to presenting the results of its research: EDHEC-Risk Institutional Days.

EDHEC also provides professionals with access to its website, www.edhec-risk.com, which is entirely devoted to international asset management research. The website, which has more than 42,000 regular visitors, is aimed at professionals who wish to benefit from EDHEC's analysis and expertise in the area of applied portfolio management research. Its monthly newsletter is distributed to close to one million readers.

EDHEC-Risk Institute: Key Figures, 2009-2010

Nbr of permanent staff	66
Nbr of research associates	18
Nbr of affiliate professors	6
Overall budget	€9,600,000
External financing	€6,345,000
Nbr of conference delegates	2,300
Nbr of participants at EDHEC-Risk Indices & Benchmarks seminars	582
Nbr of participants at EDHEC-Risk Institute Risk Management seminars	512
Nbr of participants at EDHEC-Risk Institute Executive Education seminars	247

About EDHEC-Risk Institute

Research for Business

The Institute's activities have also given rise to executive education and research service offshoots. EDHEC-Risk's executive education programmes help investment professionals to upgrade their skills with advanced risk and asset management training across traditional and alternative classes.

The EDHEC-Risk Institute PhD in Finance

www.edhec-risk.com/AIeducation/PhD_Finance

The EDHEC-Risk Institute PhD in Finance is designed for professionals who aspire to higher intellectual levels and aim to redefine the investment banking and asset management industries. It is offered in two tracks: a residential track for high-potential graduate students, who hold part-time positions at EDHEC, and an executive track for practitioners who keep their full-time jobs. Drawing its faculty from the world's best universities and enjoying the support of the research centre with the greatest impact on the financial industry, the EDHEC-Risk Institute PhD in Finance creates an extraordinary platform for professional development and industry innovation.

FTSE EDHEC-Risk Efficient Indices

www.edhec-risk.com/indexes/efficient

FTSE Group, the award winning global index provider, and EDHEC-Risk Institute launched the first set of FTSE EDHEC-Risk Efficient Indices at the beginning of 2010. Offered for a full global range, including All World, All World ex US, All World ex UK, Developed, Emerging, USA, UK, Eurobloc, Developed Europe, Developed Europe ex UK, Japan, Developed Asia Pacific ex Japan, Asia Pacific, Asia Pacific ex Japan, and Japan, the index series aims to capture equity market returns with an improved risk/reward efficiency compared to cap-weighted indices. The weighting of the portfolio of constituents achieves the highest possible return-to-risk efficiency by maximising the Sharpe ratio (the reward of an investment per unit of risk). These indices provide investors with an enhanced risk-adjusted strategy in comparison to cap-weighted indices, which have been the subject of numerous critiques, both theoretical and practical, over the last few years. The index series is based on all constituent securities in the FTSE All-World Index Series. Constituents are weighted in accordance with EDHEC-Risk's portfolio optimisation, reflecting their ability to maximise the reward-to-risk ratio for a broad market index. The index series is rebalanced quarterly at the same time as the review of the underlying FTSE All-World Index Series. The performances of the EDHEC-Risk Efficient Indices are published monthly on www.edhec-risk.com.

EDHEC-Risk Alternative Indexes

www.edhec-risk.com/indexes/pure_style

The different hedge fund indexes available on the market are computed from different data, according to diverse fund selection criteria and index construction methods; they unsurprisingly tell very different stories. Challenged by this heterogeneity, investors cannot rely on competing hedge fund indexes to obtain a "true and fair" view of performance and are at a loss when selecting benchmarks. To address this issue, EDHEC Risk was the first to launch composite hedge fund strategy indexes as early as 2003. The thirteen EDHEC-Risk Alternative Indexes are published monthly on **www.edhec-risk.com** and are freely available to managers and investors.

About CME Group

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CME Group

http://www.cmegroup.com

CME Group is the world's leading and most diverse derivatives marketplace. The Group is comprised of four major futures exchanges – CME, CBOT, NYMEX and COMEX – and offers the widest range of benchmark futures and options products available on any exchange. Our products cover all major asset classes, including interest rates, equity indexes, foreign exchange, energy, agricultural commodities, metals, weather and real estate.

In June 1992, CME launched CME Globex®, a global electronic trading platform for the trading of futures and options on futures products. Initially implemented for after-hours trading, today CME Globex is available virtually 24 hours a day offering customers around the world the capability to trade all of CME Group's products.

CME Globex is currently approved to operate in 88 countries and foreign territories. We operate eight global telecommunications hubs in Amsterdam, Dublin, London, Milan, Paris, Sao Paulo, Seoul and Singapore.

CME Group has grown its portion of electronic trading from approximately 15 percent in 2000 to more than 80 percent today.

CME Group also operates CME Clearing, one of the largest central counterparty clearing services in the world. CME Clearing provides clearing and settlement services for exchange–traded contracts, as well as for over–the–counter derivatives transactions through CME ClearPort. These products and services ensure that businesses everywhere can substantially mitigate counterparty credit risk in both listed and over-the-counter derivatives markets.

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EDHEC-Risk Institute Publications and Position Papers (2008-2011)

EDHEC-Risk Institute Publications (2008-2011)

2011

- Amenc, N., F. Goltz, and S. Stoyanov. A post-crisis perspective on diversification for risk management (May).
- Amenc, N., F. Goltz, Martellini, L., and L. Tang. Improved beta? A comparison of index-weighting schemes (April).
- Amenc, N., F. Goltz, Martellini, L., and D. Sahoo. Is there a risk/return tradeoff across stocks? An answer from a long-horizon perspective (April).
- Sender, S. The elephant in the room: Accounting and sponsor risks in corporate pension plans (March).
- Martellini, L., and V. Milhau. Optimal design of corporate market debt programmes in the presence of interest-rate and inflation risks (February).

2010

- Amenc, N., and S. Sender. The European fund management industry needs a better grasp of non-financial risks (December).
- Amenc, N., S, Focardi, F. Goltz, D. Schröder, and L. Tang. EDHEC-Risk European private wealth management survey (November).
- Amenc, N., F. Goltz, and L. Tang. Adoption of green investing by institutional investors: A European survey (November).
- Martellini, L., and V. Milhau. An integrated approach to asset-liability management: Capital structure choices, pension fund allocation decisions and the rational pricing of liability streams (November).
- Amenc, N., F. Goltz, Martellini, L., and V. Milhau. New frontiers in benchmarking and liability-driven investing (September).
- Martellini, L., and V. Milhau. From deterministic to stochastic life-cycle investing: Implications for the design of improved forms of target date funds (September).
- Martellini, L., and V. Milhau. Capital structure choices, pension fund allocation decisions and the rational pricing of liability streams (July).
- Sender, S. EDHEC survey of the asset and liability management practices of European pension funds (June).
- Goltz, F., A. Grigoriu, and L. Tang. The EDHEC European ETF survey 2010 (May).
- Martellini, L., et V. Milhau. Asset-liability management decisions for sovereign wealth funds (May).
- Amenc, N., and S. Sender. Are hedge-fund UCITS the cure-all? (March).
- Amenc, N., F. Goltz, and A. Grigoriu. Risk control through dynamic core-satellite portfolios of ETFs: Applications to absolute return funds and tactical asset allocation (January).
- Amenc, N., F. Goltz, and P. Retkowsky. Efficient indexation: An alternative to cap-weighted indices (January).

EDHEC-Risk Institute Publications (2008-2011)

• Goltz, F., and V. Le Sourd. Does finance theory make the case for capitalisation-weighted indexing? (January).

2009

• Sender, S. Reactions to an EDHEC study on the impact of regulatory constraints on the ALM of pension funds (October).

• Amenc, N., L. Martellini, V. Milhau, and V. Ziemann. Asset-liability management in private wealth management (September).

• Amenc, N., F. Goltz, A. Grigoriu, and D. Schroeder. The EDHEC European ETF survey (May).

• Sender, S. The European pension fund industry again beset by deficits (May).

• Martellini, L., and V. Milhau. Measuring the benefits of dynamic asset allocation strategies in the presence of liability constraints (March).

• Le Sourd, V. Hedge fund performance in 2008 (February).

• La gestion indicielle dans l'immobilier et l'indice EDHEC IEIF Immobilier d'Entreprise France (February).

• Real estate indexing and the EDHEC IEIF Commercial Property (France) Index (February).

• Amenc, N., L. Martellini, and S. Sender. Impact of regulations on the ALM of European pension funds (January).

• Goltz, F. A long road ahead for portfolio construction: Practitioners' views of an EDHEC survey. (January).

2008

• Amenc, N., L. Martellini, and V. Ziemann. Alternative investments for institutional investors: Risk budgeting techniques in asset management and asset-liability management (December).

• Goltz, F., and D. Schroeder. Hedge fund reporting survey (November).

• D'Hondt, C., and J.-R. Giraud. Transaction cost analysis A-Z: A step towards best execution in the post-MiFID landscape (November).

• Amenc, N., and D. Schroeder. The pros and cons of passive hedge fund replication (October).

• Amenc, N., F. Goltz, and D. Schroeder. Reactions to an EDHEC study on asset-liability management decisions in wealth management (September).

• Amenc, N., F. Goltz, A. Grigoriu, V. Le Sourd, and L. Martellini. The EDHEC European ETF survey 2008 (June).

• Amenc, N., F. Goltz, and V. Le Sourd. Fundamental differences? Comparing alternative index weighting mechanisms (April).

• Le Sourd, V. Hedge fund performance in 2007 (February).

• Amenc, N., F. Goltz, V. Le Sourd, and L. Martellini. The EDHEC European investment practices survey 2008 (January).

EDHEC-Risk Institute Position Papers (2008-2011)

2010

- Amenc, N., and V. Le Sourd. The performance of socially responsible investment and sustainable development in France: An update after the financial crisis (September).
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2008

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- Amenc, N., and S. Sender. Les mesures de recapitalisation et de soutien à la liquidité du secteur bancaire européen (December).
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- Amenc, N., and V. Le Sourd. Les performances de l'investissement socialement responsable en France (December).
- Amenc, N., and V. Le Sourd. Socially responsible investment performance in France (December).
- Amenc, N., B. Maffei, and H. Till. Les causes structurelles du troisième choc pétrolier (November).
- Amenc, N., B. Maffei, and H. Till. Oil prices: The true role of speculation (November).

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- Amenc, N., F. Goltz, and V. Le Sourd. A comparison of fundamentally weighted indices: Overview and performance analysis (March).
- Sender, S. QIS4: Significant improvements, but the main risk for life insurance is not taken into account in the standard formula (February). With the EDHEC Financial Analysis and Accounting Research Centre.

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