# Capturing the Risk Premium of Commodity Futures: The Role of Hedging Pressure

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### Abstract

We construct long-short factor mimicking portfolios that capture the hedging pressure risk premium of commodity futures. We consider single sorts based on the open interests of hedgers or speculators, as well as double sorts based on both positions. The long-short hedging pressure portfolios are priced cross-sectionally and present Sharpe ratios that systematically exceed those of long-only benchmarks. Further tests show that the hedging pressure risk premiums rise with the volatility of commodity futures markets and that the predictive power of hedging pressure over cross-sectional commodity futures returns is different from the previously documented forecasting power of past returns and the slope of the term structure.

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## 1. Introduction

While commodity futures have moved into the investment mainstream only over the last decade,[1] the academic debate over the existence and source of a commodity futures risk premium has been intense ever since the 1930s. The first hypothesis for the source of a commodity futures risk premium was the risk transfer or hedging pressure hypothesis of Keynes (1930) and Hicks (1939), where a risk premium accrued to speculators as a reward for accepting the price risk which hedgers sought to transfer. This theory was extended by several authors culminating in the equilibrium-based generalized hedging pressure hypothesis of Hirshleifer (1989, 1990) where non-participation effects lead to hedging pressure influencing the risk premium of commodity futures. The theories of Working (1949) and Brennan (1958) relate the variation in futures prices to issues of storage and inventories rather than issues of risk transfer, with recent papers giving credence to this approach.[2] Hirshleifer's (1990) main contribution is to link backwardation[3], the mainstay of the Keynesian theory, to lower levels of hedgers' hedging pressure, and contango[4], the mainstay of the Working (1949) viewpoint, to higher levels of hedgers' hedging pressure, where hedging pressure measures the

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[1] Commodities institutional investments rose from $18 billion in 2003 to $250 billion in 2010 according to a Barclays Capital survey of over 250 institutional investors.

[2] Routledge *et al.* (2000) show that time-varying convenience yields can arise in the presence of risk-neutral agents from the presence of an embedded timing option, while Gorton *et al.* (2012) model the risk premium of commodity futures as a function of inventory levels.

[3] Backwardation occurs when commodity producers are more prone to hedge than commodity consumers and processors. The then net short positions of hedgers translate into low hedgers' hedging pressure, leading to the necessary intervention of net long speculators and to the rising price pattern associated with backwardation. Backwardation is also linked to scarce inventories as explained in footnote 8.

[4] Contango arises when commodity consumers and processors outnumber producers. The then net long positions of hedgers translate into high hedgers' hedging pressure, leading to the intervention of net short speculators and to the falling price pattern linked to contango. Contango is also associated with abundant inventories (see footnote 8).

propensity of market participants to be net long. By so doing, the Hirshleifer (1990) generalized hedging pressure hypothesis synthesizes the viewpoints of Keynes (1930) and Working (1949).[5]

The early empirical tests of the hedging pressure hypothesis focused on the role of own commodity hedging pressure as a determinant of either futures prices (Houthakker, 1957; Cootner, 1960; Chang, 1985; Bessembinder, 1992) or of the CAPM risk premium (Dusak, 1973; Carter *et al.*, 1983). More recent studies centered on the role of hedging pressure as a systematic risk factor. De Roon *et al.* (2000) find cross-commodity hedging pressure effects for individual commodity futures risk premium, as suggested in Anderson and Danthine (1981). Acharya *et al.* (2010) show that systematic hedging pressure effects can arise in the context of limits on risk-taking capacity of speculators.[6]

In this paper we construct factor mimicking portfolios to examine the systematic effects of hedging pressure on the commodity futures risk premium. We first sort our cross section of commodity futures on each contract's hedging pressure. Using single- and double-sorts[7], we then systematically *i*) buy the contracts for which hedgers are the shortest and/or speculators are the longest and *ii*) sell the contracts for which hedgers are the longest and/or speculators are the shortest. As the hedging pressure hypothesis does not specify investment horizon, we

[5] There have been several attempts to connect the theory of storage to the hedging pressure hypothesis (Cootner, 1967; Khan *et al.*, 2008, for example).

[6] In addition, two recent papers (Hong and Yogo, 2012; Tang and Xiong, 2010) suggest the presence of systematic factors in the cross section of commodity futures prices driven by the arrival of financial investors in these markets.

[7] The motivation for having two single sorts comes from the fact that the hedging pressure hypothesis implies two separate sub-hypotheses (Chang, 1985): the first one relates to naïve speculators who earn a risk premium by simply taking positions that are opposite to those of hedgers, while the second one relates to informed speculators who earn a risk premium as a compensation for both initiating trades with hedgers and identifying profit opportunities (Working, 1958).

consider different ranking and holding periods for our hedging pressure portfolios ranging from 4 to 52 weeks. Our empirical results support the hypothesis that hedging pressure is a systematic factor in determining commodity futures risk premiums. Over the period analyzed (1992-2011), our fully-collateralized hedging pressure long-short portfolios present Sharpe ratios that range from 0.27 to 0.93 with an average at 0.51. By contrast, a long-only equally-weighted portfolio of all commodities generates a Sharpe ratio of only 0.08, while that of the S&P-GSCI stands at merely 0.19.

Further to this main contribution, we also report a set of four results. First, we find a positive relationship between our hedging pressure risk premiums and the lagged volatility of an equally-weighted portfolio of all commodities. This result is consistent with the hedging pressure hypothesis, as speculators are deemed to demand, and hedgers should be willing to pay, a higher premium when the risk of commodity markets rises. Second, the hedging pressure risk premiums are found to diversify equity risk better than long-only commodity portfolios. However, the incremental mean returns and added diversification benefits of being long-short (as opposed to long-only) come at the cost of losing the inflation hedge that is naturally provided by commodities (Bodie and Rosansky, 1980; Bodie, 1983). Third, alongside with the slope of the term structure of commodity futures prices[8], hedging pressure is found to command a positive and significant risk premium, while the prices of risk associated with the S&P-GSCI or an equally-weighted portfolio of all commodities are zero, both statistically and

[8] The theory of storage of Working (1949) and Brennan (1958) explains the slope of the term structure of commodity futures prices by means of the incentive that inventory holders have in carrying the spot commodity. When inventories are abundant, the term structure of commodity futures prices is upward-sloping (and the market moves into contango) to give inventory holders an incentive to buy the commodity spot at a cheap price and to sell it forward at a premium that exceeds the cost of storing and financing the commodity. However, when inventories are scarce, the term structure of commodity futures prices becomes downward-sloping (and the market moves into backwardation): then, the convenience yield derived from owning the commodity spot exceed the incurred costs, giving inventory holders an incentive to own the asset spot even though it is expensive compared to the futures contract.

economically. This suggests that a failure to account for either hedging pressure or the slope of the term structure results in the misleading conclusion that there is no risk premium or risk transfer in commodity futures markets. Fourth, we show that the predictive power of hedging pressure over future commodity excess returns is different from the forecasting power of both past returns and the slope of the term structure (Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006; Miffre and Rallis, 2007). The positions of speculators and the slope of the term structure are found to be the most important drivers of commodity futures returns, leading us to conclude that commodity futures risk premiums depend on considerations relating to both speculators' hedging pressure and inventory levels.

The rest of the paper is organized as follows. Section 2 presents the dataset. Section 3 highlights the methodology used to construct long-short mimicking portfolios for hedging pressure and analyzes the performance of these portfolios. Section 4 studies the strategic role of the hedging pressure risk premiums (namely, their risk diversification and inflation hedging properties). Section 5 considers the cross-sectional pricing of hedging pressure and identifies its marginal effect on commodity futures returns, while simultaneously controlling for the effects of other signals (momentum and term structure). Finally Section 6 concludes.

## 2. Data

The dataset includes Friday settlement prices for 27 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 Aggregated Commitment of Traders Report. The cross section includes 12 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), 5 energy commodities (electricity, gasoline, heating oil n° 2, light sweet crude oil, natural gas), 4 livestock commodities (feeder cattle, frozen pork bellies, lean hogs, live cattle), 5 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 September, 30 1992 – March, 25 2011.

To model futures returns, we assume that investors hold the nearest contract up to the last Friday of the month prior to maturity. On that Friday, we assume that investors roll their position to the second-nearest contract and hold that contract up to the last Friday of the month prior to maturity. The procedure is then reiterated using the then second-nearest contract. Thus futures returns are always calculated using price changes on the same contract; namely, in a way that investors could replicate. The choice of nearest and second-nearest contracts (as opposed to more distant contracts) is driven by liquidity considerations.

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 of any futures markets[9] and are further classified as commercial (hedgers) or non-commercial (speculators). A trader's futures position is determined to be commercial if the position is used for hedging purposes as defined by CFTC regulations. According to CFTC Form 40, this requires that the trader be "…engaged in business activities hedged by the use of the futures and option markets." A reportable trader's futures position is otherwise classified as non-commercial.[10]

Hedging pressure for a category (say, speculators) is defined as the number of long open interest in that category divided by the total number of open interest in the category. For

[9] The remaining percentages cover the positions of non-reportable traders; these are not considered in this study since they cannot be identified as hedgers or speculators.

[10] While we treat commercial traders as hedgers and non-commercial traders as speculators, we appreciate that motives of participants in each category are not always easy to discern (Ederington and Lee, 2002, for example, show that commercial traders do not necessarily have known spot positions and thus their classification as hedgers might be inaccurate).

example, a hedgers' hedging pressure of 0.3 means that over the previous week 30% of hedgers were long and thus 70% were short. As explained in Section 3, we interpret the then net short positions of hedgers as a potential buy signal. Vice versa, a speculators' hedging pressure of 0.3 means that over the previous week 30% of speculators were long and thus 70% were short. We then interpret the tendency of speculators to be short as a potential sell recommendation.

Academic research shows that past performance and roll yields are key to modeling the risk premium of commodity futures contracts (Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006; Miffre and Rallis, 2007; Shen *et al.*, 2007; Fuertes *et al.*, 2010; Szakmary *et al.*, 2010). Table 1 presents for each commodity correlations between *i*) hedgers' and speculators' hedging pressures and *ii*) either contemporaneous roll yields[11] or past performance measured over ranking periods of 4, 13, 26 or 52 weeks. As predicted by the hedging pressure analysis of Hirshleifer (1990), 97% of the correlations between hedgers' hedging pressure and past returns are negative at the 5% level with cross-sectional averages at -0.35, -0.45, -0.42 and -0.34 for the 4, 13, 26 and 52-week returns, respectively. This shows that commercial hedgers are contrarians across commodities. The correlations between past returns and the hedging pressure of speculators on the right-hand side of Table 1 are all positive and mostly significant at the 1% level with cross-sectional averages at 0.29, 0.49, 0.49 and 0.42 for the 4, 13, 26 and 52-week returns, respectively. This shows that speculators, or non-commercial traders, are

[11] Roll yields are measured as the difference in the log of the prices of the nearest and second-nearest contracts. Thus, a positive (negative) roll yield indicates a downward (upward)-sloping term structure.

collectively momentum traders across commodities.[12] Overall these results indicate that the hedging pressures of both hedgers and speculators are strongly linked to past performance.

<< Insert Table 1 >>

At the 5% level, the correlations between hedgers' hedging pressure and roll yields are negative (positive) for 17 (4) of the 27 commodities considered with a cross-sectional average at -0.10. Of the correlations between speculators' hedging pressure and roll yields, 18 are positive and 2 are negative at the 5% level with a cross-sectional average at 0.15. Thus, albeit not as strong, the link between the term structure as modeled by roll yields and hedging pressure is of the same nature as that between past returns and hedging pressure. Yet, the correlations between hedging pressure and roll yields are low in absolute term suggesting that hedging pressure and the slope of the term structure might be independent drivers of commodity futures returns. We will return to this point in detail in Section 5.

## 3. Time-Series Properties of the Hedging Pressure Risk Premiums

### *3.1. Methodology*

The hedging pressure theory of Hirshleifer (1990) assumes that risk premiums are present in both backwardated markets (when hedgers are net short and speculators are net long) and in contangoed markets (when hedgers are net long and speculators are net short). As backwardation is associated with an appreciation in commodity futures prices and contango with a price decline, the methodology employed to capture the hedging pressure risk premium simultaneously buys the contracts for which hedgers are the shortest and/or speculators the

[12] Relatedly, Bhardwaj *et al.* (2008) show that the average CTA manager (which would qualify as speculator in our setting) follows long-short momentum strategies in commodity futures markets. Likewise, Rouwenhorst and Tang (2012) find that money managers tend to be momentum traders, while producers tend to be contrarians.

longest and sells the contracts for which hedgers are the longest and/or speculators the shortest.

Using as many commodities as possible, we sort commodities based on the average hedging pressure of hedgers and speculators over a ranking period of $R$ weeks[13]. For the hedger-based portfolio, we go long the 15% of the cross section with the lowest average hedgers' hedging pressure and short the 15% of the cross section with the highest average hedgers' hedging pressure over the previous $R$ weeks. The resulting long-short portfolio is labeled $Low_{Hedg}$ – $High_{Hedg}$, where $Low_{Hedg}$ and $High_{Hedg}$ refer to portfolios with low and high hedgers' hedging pressure, respectively. Vice versa, the speculator-based portfolio goes long the 15% of the cross section with the highest average speculators' hedging pressure and shorts the 15% of the cross section with the lowest average speculators' hedging pressure over the previous $R$ weeks. Following similar notation, the resulting long-short portfolio is labeled $High_{Spec}$ – $Low_{Spec}$. To preserve diversification and avoid concentration in any asset, the constituents of the long-short portfolios are equally-weighted. The portfolios are held over a holding period of $H$ weeks, at the end of which two new $Low_{Hedg}$ – $High_{Hedg}$ and $High_{Spec}$ – $Low_{Spec}$ portfolios are formed.

While these single-sort portfolios give *prime facie* evidence of the possible existence of a risk premium, there might be some benefit from using the positions of hedgers and speculators jointly in a double sort. The methodology is then as follows. The available cross section is first split into $Low_{Hedg}$ and $High_{Hedg}$ based on the average hedging pressure of hedgers over the previous $R$ weeks using a 50% breakpoint. As before with the single-sort portfolios and based

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[13] Because of our limited cross section (of up to 27 commodities), we do not limit ourselves to the commodities with exactly $R$ observations in the ranking period. We include all the commodities with up to $R$ weeks of observations. This is to ensure that our portfolios are sufficiently diversified.

on Hirshleifer's (1990) theory, $Low_{Hedg}$ is presumably made of backwardated contracts for which hedgers are net short and thus their prices are expected to appreciate; likewise, $High_{Hedg}$ is presumably made of contangoed contracts for which hedgers are net long and thus their prices are expected to depreciate. We then combine the positions of hedgers with those of speculators by buying the 30% of $Low_{Hedg}$ for which speculators have the highest average hedging pressure over the previous $R$ weeks and selling the 30% of $High_{Hedg}$ for which speculators have the lowest average hedging pressure over the previous $R$ weeks. As with the single-sort portfolios, the constituents of the double-sort portfolios are equally-weighted and held for $H$ weeks. We also reverse the sorting order as it was arbitrary to sort on the hedging pressure of first, hedgers and second, speculators.

Three points are important to note. First, when it comes to setting $R$ and $H$, the hedging pressure hypothesis does not help us, so we analyze any combination of ranking and holding periods of 4, 13, 26 and 52 weeks. These permutations result in a total of 16 commodity futures risk premiums for each of the two single sorts and each of the two double sorts. Second, the single- and double-sort portfolios contain 30% of the cross section available at the time of portfolio formation, taking long positions in the 15% of commodities with the lowest commercial and highest non-commercial hedging pressures and short positions in the 15% of commodities with the highest commercial and lowest non-commercial hedging pressures.[14] By contrast, the S&P-GSCI, like all first generation indices, take long positions on the whole of the cross section. Third, following industry practice (e.g., S&P-GSCI) and Szakmary *et al.* (2010), our long-short portfolios are fully-collateralized, meaning that half of the trading capital is invested into risk-free assets for the longs and likewise for the shorts. As a result, the

[14] We also form portfolios with 40% (50%) of the cross section available at the time of portfolio formation, taking long positions in 20% (25%) and short positions in 20% (25%). The conclusions of the article remain unchanged. In particular, all the long-short portfolios earn Sharpe ratios that exceed that of the S&P-GSCI.

unlevered long-short portfolios generate excess returns equal to half of the excess returns of the long portfolios minus half of the excess returns of the short portfolios.

*3.2. Empirical Results*

Panels A and B of Tables 2 and 3 present summary statistics for the excess returns of fully-collateralized long, short and long-short hedging pressure portfolios. More specifically, Table 2 summarizes the results when either the hedging pressure of hedgers (in Panel A) or the hedging pressure of speculators (in Panel B) is used as sorting criterion for asset allocation. Table 3 reports the same information for the double-sort portfolios which combine both signals, with Panel A sorting on the positions of first hedgers and second speculators and Panel B reversing the sorting order. For the sake of comparison with long-only benchmarks, both tables present in Panel C summary statistics for the excess returns of long-only portfolios, such as the S&P-GSCI and an equally-weighted portfolio of all commodities.

<< Insert Tables 2 and 3 >>

Irrespective of whether the sorting is based on hedgers' or speculators' positions, the excess returns of the single-sort long-short portfolios in Table 2 are always positive and often significant at the 5% level. The mean performance stands at 5.63% a year in Panel A and at 5.78% a year in Panel B with 75% of the risk premiums that are positive and significant at the 5% level. Similar results are obtained when the sorting is based on the positions of both hedgers and speculators in Table 3. The fully-collateralized long-short portfolios then earn annualized mean excess returns that average out to 5.33% (Table 3, Panel A) and 5.45% (Table 3, Panel B). 43.75% of the risk premiums in Table 3, Panels A and B are positive and significant at the 5% level, with that percentage reaching 78.13% at the 10% level. By contrast, none of the long-only portfolios earn positive and significant mean excess returns in Panels C, suggesting that long-only positions in commodity futures markets are ill-suited to capturing a risk premium. It is interesting to note also that, in line with the prediction of the hedging pressure hypothesis, the long backwardated portfolios in Panels A and B of Tables 2 and 3 earn positive (albeit at times insignificant) mean excess returns, while the short contangoed portfolios present negative (albeit often insignificant) mean excess returns.

As the shorts (longs) provide a partial hedge against the risk that the longs (shorts) could depreciate (appreciate), the average annualized volatility of the fully-collateralized long-short portfolios (at 0.1078) is substantially less than that of long-only or short-only portfolios (the average annualized volatility of the long-only and short-only portfolios in Panels A and B equal 0.1911 and 0.1699, respectively; that of long-only benchmarks in Panels C stands at 0.1694). Thus, the Sharpe ratios of the long-short portfolios substantially exceed those of long-only benchmarks. The former range from 0.29 to 0.76 with a mean of 0.53 in Table 2 and from 0.27 to 0.93 with a mean of 0.50 in Table 3, while the later stand merely at 0.08 for the equally-weighted portfolio of all commodities and at 0.19 for the S&P-GSCI (Panels C).

Alongside with some summary statistics on hedgers' hedging pressure, Appendix 1, Panel A presents the percentages of times each commodity enters the long hedgers' hedging pressure portfolios ($\omega_{Long}$) and the short hedger's hedging pressure portfolios ($\omega_{Short}$). The correlations in Appendix 1, Panel B show that, as expected, we buy the commodities with lower average hedgers' hedging pressures and lower minimums and sell the commodities with higher average hedgers' hedging pressures and higher maximums. The more volatile the hedging pressure measure, the more likely the commodity is to enter the long-short hedging pressure portfolios. With only three exceptions[15], the weights allocated to the commodities are within reasonable range (0% to 57.55% averaging out to 15.3%). The constituents of the long-short portfolios are thus likely to change hands, switching between buy, neutral and sell

[15] The exceptions are for silver and platinum that are mainly backwardated ($\omega_{Long}$ of 84.73% and 72.62%, respectively) and for feeder cattle that is mainly contangoed ($\omega_{Short}$ of 70.17%).

recommendations over time. The correlations between average roll yields and $\omega_{Long}$ or $\omega_{Short}$ are zero in statistical term, suggesting that the trade recommendations emanating from the term structure signal are likely to differ from those triggered by the hedging pressure signal.

Clearly, allowing for short, as well as long, positions is important when it comes to capturing the risk premium of commodity futures. Clearly also, dynamic trading (beyond mere rebalancing to equal weights) is required to capture this risk premium. These two points highlight the limits of long-only passive benchmarks (such as the S&P-GSCI or a long-only equally-weighted portfolio) that are traditionally used in an attempt to capture the risk premium present in commodity futures markets. Not only do these benchmarks fail to recognize the long-short nature of the commodity futures risk premium, but also they fail to account for the need to dynamically trade commodity futures (beyond mere rebalancing) if one is to capture this risk premium accurately.

### *3.3. The Relationship between Risk Premium and Volatility*

We next examine the relationship between our hedging pressure risk premium and the volatility of commodity markets. Several studies (amongst others, Litzenberger and Rabinowitz, 1995) suggest that changes in volatility could affect commodity price levels. Thus it seems fair to hypothesize that the higher the volatility of commodity markets, the higher the propensity of producers and consumers to hedge and thus the higher the premium that they are likely to pay to get rid of price risk. Likewise, in periods of high volatility in commodity markets, speculators are likely to demand higher risk premiums as a compensation for the incremental risk taken.

To test this hypothesis empirically, we model the volatility of an equally-weighted portfolio of commodities as an asymmetric GARCH(1,1) process (Glosten *et al*, 1993) using the first 52 observations of our sample. Therefore we obtain

$$r_{P,t} = \mu + \varepsilon_{P,t}$$

$$h_{P,t} = \omega + \gamma\varepsilon_{P,t-1}^2 + \eta I_{t-1}\varepsilon_{P,t-1}^2 + \theta h_{P,t-1} \quad (1)$$

$\varepsilon_{P,t} \sim N(0, h_{P,t})$, $h_{P,t}$ is the conditional variance of returns, $\mu$, $\omega$, $\gamma$, $\eta$ and $\theta$ are parameters to estimate and $I_{t-1} = 1$ if $\varepsilon_{P,t-1} < 0$ (bad news) and $I_{t-1} = 0$ otherwise.

We then regress the hedging pressure risk premium on a constant and lagged conditional variance using a 2SLS estimator to address issues of endogeneity.[16]

$$RP_t = \alpha + \beta h_{P,t-1} + u_t \quad (2)$$

where $RP_t$ are the hedging pressure risk premiums modelled in Section 3, $\alpha$ and $\beta$ are parameters to estimate and $u_t$ is an error term. The sample is then rolled over to the next weekly observation. Regressions (1) and (2) are re-estimated to produce a new estimate of $\beta$. *t*-tests, with a Newey and West (1987) correction of the standard errors, are then performed on the resulting vector of $\beta$ to determine whether speculators demand higher risk premiums in periods of increased volatility. This rolling-window approach is chosen to ensure that the relationship between hedging pressure risk premiums and conditional volatility does not suffer from a look-ahead bias.

Table 4 reports the averages of the $\beta$ coefficients from (2) for each of the hedging pressure risk premiums modeled in Section 3. It is clear from the table that, irrespective of the criterion used to allocate commodities to portfolios, higher conditional volatility usually leads to higher risk premium. On average, a 1% rise in weekly conditional volatility leads to a 1.6% rise in weekly risk premium across the various single and double sorts. This is consistent with the

[16] We use as instruments a constant term and lagged values of 1. default spread, 2. the slope of the term structure of interest rates and 3. the one-month Treasury-bill rate.

idea that in periods of high volatility in commodity markets hedgers are willing to pay a higher cost for their insurance. Likewise, speculators demand a risk premium that is proportionate to the price risk they take on. If in place of the long-short hedging pressure risk premiums we use the returns of long-only benchmarks as dependent variables in (2), the results go against the notion that risk and return go hand-in-hand. Indeed, the average $\beta$ coefficient relative to a long-only equally-weighted portfolio of all commodities (the S&P-GSCI) stands at -0.3206 (-0.8843) with an associated *t*-statistic at -1.08 (-1.68).

<< Insert Table 4 >>

## 4. Strategic Role of Hedging Pressure Portfolios

The strategic decision to invest into commodities depends on the risk-return trade-off that commodities offer – as captured by the hedging pressure long-short portfolios modeled in Section 3. This decision also breaks down to the risk diversification and inflation hedging properties of commodities (Bodie and Rosansky, 1980; Bodie, 1983; Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006). This section tests whether the long-short hedging pressure portfolios serve as better tools for risk diversification and inflation hedging than long-only commodity portfolios (such an equally-weighted portfolio of all commodities or the S&P-GSCI). Figure 1 reports correlations between *i*) the total returns of long-short or long-only fully-collateralized commodity portfolios and *ii*) those of three traditional asset classes (3-month Treasury-bills, Barclays Capital US Aggregate Bond Index and S&P500 Composite Index) or shocks to inflation[17]. To conserve space and without loss of generality, the long-short portfolios in Figure 1 are based solely on the positions of hedgers. Only the lowest, highest

[17] Unexpected inflation is measured monthly as the spread between the percentage change in the consumer price index (CPI) and the one-year moving average of the percentage CPI change.

and average correlations out of the 16 correlations coming from the permutations of 4 ranking and 4 holding periods are reported. We also report under the label 'Long-Only Average' the average correlation between long-only portfolios (S&P-GSCI and long-only equally-weighted portfolio of all commodities) and e.g., 3-month Treasury bills. The frequency used to model correlations with traditional assets (shocks to inflation) is weekly (monthly).

<< Insert Figure 1 >>

Figure 1 shows that the correlations between 3-month Treasury bills and commodity returns are of similar magnitude irrespective of whether investors take long-only or long-short positions in commodity futures markets. The same conclusion applies when the total returns of Barclays bond index is used in place of the 3-month Treasury bill rates. However the correlations between the S&P500 index and long-short commodity portfolios (at 0% on average) are found to be much lower than those measured relative to long-only commodity indices (at 23.5% on average). Thus, while both long-only and long-short commodity portfolios act as good diversifiers of fixed income risk, the diversification benefits of including commodity futures in an equity portfolio are stronger if we take a long-short approach to commodity investing than if we are long-only.

When it comes to inflation hedging however, long-only commodity portfolios present a clear advantage relative to their long-short counterparts. The right-hand side of Figure 1 indeed shows that the correlations between the total returns of long-short hedging pressure portfolios and unexpected inflation average out at 1.5%, while the average correlation between the total returns of long-only commodity benchmarks and unexpected inflation equals 32.8%. This suggests that the incremental performance and added diversification benefits of long-short hedging pressure portfolios come at the cost of losing the inflation hedge that is naturally provided by commodities (Bodie and Rosansky, 1980; Bodie, 1983). This result corroborates the evidence of Miffre and Rallis (2007) who also show that commodity-based momentum portfolios fail to hedge inflation shocks.

## 5. Cross-Sectional Pricing of Hedging Pressure, Term Structure and Momentum

Academic research has made it clear that long-short commodity strategies based on momentum, the slope of the term structure of commodity futures prices, or a combination of both signals outperform long-only strategies on a risk-adjusted basis (Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006; Miffre and Rallis, 2007; Fuertes *et al*., 2010; Szakmary *et al.*, 2010). This section tests whether the long-short portfolios based on hedging pressure, momentum and term structure are priced cross-sectionally and then studies the extent to which the three strategies overlap. This section starts with a brief presentation of the methodology used to form momentum and term structure portfolios.

### *5.1. Momentum and term structure portfolios*

The momentum (term structure) portfolios consist of long positions in the 15% of commodity futures with the highest average excess returns (roll yields) over the previous *R* weeks and short positions in the 15% of commodity futures with the lowest average excess returns (roll yields) over the previous *R* weeks. The positions are then held for *H* weeks, when new momentum and term structure portfolios are formed. For the sake of consistency with the hedging pressure risk premiums modeled in Section 3, all the momentum and term structure portfolios estimated here present the following characteristics. They are formed from permutations of 4 ranking and 4 holding periods (set to 4, 13, 26 or 52 weeks), where these combinations generate 16 momentum and 16 term structure portfolios. The portfolio constituents are equally-weighted and the positions are fully-collateralized.

Table 5, Panel A presents summary statistics for the excess returns of long-short momentum and term structure portfolios. Unlike previously reported (Erb and Harvey, 2006; Miffre and Rallis, 2007), the momentum strategies fail to consistently outperform long-only positions: over the sample considered (1992-2011), the average Sharpe ratio across the 16 momentum portfolios stands at merely 0.15 (versus 0.19 for the S&P-GSCI in Table 5, Panel B). Relatedly, only 12.5% (18.75%) of the 16 momentum portfolios considered earn positive mean excess returns at the 5% (10%) level.

<< Insert Table 5 >>

The right-hand side of Table 5 shows that 75% of the 16 term structure strategies analyzed present Sharpe ratios that are higher than 0.19, the Sharpe ratio of the S&P-GSCI. This indicates that roll yield is a better signal on which to allocate wealth than long-only positions (see also Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006). The performance of term structure portfolios however compares unfavorably to that of hedging pressure portfolios as reported in Tables 2 and 3. For example, while all 64 hedging pressure portfolios offered Sharpe ratios superior to that of the S&P-GSCI, only 75% of the term structure portfolios considered in Table 5 outperform the S&P-GSCI on a risk-adjusted basis. Besides, the average Sharpe ratio of the term structure portfolios at 0.39 in Table 5 is lower than that of the hedging pressure portfolios at 0.51 in Tables 2 and 3. Likewise, the average annualized mean excess return of the term structure portfolios merely equals 4.36% in Table 5 versus 5.55% in Tables 2 and 3 for the hedging pressure portfolios. Finally, while 82.81% of the mean excess returns of the long-short hedging pressure portfolios in Tables 2 and 3 were significant at the 10% level, that conclusion applies to merely 50% of the term structure portfolios in Table 5. So the conclusion thus far hints towards the superiority of the hedging pressure signal at explaining commodity futures prices.

*5.2. Cross-sectional pricing*

We use the two-step methodology of Fama and MacBeth (1973) to investigate whether the hedging pressure, momentum and term structure portfolios explain cross-sectional commodity futures returns. The first step consists of time-series regressions of weekly commodity futures returns on the excess returns of either one of the long-short hedging pressure, momentum or term structure portfolios presented in Tables 2, 3 and 5 over a window spanning 5 years. The second step entails running the following cross-sectional regressions in each of the next *k* (*k* = 1,…,52) weeks

$$r_{i,t+k} = \lambda_{0,t+k} + \lambda_{1,t+k}\,\hat{\beta}_{i,t} + \upsilon_{i,t+k} \tag{3}$$

$\hat{\beta}_{i,t}$ is the slope coefficient from the first-step, $i$ = 1,…, $N$ where $N$ is the number of commodity futures contracts included in the first and second steps, $\upsilon_{i,t+k}$ is a random error term. This two-stage procedure is applied iteratively until the sample ends. The significance of $\lambda_0$ and $\lambda_1$is then tested using Shanken's (1992) corrected *t*-tests to determine which factor prices the cross section of commodity futures returns.

As we have 4 ranking and 4 holding periods, we end up with 16 long-short portfolios for each of the following six signals: hedgers' hedging pressure, speculators' hedging pressure, hedgers and speculators' hedging pressure, speculators and hedgers' hedging pressure, momentum and term structure. The prices of risk obtained for the various 16 portfolios are stacked together for each of the 6 signals, resulting, as in Table 6, Panel A, in six estimates for the average intercept ($\lambda_0$) and in six estimates for the average price of risk ($\lambda_1$). In Table 6, Panel B, we test for the cross-sectional pricing of long-only commodity portfolios such as an equally-weighted portfolio of all commodities and the S&P-GSCI.

<< Insert Table 6 >>

While momentum is not priced cross-sectionally, the prices of risk associated with hedging pressure and term structure are found to be positive at the 1% level in Table 6, Panel A, with a relative advantage for the risk premiums modeled from the positions of speculators (in isolation or in conjunction with those of hedgers) and for the signal emanating from the slope of the term structure. Further, the fact that the prices of risk associated with long-only portfolios (Table 6, Panel B) are zero at even the 10% level highlights the need to take both long and short positions (based on hedging pressure or the slope of the term structure) to accurately capture the risk premium of commodity futures contracts. A failure to take hedging pressure or inventory considerations into account results in the misleading conclusion that there is no risk premium in commodity futures markets.

### *5.3. Disentangling the three effects*

Tables 2, 3 and 6 show that contracts with low hedgers' hedging pressure, high speculators' hedging pressure, high average roll yields and possibly good past performance outperform contracts with high hedgers' hedging pressure, low speculators' hedging pressure, low average roll yields and possibly poor past performance. To identify the marginal effect of each signal on commodity futures prices while controlling for the effect of other signals, we apply to our setting the methodology proposed by George and Huang (2004) and Park (2010). Each week $t$, we run the following Fama and MacBeth (1973) cross-sectional regressions

$$R_{i,t} = b_{0,t} + b_{1,t}R_{i,t-1} + b_{2,t}ln\left(OI_{i,t-1}\right) + b_{3,t}HPL_{i,t-k}^{Hedg} + b_{4,t}HPS_{i,t-k}^{Hedg} + b_{5,t}HPL_{i,t-k}^{Spec}$$
$$+ b_{6,t}HPS_{i,t-k}^{Spec} + b_{7,t}MomL_{i,t-k} + b_{8,t}MomS_{i,t-k} + b_{9,t}TSL_{i,t-k}$$
$$+ b_{10,t}TSS_{i,t-k} + e_{i,t}$$

$k$ = 1, …, $H$ for a strategy with a $H$-week holding period ($H$ = {4, 13, 26, 52}), $R_{i,t}$ is the excess return of commodity futures contract $i$ in week $t$, $OI_{i,t-1}$ is the dollar value of open interest for contract $i$ in week $t$-1,[18] $HPL_{i,t-k}^{Hedg}$ is a dummy variable equal to 1 (0) if commodity $i$ is included in (excluded from) the long portfolio formed at time $t$-$k$ that is based on hedgers' hedging pressure over the former $R$ weeks ($R$ = {4, 13, 26, 52}), $HPS_{i,t-k}^{Hedg}$ is a dummy variable equal to 1 (0) if commodity $i$ is included in (excluded from) the short portfolio formed at time $t$-$k$ that is based on hedgers' hedging pressure over the former $R$ weeks. Likewise, we form two speculators' hedging pressure dummies $HPL_{i,t-k}^{Spec}$ and $HPS_{i,t-k}^{Spec}$, two momentum dummies $MomL_{i,t-k}$ and $MomS_{i,t-k}$ and two term structure dummies $TSL_{i,t-k}$ and $TSS_{i,t-k}$. For example, $MomL_{i,t-k}$ equals 1 (0) if commodity $i$ is included in (excluded from) the long momentum portfolio formed at time $t$-$k$ that is based on performance over the former $R$ weeks. Similarly, $TSS_{i,t-k}$ equals 1 (0) if commodity $i$ is included in (excluded from) the short term structure portfolio formed at time $t$-$k$ based on roll yields over the previous $R$ weeks. Finally, $e_{i,t}$ is an error term and $b_{j,t}$ are the $j$ = 0,…,10 parameters to estimate. We then compute $t$-statistics for the resulting $b_{j,t}$ coefficients to test the marginal effect of each signal on commodity futures returns. Following George and Huang (2004) and Park (2010), we interpret the differences $(\hat{b}_{3,t} - \hat{b}_{4,t})/2$, $(\hat{b}_{5,t} - \hat{b}_{6,t})/2$, $(\hat{b}_{7,t} - \hat{b}_{8,t})/2$ and $(\hat{b}_{9,t} - \hat{b}_{10,t})/2$ as the weekly excess returns of fully-collateralized pure hedgers' hedging pressure, pure speculators' hedging pressure, pure momentum and pure term structure strategies, respectively.

Table 7 presents the mean of the estimated $b_{j,t}$ coefficients in Panel A and the annualized mean excess returns of pure commodity strategies in Panel B. Alongside with lagged returns and lagged \$OI, regressions (A) to (D) use one set of dummies as regressors, while regressions (E) to (G) use more than one set of dummies as regressors. $b_1$ is positive at the 1% level, indicating the presence of first-order serial correlation over short-horizons (as in Kat

[18] $ln(OI_{i,t-1})$ is used as a proxy for size in George and Huang (2004) and Park (2010).

and Oomen, 2007). $b_2$ is negative and significant at the 10% level or better, suggesting that relatively less liquid contracts with lower dollar value of open interests earn higher mean returns[19].

<< Insert Table 7 >>

As expected, the estimated $b_{j,t}$ coefficients for $j$ = 3,…,10 in models (A) to (D) are positive and often significant for the long dummies, an indication that the commodities included in these long portfolios appreciated in value, even after accounting for lagged returns and lagged open interest. Vice versa, the estimated $b_{j,t}$ coefficients are negative and often significant for the short dummies, a sign that the commodities included in these short portfolios depreciated in value. The annualized mean excess returns of pure fully-collateralized long-short strategies reported in Table 7, Panel B range from 1.41% (*t*-statistic of 1.75) for the pure momentum signal to 5.31% (*t*-statistic of 8.26) for the pure speculators' hedging pressure signal. The results thus show that, even after accounting for lagged returns and lagged $OI, the pure term structure and hedging pressure strategies are profitable. The momentum signal performs the worst. These results scare well with the analysis performed in Tables 2, 3, 5 and 6.

Models (E) to (F) capture the role of one signal (e.g., hedgers' hedging pressure) after controlling for the other signals (e.g., term structure and momentum). This is done by including more than one set of dummies in the cross-sectional regressions. Model (E) shows that profits from the pure hedgers' hedging pressure strategy persists after accounting for the performance of both momentum and term structure strategies (as demonstrated by $\hat{b}_{3,t} > 0$, $\hat{b}_{4,t} < 0$ in Panel A and by $(\hat{b}_{3,t} - \hat{b}_{4,t})/2 > 0$ in Panel B). The same conclusion applies to the pure speculators' hedging pressure strategy in model (F). Albeit slightly reduced compared

[19] This result is consistent with the well-documented negative relationship identified in equity markets between liquidity levels and expected returns (Amihud and Mendelson, 1989).

to the mean excess returns reported in Table 2, profits from hedging pressure strategies are still significant when commodity futures returns are controlled for lagged returns, lagged $OI and the returns predicted from momentum and term structure signals. It follows that the predictive power of hedging pressure over future commodity excess returns is different from the forecasting power of *i*) past returns and *ii*) the slope of the term structure. In relative terms, the pure term structure signal and pure speculators' hedging pressure signal generate profits in Panel B that are more sizeable than those emanating from hedgers' hedging pressure or momentum.

When all four sets of dummies are included in the cross-sectional model (G) in Table 7, Panel A, $\hat{b}_{5,t}$ and $\hat{b}_{6,t}$ for the long and short speculators' hedging pressure dummies and $\hat{b}_{9,t}$ for the long term structure dummy are the only coefficients that are significant at the 5% level. Likewise, the results from Panel B show that the mean excess returns of pure speculators' hedging pressure and pure term structure portfolios are sizeable both in economic term (3.74% and 3.78% a year, respectively) and in statistical term (the associated *t*-statistics are 4.20 and 4.62, respectively). This shows that the positions of speculators and the slope of the term structure are independent drivers of commodity futures returns. As the slope of the term structure of commodity futures prices is considered as proxy for inventory levels (Working, 1949; Brennan, 1958), we conclude that commodity futures risk premiums depend on considerations relating to both speculators' hedging pressure and inventory levels.

By contrast, none of the hedgers' hedging pressure dummies is priced cross-sectionally in Table 7, Panel A, model (G) and the mean excess returns of pure hedgers' hedging pressure portfolios equals zero in statistical term in Table 7, Panel B. The results of models (A), (E) and (G) therefore suggest that the predictive power of hedgers' hedging pressure over future excess returns in models (A) and (E) derives from that of speculators' hedging pressure: once the later is properly accounted for, the former disappears. Finding that out of the two hedging pressure signals, the one derived from the positions of speculators dominates the one based on the positions of hedgers suggests that, as hypothesized by Working (1958) and Chang (1985), speculators earn a risk premium as compensation both for providing risk-bearing capacity to hedgers and for identifying profitable opportunities.

Finally, the momentum strategy fails to dominate any other signal: when the term structure and hedging pressure dummies are included in the cross-sectional model (G), none of the momentum dummies is priced in Table 7, Panel A and the mean excess return of the pure momentum strategy in Table 7, Panel B is found to be one of the lowest reported (at 1.70% a year with a *t*-statistic of 1.75). Barberis *et al.* (1998), Daniel *et al*. (1998) and Hong and Stein (1999) view the profitability of momentum strategies as a manifestation of behavioral biases. Finding as in Tables 6 and 7 that momentum is not priced, when term structure and hedging pressure are, indicates that rational pricing relating to hedging demand and inventory considerations is more likely to drive commodity futures risk premiums than cognitive errors made while incorporating information into prices.

## 6. Conclusions

We construct factor mimicking portfolios to capture the effect of systematic hedging pressure on the risk premium of commodity futures contracts. The long-short portfolios we then form buy commodity contracts for which hedgers are particularly short and speculators particularly long and sell commodity contracts for which hedgers are particularly long and speculators particularly short. Our fully-collateralized hedging pressure portfolios present Sharpe ratios that range from 0.27 to 0.93 with an average at 0.51. By contrast, over the same period (1992-2011), a long-only equally-weighted portfolio made of the same 27 commodity futures contracts presents a Sharpe ratio of 0.08 only. The Sharpe ratio of the S&P-GSCI stands at merely 0.19. These results suggest that systematic hedging pressure is a significant determinant of commodity futures risk premiums.

Further results can be summarized as follows. First, in line with the notion that higher risk should be rewarded by higher returns, we find a positive relationship between our hedging pressure risk premiums and the lagged conditional volatility of commodity futures markets. Second, the hedging pressure portfolios are found to be better suited at diversifying equity risk than long-only commodity portfolios, but fail to hedge inflation shocks. Third, our cross-sectional results show that hedging pressure (and the slope of the term structure) command positive and significant risk premiums, while the prices of risk associated with long-only benchmarks are zero, both statistically and economically. Fourth, the predictive power of hedging pressure over future commodity excess returns is shown to be different from the forecasting power of *i*) past returns and *ii*) the slope of the term structure. Out of all the signals considered (hedgers' and speculators' hedging pressures, past performance and past roll yields), the positions of speculators and the slope of the term structure are found to be the most important drivers of commodity futures returns. This leads us to the conclusion that commodity futures risk premiums depend on considerations relating to both speculators' hedging pressure and inventory levels.

Overall our paper contributes to the recent literature (Acharya *et al.*, 2010; Hong and Yogo, 2012; Tang and Xiong, 2010; Gorton *et al.*, 2012) that examines the role of systematic factors which influence the cross section of commodity prices. It would be interesting to analyze the relationship between our long-short hedging pressure portfolios and those based on inventory considerations, in order to further study the link between hedging pressure- and storage-based theories. Our dynamic long-short portfolios could also provide useful benchmarks for analyzing the performance of commodity trading advisers and, more generally, any hedge fund with commodity exposure. We see these issues as interesting avenues for future research.

## References


Acharya, V., Lochstoer, L., Ramadorai, T., 2010. Does hedging affect commodity prices: The role of producer default risk, Working paper, London Business School.

Amihud, Y., Mendelson, H., 1986. Asset pricing and the bid-ask spread, *Journal of Financial Economics* 17, 223–249.

Anderson, R., Danthine, J-P., 1981. Cross-hedging, *Journal of Political Economy* 89, 1182-1196.

Barberis, N, Schleifer, A., Vishny, R., 1998. A model of investor sentiment, *Journal of Financial Economics* 49, 307-343.

Bessembinder, H., 1992. Systematic risk, hedging pressure and risk premiums in futures markets, *Review of Financial Studies* 5, 637-667.

Bhardwaj, G., Gorton, G., Rouwenhorst, K. G., 2008. You can fool some of the people all of the time: The inefficient performance and persistence of commodity trading advisors, Yale ICF Working paper N$^{o}$ 08-21.

Bodie, Z., 1983. Commodity futures as a hedge against inflation, *Journal of Portfolio Management* 12-17.

Bodie, Z., Rosansky, V., 1980. Risk and return in commodity futures, *Financial Analysts Journal* 27-39.

Brennan, M., 1958. The supply of storage, *American Economic Review* 47, 50-72.

Carter, C., Rausser, G., Schmitz, A., 1983. Efficient asset portfolios and the theory of normal backwardation, *Journal of Political Economy* 91, 319–331.

Chang, E., 1985. Return to speculators and the theory of normal backwardation, *Journal of Finance* 40, 193-208.

Cootner, P., 1960. Returns to speculators: Telser vs. Keynes, *Journal of Political Economy* 68, 396-404.

Cootner, P., 1967. Speculation and hedging, *Food Research Institute Studies* 7, 65-105.

Daniel, K, Hirshleifer, D., Subrahmanyam, A., 1998. Investor psychology and security market under- and overreactions, *Journal of Finance* 53, 1839-1885.

DeRoon, F., Nijman, T., Veld, C., 2000. Hedging pressure effects in futures markets, *Journal of Finance* 55, 1437–1456.

Dusak, K., 1973. Futures trading and investor returns: An investigation of commodity market risk premiums, *Journal of Political Economy* 81, 1387–1406.

Ederington, L., Lee J. H., 2002. Who trades futures and how: Evidence from the heating oil futures market, *Journal of Business* 75, 353-373.

Erb, C., Harvey C., 2006. The strategic and tactical value of commodity futures, *Financial Analysts Journal* 62, March/April, 69-97.

Fama, E. F., MacBeth, J. D., 1973. Risk, return and equilibrium: Empirical tests, *Journal of Political Economy* 71, 607-636.

Fuertes, A-M., Miffre, J., Rallis, G., 2010. Tactical allocation in commodity futures markets: Combining momentum and term structure signals, *Journal of Banking and Finance* 34, 10, 2530–2548.

George, T. J., Hwang, C. Y., 2004. The 52 week high and momentum investing, *Journal of Finance* 59, 2145-2175.

Glosten, L. R., Jagannathan, R., Runkle, D. E., 1993. On the relation between the expected value and the volatility of the nominal excess return on stocks, *Journal of Finance* 48, 1779-1801.

Gorton, G., Hayashi, F., Rouwenhorst, G., 2012. The fundamentals of commodity futures returns, *Review of Finance* forthcoming.

Gorton, G., Rouwenhorst, G., 2006. Facts and fantasies about commodity futures, *Financial Analysts Journal* 62, March/April, 47-68.

Hicks, J., 1939. *Value and Capital*, Oxford University Press.

Hirshleifer, D., 1989. Determinants of hedging and risk premia in commodity futures markets, *Journal of Financial and Quantitative Analysis* 24, 313-331.

Hirshleifer, D., 1990. Hedging pressure and future price movements in a general equilibrium model, *Econometrica* 58, 441-28.

Hong, H., Stein, J., 1999. A unified theory of underreaction, momentum trading and overreaction in asset markets, *Journal of Finance* 54, 2143-2184.

Hong, H., Yogo, M., 2012. What does futures market interest tell us about the macroeconomy and asset prices?, *Journal of Financial Economics* 105, 473–490.

Houthakker, H., 1957. Can speculators forecast prices? *Review of Economic and Statistics* 39, 143-151.

Kat, H., Oomen, R., 2007. What every investor should know about commodities I: Univariate return analysis, *Journal of Investment Management* 5, 4-28.

Keynes, J., 1930. *Treatise on Money* (Macmillan, London).

Khan, S., Khoker, Z., Simin, T., 2008. Expected commodity futures return, Working Paper, University of Western Ontario.

Litzenberger, R., Rabinowitz, N., 1995. Backwardation in oil futures markets: Theory and empirical evidence, *Journal of Finance* 50, 1517–1545.

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

Newey, W. K., West, K. D., 1987. Hypothesis testing with efficient method of moments estimation, *International Economic Review* 28, 777-787.

Park, S-C., 2010. The moving average ratio and momentum, *Financial Review* 45, 415-447.

Routledge, B., Seppi, D., Spatt, C., 2000. Equilibrium forward curves for commodities, *Journal of Finance* 55, 1297-1338.

Rouwenhorst, K. G., Tang, K., 2012. Commodity investing, *Annual Review of Financial Economics* forthcoming.

Shanken, J., 1992. On the estimation of beta-pricing models, *Review of Financial Studies* 5, 1-33.

Shen, Q., Szakmary, A., Sharma, S., 2007. An examination of momentum strategies in commodity futures markets, *Journal of Futures Markets* 27, 227-256.

Szakmary, A., Shen, Q., Sharma, S., 2010. Trend-following strategies in commodity futures: A re-examination, *Journal of Banking and Finance* 34, 409-426.

Tang, K., Xiong, W., 2010. Index investment and the financialization of commodities, Working paper, Princeton University.

Working, H., 1949. The theory of the price of storage, *American Economic Review* 39, 1254-1266.

Working, H., 1958. A theory of anticipatory prices, *American Economic Review* 48, 1188-1199.

**Table 1: Correlations between Hedging Pressure, Roll Yields and Past Performance**

The table presents correlations between *i*) hedging pressure and *ii*) either past performance measured over ranking periods equal to 4, 13, 26 and 52 weeks or contemporaneous roll yields. * and ** signify significance at the 1% and 5% levels, respectively.

| | Correlation with hedgers' hedging pressure | | | | | Correlation with speculators' hedging pressure | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Past performance measured over | | | | Roll | Past performance measured over | | | | Roll |
| | 4 weeks | 13 weeks | 26 weeks | 52 weeks | yields | 4 weeks | 13 weeks | 26 weeks | 52 weeks | yields |
| Cocoa | -0.30 * | -0.39 * | -0.33 * | -0.24 * | 0.18 * | 0.21 * | 0.39 * | 0.36 * | 0.29 * | -0.13 * |
| Coffee | -0.54 * | -0.67 * | -0.58 * | -0.54 * | -0.35 * | 0.36 * | 0.65 * | 0.62 * | 0.59 * | 0.28 * |
| Copper | -0.35 * | -0.40 * | -0.37 * | -0.22 * | -0.18 * | 0.30 * | 0.42 * | 0.42 * | 0.29 * | 0.21 * |
| Corn | -0.41 * | -0.60 * | -0.62 * | -0.56 * | -0.12 * | 0.35 * | 0.62 * | 0.65 * | 0.56 * | 0.24 * |
| Cotton | -0.49 * | -0.60 * | -0.57 * | -0.44 * | 0.00 | 0.37 * | 0.58 * | 0.56 * | 0.45 * | 0.04 |
| Crude oil | -0.48 * | -0.45 * | -0.33 * | -0.17 * | -0.18 * | 0.39 * | 0.46 * | 0.39 * | 0.28 * | 0.27 * |
| Electricity | -0.10 ** | -0.35 * | -0.40 * | -0.32 * | -0.06 | 0.09 | 0.28 * | 0.24 * | 0.05 | -0.04 |
| Feeder cattle | -0.18 * | -0.24 * | -0.01 | 0.11 * | 0.09 * | 0.28 * | 0.51 * | 0.44 * | 0.39 * | 0.02 |
| Gasoline | -0.47 * | -0.42 * | -0.33 * | -0.27 * | -0.10 * | 0.37 * | 0.44 * | 0.37 * | 0.29 * | 0.10 * |
| Gold | -0.38 * | -0.58 * | -0.68 * | -0.79 * | -0.32 * | 0.28 * | 0.53 * | 0.63 * | 0.77 * | 0.28 * |
| Heating oil | -0.49 * | -0.47 * | -0.42 * | -0.24 * | -0.12 * | 0.38 * | 0.49 * | 0.47 * | 0.34 * | 0.17 * |
| Lean hogs | -0.36 * | -0.62 * | -0.60 * | -0.47 * | 0.04 | 0.32 * | 0.66 * | 0.66 * | 0.56 * | -0.01 |
| Live cattle | -0.36 * | -0.53 * | -0.52 * | -0.41 * | -0.25 * | 0.33 * | 0.58 * | 0.54 * | 0.41 * | 0.22 * |
| Lumber | -0.24 * | -0.25 * | -0.28 * | -0.32 * | -0.15 * | 0.18 * | 0.26 * | 0.29 * | 0.35 * | 0.14 * |
| Natural gas | -0.34 * | -0.42 * | -0.43 * | -0.44 * | -0.22 * | 0.42 * | 0.61 * | 0.55 * | 0.42 * | 0.30 * |
| Oats | -0.23 * | -0.31 * | -0.26 * | -0.23 * | -0.08 * | 0.18 * | 0.45 * | 0.52 * | 0.52 * | 0.20 * |
| Orange | -0.30 * | -0.37 * | -0.32 * | -0.15 * | 0.06 | 0.27 * | 0.52 * | 0.54 * | 0.35 * | -0.05 |
| Palladium | -0.18 * | -0.18 * | -0.12 * | -0.07 ** | 0.29 * | 0.16 * | 0.21 * | 0.14 * | 0.10 * | -0.10 * |
| Platinum | -0.37 * | -0.43 * | -0.40 * | -0.40 * | -0.01 | 0.25 * | 0.34 * | 0.26 * | 0.22 * | 0.01 |
| Pork bellies | -0.12 * | -0.24 * | -0.11 * | 0.19 * | 0.16 * | 0.32 * | 0.59 * | 0.55 * | 0.41 * | 0.11 * |
| Rough rice | -0.41 * | -0.62 * | -0.63 * | -0.41 * | -0.09 * | 0.15 * | 0.39 * | 0.51 * | 0.52 * | 0.28 * |
| Silver | -0.31 * | -0.36 * | -0.39 * | -0.42 * | -0.37 * | 0.21 * | 0.43 * | 0.47 * | 0.51 * | 0.33 * |
| Soybeans | -0.31 * | -0.48 * | -0.54 * | -0.47 * | -0.01 | 0.30 * | 0.56 * | 0.64 * | 0.59 * | 0.04 |
| Soybean meal | -0.45 * | -0.62 * | -0.65 * | -0.56 * | -0.19 * | 0.32 * | 0.60 * | 0.69 * | 0.65 * | 0.26 * |
| Soybean oil | -0.45 * | -0.59 * | -0.59 * | -0.56 * | -0.29 * | 0.32 * | 0.61 * | 0.65 * | 0.65 * | 0.35 * |
| Sugar | -0.44 * | -0.55 * | -0.49 * | -0.39 * | -0.14 * | 0.30 * | 0.54 * | 0.52 * | 0.42 * | 0.14 * |
| Wheat | -0.31 * | -0.33 * | -0.28 * | -0.32 * | -0.18 * | 0.29 * | 0.47 * | 0.47 * | 0.49 * | 0.29 * |
| Average | -0.35 | -0.45 | -0.42 | -0.34 | -0.10 | 0.29 | 0.49 | 0.49 | 0.42 | 0.15 |

**Table 2: Single-Sort Risk Premiums Based on the Positions of either Hedgers or Speculators**

The table presents summary statistics for fully-collateralized long, short and long-short portfolios based on the positions of either hedgers (Panel A) or speculators (Panel B). R (H) is the number of weeks in the ranking (holding) period. “Mean excess return” and “SD” are the annualized mean and annualized standard deviation of the portfolios' excess returns. Sharpe is the ratio of Mean excess return to SD. “Significant at *x*%” represents the percentage of mean excess returns that are significant at the *x*% level. EW stands for equally-weighted. *t*-statistics in parentheses.

| | Long | | | | Short | | | | Long-Short | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean excess return | | SD | Sharpe ratio | Mean excess return | | SD | Sharpe | Mean excess return | | SD | Sharpe ratio |
| **Panel A: Portfolios based on hedgers' positions** | | | | | | | | | | | | |
| R = 4, H = 4 | 0.0320 | (0.70) | 0.1977 | 0.1618 | -0.0324 | (-0.88) | 0.1577 | -0.2056 | 0.0322 | (1.24) | 0.1118 | 0.2881 |
| R = 4, H = 13 | 0.0664 | (1.47) | 0.1938 | 0.3425 | -0.0500 | (-1.34) | 0.1600 | -0.3123 | 0.0582 | (2.27) | 0.1103 | 0.5274 |
| R = 4, H = 26 | 0.0908 | (1.99) | 0.1963 | 0.4625 | -0.0344 | (-0.92) | 0.1612 | -0.2135 | 0.0626 | (2.44) | 0.1104 | 0.5671 |
| R = 4, H = 52 | 0.0984 | (2.13) | 0.1986 | 0.4955 | -0.0350 | (-0.96) | 0.1568 | -0.2235 | 0.0667 | (2.68) | 0.1069 | 0.6243 |
| R = 13, H = 4 | 0.0760 | (1.64) | 0.1986 | 0.3826 | -0.0477 | (-1.25) | 0.1632 | -0.2922 | 0.0618 | (2.32) | 0.1141 | 0.5417 |
| R = 13, H = 13 | 0.1015 | (2.22) | 0.1952 | 0.5199 | -0.0337 | (-0.89) | 0.1630 | -0.2070 | 0.0676 | (2.63) | 0.1098 | 0.6154 |
| R = 13, H = 26 | 0.0668 | (1.46) | 0.1962 | 0.3403 | -0.0240 | (-0.64) | 0.1605 | -0.1499 | 0.0454 | (1.77) | 0.1096 | 0.4143 |
| R = 13, H = 52 | 0.0833 | (1.84) | 0.1942 | 0.4289 | -0.0137 | (-0.36) | 0.1614 | -0.0849 | 0.0485 | (1.89) | 0.1097 | 0.4420 |
| R = 26, H = 4 | 0.0712 | (1.53) | 0.1977 | 0.3602 | -0.0671 | (-1.84) | 0.1546 | -0.4338 | 0.0691 | (2.68) | 0.1098 | 0.6299 |
| R = 26, H = 13 | 0.0885 | (1.93) | 0.1951 | 0.4539 | -0.0384 | (-1.06) | 0.1540 | -0.2494 | 0.0635 | (2.50) | 0.1080 | 0.5875 |
| R = 26, H = 26 | 0.0691 | (1.52) | 0.1939 | 0.3566 | -0.0622 | (-1.75) | 0.1507 | -0.4126 | 0.0657 | (2.62) | 0.1066 | 0.6159 |
| R = 26, H = 52 | 0.0830 | (1.80) | 0.1961 | 0.4236 | -0.0408 | (-1.17) | 0.1479 | -0.2758 | 0.0619 | (2.48) | 0.1059 | 0.5845 |
| R = 52, H = 4 | 0.1121 | (2.42) | 0.1939 | 0.5782 | 0.0104 | (0.28) | 0.1540 | 0.0678 | 0.0508 | (2.04) | 0.1047 | 0.4857 |
| R = 52, H = 13 | 0.0603 | (1.32) | 0.1920 | 0.3139 | -0.0074 | (-0.21) | 0.1476 | -0.0502 | 0.0338 | (1.37) | 0.1037 | 0.3264 |
| R = 52, H = 26 | 0.1069 | (2.28) | 0.1966 | 0.5436 | -0.0183 | (-0.53) | 0.1449 | -0.1260 | 0.0626 | (2.51) | 0.1044 | 0.5991 |
| R = 52, H = 52 | 0.0840 | (1.89) | 0.1864 | 0.4510 | -0.0152 | (-0.43) | 0.1485 | -0.1027 | 0.0496 | (2.08) | 0.1002 | 0.4956 |
| Average | 0.0806 | | 0.1951 | 0.4134 | -0.0319 | | 0.1554 | -0.2045 | 0.0563 | | 0.1079 | 0.5216 |
| Significant at 5% | 31.25% | | | | 0.00% | | | | 75.00% | | | |
| Significant at 10% | 56.25% | | | | 12.50% | | | | 87.50% | | | |
| **Panel B: Portfolios based on speculators' positions** | | | | | | | | | | | | |
| R = 4, H = 4 | 0.0561 | (1.22) | 0.1979 | 0.2834 | -0.0447 | (-1.06) | 0.1816 | -0.2463 | 0.0504 | (1.91) | 0.1136 | 0.4439 |
| R = 4, H = 13 | 0.0355 | (0.82) | 0.1865 | 0.1906 | -0.0417 | (-0.98) | 0.1825 | -0.2282 | 0.0386 | (1.51) | 0.1100 | 0.3509 |
| R = 4, H = 26 | 0.0645 | (1.39) | 0.1993 | 0.3236 | -0.0548 | (-1.27) | 0.1855 | -0.2953 | 0.0596 | (2.24) | 0.1144 | 0.5213 |
| R = 4, H = 52 | 0.0639 | (1.48) | 0.1861 | 0.3435 | -0.0393 | (-0.95) | 0.1784 | -0.2204 | 0.0516 | (2.06) | 0.1076 | 0.4798 |
| R = 13, H = 4 | 0.0444 | (1.01) | 0.1876 | 0.2367 | -0.0646 | (-1.46) | 0.1886 | -0.3423 | 0.0545 | (2.08) | 0.1123 | 0.4854 |
| R = 13, H = 13 | 0.0578 | (1.32) | 0.1876 | 0.3082 | -0.0703 | (-1.57) | 0.1913 | -0.3674 | 0.0641 | (2.39) | 0.1146 | 0.5588 |
| R = 13, H = 26 | 0.0773 | (1.71) | 0.1929 | 0.4005 | -0.0480 | (-1.14) | 0.1810 | -0.2654 | 0.0627 | (2.33) | 0.1148 | 0.5456 |
| R = 13, H = 52 | 0.0425 | (0.99) | 0.1831 | 0.2323 | -0.0632 | (-1.46) | 0.1856 | -0.3402 | 0.0528 | (2.03) | 0.1115 | 0.4738 |
| R = 26, H = 4 | 0.0963 | (2.22) | 0.1845 | 0.5222 | -0.0700 | (-1.57) | 0.1900 | -0.3684 | 0.0832 | (3.22) | 0.1096 | 0.7587 |
| R = 26, H = 13 | 0.0531 | (1.21) | 0.1870 | 0.2841 | -0.0711 | (-1.64) | 0.1842 | -0.3859 | 0.0621 | (2.37) | 0.1114 | 0.5577 |
| R = 26, H = 26 | 0.0725 | (1.64) | 0.1882 | 0.3853 | -0.0833 | (-1.98) | 0.1788 | -0.4661 | 0.0779 | (3.15) | 0.1052 | 0.7403 |
| R = 26, H = 52 | 0.0544 | (1.34) | 0.1727 | 0.3150 | -0.0222 | (-0.52) | 0.1815 | -0.1224 | 0.0383 | (1.57) | 0.1040 | 0.3684 |
| R = 52, H = 4 | 0.0587 | (1.28) | 0.1915 | 0.3065 | -0.0741 | (-1.73) | 0.1797 | -0.4123 | 0.0664 | (2.59) | 0.1074 | 0.6184 |
| R = 52, H = 13 | 0.0578 | (1.26) | 0.1925 | 0.3001 | -0.0502 | (-1.17) | 0.1803 | -0.2786 | 0.0540 | (2.14) | 0.1057 | 0.5109 |
| R = 52, H = 26 | 0.0502 | (1.09) | 0.1931 | 0.2599 | -0.0409 | (-0.94) | 0.1817 | -0.2248 | 0.0455 | (1.82) | 0.1048 | 0.4345 |
| R = 52, H = 52 | 0.0584 | (1.34) | 0.1821 | 0.3207 | -0.0663 | (-1.56) | 0.1780 | -0.3727 | 0.0624 | (2.66) | 0.0982 | 0.6351 |
| Average | 0.0590 | | 0.1883 | 0.3133 | -0.0565 | | 0.1830 | -0.3085 | 0.0578 | | 0.1091 | 0.5302 |
| Significant at 5% | 6.25% | | | | 6.25% | | | | 75.00% | | | |
| Significant at 10% | 12.50% | | | | 12.50% | | | | 87.50% | | | |
| **Panel C: Long-only portfolios** | | | | | | | | | | | | |
| EW | 0.0100 | (0.35) | 0.1215 | 0.0823 | | | | | | | | |
| S&P-GSCI | 0.0419 | (0.83) | 0.2174 | 0.1925 | | | | | | | | |

**Table 3: Double-Sort Risk Premiums Based on the Positions of both Hedgers and Speculators**

The table presents summary statistics for fully-collateralized long, short and long-short portfolios based on the positions of both hedgers and speculators. In Panel A, the sorting is implemented on the positions of, first, hedgers and, second, speculators. The sorting order is reversed in Panel B. R (H) is the number of weeks in the ranking (holding) period. "Mean excess return" and "SD" are the annualized mean and annualized standard deviation of the portfolios' excess returns. Sharpe is the ratio of Mean excess return to SD. "Significant at *x*%" represents the percentage of mean excess returns that are significant at the *x*% level. EW stands for equally-weighted. *t*-statistics in parentheses.

| | Long | | | | Short | | | | Long-Short | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean excess return | | SD | Sharpe ratio | Mean excess return | | SD | Sharpe | Mean excess return | | SD | Sharpe ratio |
| **Panel A: Portfolios based on the positions of first hedgers and second speculators** | | | | | | | | | | | | |
| R = 4, H = 4 | 0.0425 | (0.94) | 0.1941 | 0.2190 | -0.0235 | (-0.56) | 0.1792 | -0.1313 | 0.0330 | (1.28) | 0.1110 | 0.2976 |
| R = 4, H = 13 | 0.0327 | (0.74) | 0.1889 | 0.1731 | -0.0308 | (-0.73) | 0.1808 | -0.1703 | 0.0317 | (1.25) | 0.1094 | 0.2901 |
| R = 4, H = 26 | 0.0587 | (1.28) | 0.1976 | 0.2968 | -0.0416 | (-0.98) | 0.1818 | -0.2287 | 0.0501 | (1.91) | 0.1128 | 0.4443 |
| R = 4, H = 52 | 0.0525 | (1.21) | 0.1866 | 0.2814 | -0.0232 | (-0.56) | 0.1768 | -0.1312 | 0.0378 | (1.57) | 0.1034 | 0.3660 |
| R = 13, H = 4 | 0.0432 | (0.98) | 0.1882 | 0.2296 | -0.0933 | (-2.07) | 0.1931 | -0.4831 | 0.0682 | (2.57) | 0.1137 | 0.6002 |
| R = 13, H = 13 | 0.0444 | (1.05) | 0.1813 | 0.2448 | -0.0422 | (-0.97) | 0.1857 | -0.2275 | 0.0433 | (1.72) | 0.1077 | 0.4021 |
| R = 13, H = 26 | 0.0542 | (1.23) | 0.1877 | 0.2884 | -0.0454 | (-1.09) | 0.1784 | -0.2547 | 0.0498 | (1.96) | 0.1089 | 0.4572 |
| R = 13, H = 52 | 0.0372 | (0.88) | 0.1803 | 0.2061 | -0.0594 | (-1.40) | 0.1816 | -0.3274 | 0.0483 | (1.95) | 0.1062 | 0.4550 |
| R = 26, H = 4 | 0.0329 | (0.76) | 0.1846 | 0.1784 | -0.1647 | (-3.57) | 0.1961 | -0.8397 | 0.0988 | (3.96) | 0.1059 | 0.9330 |
| R = 26, H = 13 | 0.0561 | (1.28) | 0.1864 | 0.3012 | -0.0598 | (-1.42) | 0.1792 | -0.3335 | 0.0579 | (2.29) | 0.1073 | 0.5399 |
| R = 26, H = 26 | 0.0784 | (1.80) | 0.1846 | 0.4247 | -0.0950 | (-2.32) | 0.1739 | -0.5462 | 0.0867 | (3.60) | 0.1022 | 0.8479 |
| R = 26, H = 52 | 0.0419 | (1.03) | 0.1732 | 0.2418 | -0.0410 | (-0.96) | 0.1817 | -0.2255 | 0.0414 | (1.75) | 0.1003 | 0.4129 |
| R = 52, H = 4 | 0.1190 | (2.61) | 0.1909 | 0.6235 | -0.0591 | (-1.45) | 0.1706 | -0.3465 | 0.0891 | (3.65) | 0.1022 | 0.8711 |
| R = 52, H = 13 | 0.0519 | (1.15) | 0.1886 | 0.2751 | -0.0288 | (-0.69) | 0.1747 | -0.1651 | 0.0404 | (1.66) | 0.1016 | 0.3972 |
| R = 52, H = 26 | 0.0520 | (1.16) | 0.1884 | 0.2762 | -0.0208 | (-0.49) | 0.1778 | -0.1172 | 0.0364 | (1.51) | 0.1012 | 0.3598 |
| R = 52, H = 52 | 0.0267 | (0.62) | 0.1811 | 0.1476 | -0.0524 | (-1.20) | 0.1823 | -0.2875 | 0.0396 | (1.70) | 0.0977 | 0.4050 |
| Average | 0.0515 | | 0.1864 | 0.2755 | -0.0551 | | 0.1809 | -0.3010 | 0.0533 | | 0.1057 | 0.5050 |
| Significant at 5% | | 6.25% | | | | 18.75% | | | | 31.25% | | |
| Significant at 10% | | 12.50% | | | | 18.75% | | | | 75.00% | | |
| **Panel B: Portfolios based on the positions of first speculators and second hedgers** | | | | | | | | | | | | |
| R = 4, H = 4 | 0.0471 | (1.03) | 0.1967 | 0.2397 | -0.0369 | (-0.97) | 0.1633 | -0.2260 | 0.0420 | (1.60) | 0.1128 | 0.3726 |
| R = 4, H = 13 | 0.0966 | (2.08) | 0.1992 | 0.4849 | -0.0370 | (-0.97) | 0.1641 | -0.2255 | 0.0668 | (2.49) | 0.1153 | 0.5795 |
| R = 4, H = 26 | 0.1129 | (2.42) | 0.2004 | 0.5632 | -0.0343 | (-0.90) | 0.1631 | -0.2102 | 0.0736 | (2.76) | 0.1146 | 0.6420 |
| R = 4, H = 52 | 0.1140 | (2.58) | 0.1902 | 0.5995 | -0.0250 | (-0.67) | 0.1603 | -0.1557 | 0.0695 | (2.91) | 0.1026 | 0.6769 |
| R = 13, H = 4 | 0.0690 | (1.51) | 0.1960 | 0.3521 | -0.0359 | (-0.93) | 0.1645 | -0.2184 | 0.0525 | (2.00) | 0.1120 | 0.4685 |
| R = 13, H = 13 | 0.0706 | (1.56) | 0.1942 | 0.3637 | -0.0266 | (-0.69) | 0.1659 | -0.1603 | 0.0486 | (1.93) | 0.1079 | 0.4507 |
| R = 13, H = 26 | 0.0696 | (1.54) | 0.1940 | 0.3589 | -0.0352 | (-0.92) | 0.1634 | -0.2153 | 0.0524 | (2.07) | 0.1083 | 0.4838 |
| R = 13, H = 52 | 0.0861 | (1.95) | 0.1885 | 0.4568 | -0.0269 | (-0.69) | 0.1674 | -0.1604 | 0.0565 | (2.27) | 0.1066 | 0.5299 |
| R = 26, H = 4 | 0.0780 | (1.69) | 0.1968 | 0.3966 | -0.1026 | (-2.63) | 0.1655 | -0.6199 | 0.0903 | (3.42) | 0.1121 | 0.8056 |
| R = 26, H = 13 | 0.0700 | (1.53) | 0.1942 | 0.3603 | -0.0295 | (-0.79) | 0.1590 | -0.1858 | 0.0497 | (1.95) | 0.1085 | 0.4586 |
| R = 26, H = 26 | 0.0603 | (1.32) | 0.1936 | 0.3117 | -0.0544 | (-1.50) | 0.1544 | -0.3524 | 0.0574 | (2.30) | 0.1060 | 0.5414 |
| R = 26, H = 52 | 0.0658 | (1.43) | 0.1952 | 0.3372 | -0.0270 | (-0.76) | 0.1512 | -0.1787 | 0.0464 | (1.88) | 0.1049 | 0.4426 |
| R = 52, H = 4 | 0.1146 | (2.47) | 0.1947 | 0.5886 | 0.0191 | (0.50) | 0.1597 | 0.1194 | 0.0478 | (1.90) | 0.1054 | 0.4530 |
| R = 52, H = 13 | 0.0488 | (1.06) | 0.1934 | 0.2526 | -0.0282 | (-0.77) | 0.1529 | -0.1845 | 0.0385 | (1.53) | 0.1056 | 0.3648 |
| R = 52, H = 26 | 0.0794 | (1.69) | 0.1969 | 0.4032 | 0.0210 | (0.57) | 0.1542 | 0.1364 | 0.0292 | (1.15) | 0.1063 | 0.2745 |
| R = 52, H = 52 | 0.0801 | (1.77) | 0.1898 | 0.4221 | -0.0217 | (-0.57) | 0.1593 | -0.1360 | 0.0509 | (2.04) | 0.1046 | 0.4868 |
| Average | 0.0789 | | 0.1946 | 0.4057 | -0.0301 | | 0.1605 | -0.1858 | 0.0545 | | 0.1083 | 0.5020 |
| Significant at 5% | | 25.00% | | | | 6.25% | | | | 56.25% | | |
| Significant at 10% | | 50.00% | | | | 6.25% | | | | 81.25% | | |
| **Panel C: Long-only portfolios** | | | | | | | | | | | | |
| EW | 0.0100 | (0.35) | 0.1215 | 0.0823 | | | | | | | | |
| S&P-GSCI | 0.0419 | (0.83) | 0.2174 | 0.1925 | | | | | | | | |

**Table 4: The Relationship between Hedging Pressure Risk Premiums and Conditional Volatility**

The table presents slope coefficients of regressions of hedging pressure risk premiums on the lagged conditional volatility of commodity futures markets, where the later is measured by applying a GARCH(1,1)-GJR process to the excess returns of an equally-weighted portfolio of all commodities. The numbers in parentheses are the associated *t*-statistics with a Newey and West (1987) correction of the standard errors. R (H) is the number of weeks in the ranking (holding) period. "Positive and significant at *x*%" represents the percentage of coefficients on lagged conditional volatility that are positive and significant at the *x*% level.

| Risk premium based on | Hedgers's positions | | Speculators's positions | | First hedgers' and then speculators' positions | | First speculators' and then hedgers' positions | |
|---|---|---|---|---|---|---|---|---|
| R = 4, H = 4 | 0.6036 | (1.01) | 1.1296 | (1.90) | 1.1843 | (2.05) | 0.8013 | (1.41) |
| R = 4, H = 13 | 0.4429 | (0.91) | 1.5835 | (2.40) | 1.6084 | (2.63) | 1.0390 | (2.03) |
| R = 4, H = 26 | 0.9141 | (1.72) | 1.8782 | (2.70) | 2.8587 | (4.31) | 1.5344 | (2.67) |
| R = 4, H = 52 | 2.1510 | (3.18) | 2.2172 | (3.09) | 2.6556 | (3.89) | 2.2922 | (3.37) |
| R = 13, H = 4 | 0.9158 | (1.55) | 1.2109 | (1.92) | 1.4513 | (2.30) | 1.0051 | (1.77) |
| R = 13, H = 13 | 0.4169 | (0.78) | 1.7386 | (2.65) | 2.1251 | (3.05) | -0.0867 | (-0.17) |
| R = 13, H = 26 | 1.2635 | (1.85) | 1.7006 | (2.58) | 2.6491 | (4.06) | 1.3273 | (2.04) |
| R = 13, H = 52 | 1.1806 | (1.87) | 2.7586 | (3.60) | 2.5534 | (3.50) | 2.1527 | (3.41) |
| R = 26, H = 4 | 0.5168 | (0.65) | 2.0623 | (2.84) | 2.3529 | (3.53) | 1.2148 | (1.84) |
| R = 26, H = 13 | 0.6751 | (0.80) | 2.3579 | (2.92) | 2.1591 | (2.81) | 0.4989 | (0.53) |
| R = 26, H = 26 | 1.0637 | (1.43) | 2.5608 | (3.74) | 1.7115 | (2.94) | 0.9880 | (1.19) |
| R = 26, H = 52 | 0.9760 | (1.21) | 0.3498 | (0.55) | -0.0353 | (-0.07) | 0.7233 | (0.86) |
| R = 52, H = 4 | 1.5938 | (2.48) | 2.5557 | (3.20) | 2.1956 | (3.63) | 2.2031 | (3.19) |
| R = 52, H = 13 | 1.6646 | (2.36) | 2.5660 | (2.98) | 2.1721 | (3.26) | 2.0142 | (2.88) |
| R = 52, H = 26 | 1.4858 | (2.60) | 2.4313 | (2.67) | 2.6745 | (3.72) | 2.4388 | (3.87) |
| R = 52, H = 52 | 1.2841 | (2.37) | 1.9764 | (2.64) | 2.1655 | (3.44) | 1.8998 | (2.79) |
| Average | 1.0718 | | 1.9423 | | 2.0301 | | 1.3779 | |
| Positive and significant at 5% | | 31.25% | | 81.25% | | 93.75% | | 56.25% |
| Positive and significant at 10% | | 50.00% | | 93.75% | | 93.75% | | 68.75% |

**Table 5: Summary Statistics for Momentum and Term Structure Portfolios**

The table presents summary statistics for the excess returns of fully-collateralized commodity strategies, based on either momentum or the slope of the term structure. R (H) is the number of weeks in the ranking (holding) period. “Mean excess return” and “SD” are the annualized mean and annualized standard deviation of the portfolios' excess returns. Sharpe is the ratio of Mean excess return to SD. “Positive and significant at *x*%” represents the percentage of mean excess returns that are positive and significant at the *x*% level. EW stands for equally-weighted. *t*-statistics in parentheses.

| | Mean excess return | | SD | Sharpe ratio | Mean excess return | | SD | Sharpe ratio |
|---|---|---|---|---|---|---|---|---|
| **Panel A: Long-short portfolios** | | | | | | | | |
| | **Momentum** | | | | **Term structure** | | | |
| R = 4, H = 4 | -0.0029 | (-0.09) | 0.1423 | -0.0203 | 0.0532 | (2.03) | 0.1125 | 0.4727 |
| R = 4, H = 13 | 0.0289 | (0.91) | 0.1369 | 0.2108 | 0.0514 | (1.99) | 0.1109 | 0.4632 |
| R = 4, H = 26 | -0.0055 | (-0.18) | 0.1275 | -0.0430 | 0.0829 | (3.36) | 0.1061 | 0.7810 |
| R = 4, H = 52 | -0.0228 | (-0.76) | 0.1284 | -0.1772 | 0.0793 | (2.95) | 0.1155 | 0.6870 |
| R = 13, H = 4 | 0.0656 | (1.90) | 0.1478 | 0.4438 | 0.0419 | (1.64) | 0.1093 | 0.3834 |
| R = 13, H = 13 | 0.0648 | (1.99) | 0.1391 | 0.4659 | 0.0588 | (2.28) | 0.1106 | 0.5322 |
| R = 13, H = 26 | -0.0240 | (-0.78) | 0.1308 | -0.1833 | 0.0426 | (1.63) | 0.1117 | 0.3814 |
| R = 13, H = 52 | -0.0292 | (-0.94) | 0.1327 | -0.2197 | 0.0488 | (1.88) | 0.1113 | 0.4383 |
| R = 26, H = 4 | 0.0433 | (1.28) | 0.1438 | 0.3014 | 0.0487 | (1.90) | 0.1089 | 0.4474 |
| R = 26, H = 13 | 0.0102 | (0.31) | 0.1393 | 0.0735 | 0.0543 | (2.10) | 0.1099 | 0.4942 |
| R = 26, H = 26 | -0.0112 | (-0.35) | 0.1355 | -0.0823 | 0.0399 | (1.49) | 0.1135 | 0.3512 |
| R = 26, H = 52 | 0.0237 | (0.77) | 0.1307 | 0.1811 | 0.0182 | (0.65) | 0.1190 | 0.1532 |
| R = 52, H = 4 | 0.0743 | (2.24) | 0.1389 | 0.5349 | 0.0290 | (1.12) | 0.1088 | 0.2669 |
| R = 52, H = 13 | 0.0391 | (1.20) | 0.1368 | 0.2858 | 0.0170 | (0.64) | 0.1120 | 0.1520 |
| R = 52, H = 26 | 0.0402 | (1.25) | 0.1344 | 0.2993 | 0.0134 | (0.51) | 0.1106 | 0.1215 |
| R = 52, H = 52 | 0.0408 | (1.35) | 0.1268 | 0.3219 | 0.0173 | (0.69) | 0.1056 | 0.1641 |
| Average | 0.0210 | | 0.1357 | 0.1495 | 0.0436 | | 0.1110 | 0.3931 |
| Positive and significant at 5% | | 12.50% | | | | 37.50% | | |
| Positive and significant at 10% | | 18.75% | | | | 50.00% | | |
| **Panel B: Long-only portfolios** | | | | | | | | |
| EW | 0.0100 | (0.35) | 0.1215 | 0.0823 | | | | |
| S&P-GSCI | 0.0419 | (0.83) | 0.2174 | 0.1925 | | | | |

**Table 6: Cross-Sectional Pricing of Hedging Pressure, Term Structure and Momentum**

The table presents means and Shanken's (1992) adjusted *t*-statistics (in parentheses) for the lambda coefficients obtained by estimating step-two Fama and MacBeth (1973) cross-section regressions. For a given signal (e.g., hedgers' hedging pressure), the lambdas have been pooled across the 16 permutations of 4 ranking and 4 holding periods (each set to 4, 13, 26 or 52 weeks).

| | $\lambda_0$ | | $\lambda_1$ | |
|---|---|---|---|---|
| **Panel A: Long-short portfolios** | | | | |
| Hedgers' hedging pressure | 0.0001 | (0.47) | 0.0008 | (3.52) |
| Speculators' hedging pressure | 0.0003 | (1.55) | 0.0023 | (7.66) |
| Hedgers and speculators' hedging pressure | 0.0004 | (1.97) | 0.0022 | (7.17) |
| Speculators and hedgers' hedging pressure | 0.0001 | (0.75) | 0.0008 | (3.63) |
| Momentum | 0.0003 | (1.57) | 0.0005 | (1.12) |
| Term structure | 0.0003 | (1.88) | 0.0012 | (3.81) |
| **Panel B: Long-only portfolios** | | | | |
| Equally-weighted portfolio of all commodities | -0.0001 | (-0.11) | 0.0005 | (0.51) |
| S&P-GSCI | 0.0002 | (0.26) | 0.0006 | (0.46) |

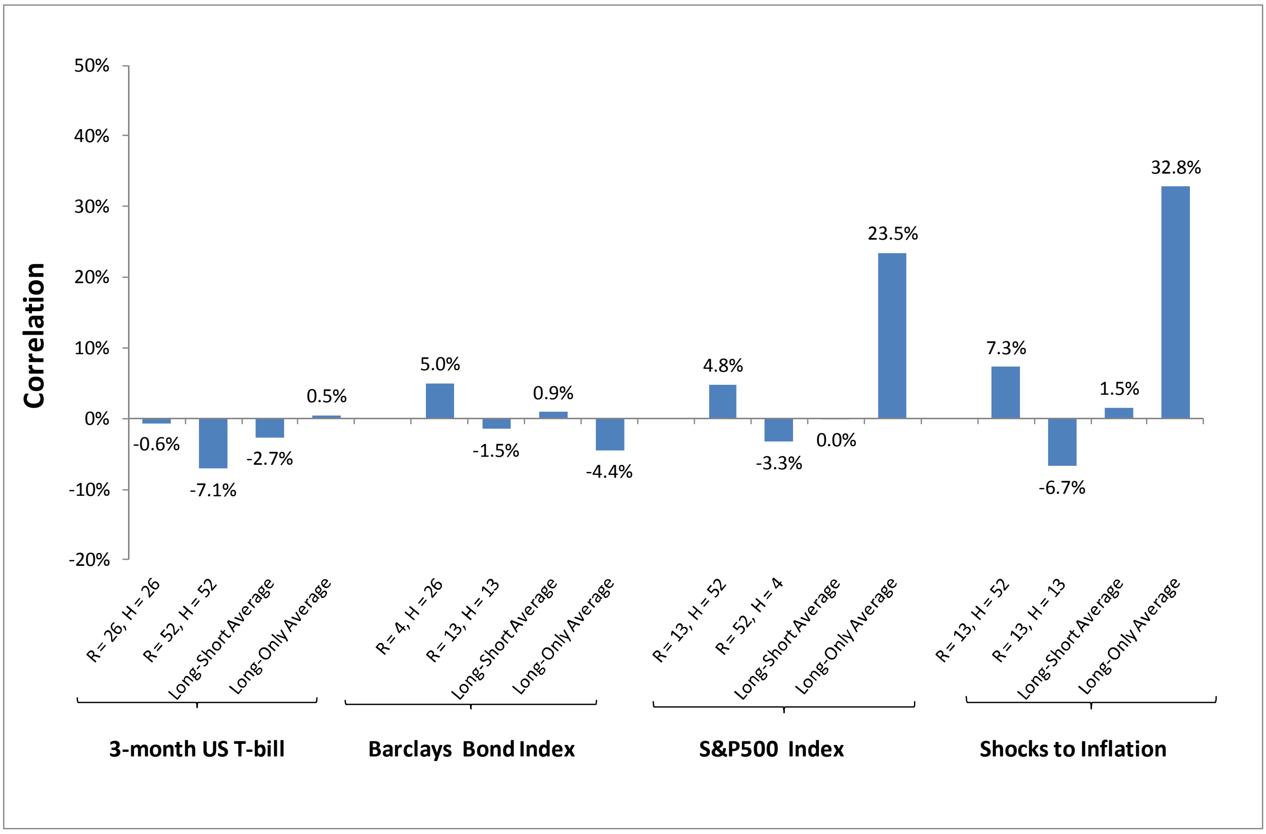
**Table 7: Disentangling the Effects of Hedging Pressure, Momentum and Term Structure on Commodity Futures Returns**

The table presents means of slope coefficients from cross-sectional regressions of commodity excess return on their first lag ($R_{i,t-1}$), lagged dollar open interest and 8 dummy variables. $HPL_{i,t-k}^{Hedg}$ is a dummy variable equal to 1 (0) if commodity $i$ is included in (excluded from) the long portfolio based on hedgers' hedging pressure (HP), $HPS_{i,t-k}^{Hedg}$ is a dummy variable equal to 1 (0) if commodity $i$ is included in (excluded from) the short portfolio based on hedgers' hedging pressure. $HPL_{i,t-k}^{Spec}$ and $HPS_{i,t-k}^{Spec}$ are two speculators' hedging pressure dummies, $MomL_{i,t-k}$ and $MomS_{i,t-k}$ are two momentum dummies and $TSL_{i,t-k}$ and $TSS_{i,t-k}$ are two term structure dummies that take values of 1 if commodity $i$ is included in the long ($L$) or short ($S$) portfolios based on speculators' hedging pressure, momentum and term structure and take values of 0, otherwise. $t$-statistics in parentheses.

| | One set of dummies only | | | | Combination of dummies | | |
|---|---|---|---|---|---|---|---|
| | (A) | (B) | (C) | (D) | (E) | (F) | (G) |
| **Panel A: Estimated parameters** | | | | | | | |
| Intercept | 0.0020 | 0.0016 | 0.0013 | 0.0012 | 0.0016 | 0.0012 | 0.0020 |
| | (3.41) | (2.99) | (2.36) | (2.26) | (2.71) | (2.09) | (3.17) |
| $R_{i,t-1}$ | 0.0094 | 0.0090 | 0.0120 | 0.0106 | 0.0111 | 0.0095 | 0.0099 |
| | (3.20) | (3.11) | (4.21) | (3.69) | (3.55) | (3.09) | (3.01) |
| $ln(OI_{i,t-1})$ | -0.0001 | -0.0001 | -0.0001 | -0.0001 | -0.0001 | -0.0001 | -0.0001 |
| | (-2.90) | (-2.44) | (-1.96) | (-1.98) | (-2.56) | (-1.87) | (-3.15) |
| $HPL_{i,t-k}^{Hedg}$ | 0.0008 | | | | 0.0007 | | 0.0004 |
| | (3.67) | | | | (3.07) | | (1.59) |
| $HPS_{i,t-k}^{Hedg}$ | -0.0008 | | | | -0.0003 | | 0.0002 |
| | (-4.67) | | | | (-1.74) | | (0.79) |
| $HPL_{i,t-k}^{Spec}$ | | 0.0008 | | | | 0.0006 | 0.0006 |
| | | (4.16) | | | | (3.02) | (2.40) |
| $HPS_{i,t-k}^{Spec}$ | | -0.0013 | | | | -0.0008 | -0.0009 |
| | | (-6.80) | | | | (-3.67) | (-3.36) |
| $MomL_{i,t-k}$ | | | 0.0002 | | 0.0004 | 0.0001 | 0.0003 |
| | | | (0.93) | | (1.50) | (0.57) | (1.10) |
| $MomS_{i,t-k}$ | | | -0.0003 | | -0.0003 | -0.0004 | -0.0003 |
| | | | (-1.49) | | (-1.24) | (-1.47) | (-1.29) |
| $TSL_{i,t-k}$ | | | | 0.0011 | 0.0010 | 0.0011 | 0.0011 |
| | | | | (5.47) | (4.33) | (5.08) | (4.66) |
| $TSS_{i,t-k}$ | | | | -0.0008 | -0.0005 | -0.0004 | -0.0003 |
| | | | | (-3.81) | (-2.12) | (-1.92) | (-1.36) |
| **Panel B: Annualized mean excess returns of pure fully-collateralized commodity strategies** | | | | | | | |
| Hedgers' HP | 0.0419 | | | | 0.0271 | | 0.0058 |
| | (6.40) | | | | (3.80) | | (0.66) |
| Speculators' HP | | 0.0531 | | | | 0.0356 | 0.0374 |
| | | (8.26) | | | | (5.00) | (4.20) |
| Momentum | | | 0.0141 | | 0.0182 | 0.0133 | 0.0170 |
| | | | (1.75) | | (2.01) | (1.48) | (1.75) |
| Term structure | | | | 0.0475 | 0.0380 | 0.0397 | 0.0378 |
| | | | | (7.16) | (4.95) | (5.34) | (4.62) |

**Figure 1: Diversification and Inflation Hedging**

The figure reports correlation coefficients between *i*) the total returns of commodity portfolios and *ii*) three traditional asset classes or shocks to inflation. The long-short portfolios are based on the positions of hedgers. To ease presentation, only the highest, lowest and average correlations out of the 16 correlations coming from the permutations of 4 ranking (R) and 4 holding (H) periods are reported. We report under the label 'Long-Only Average' the average correlation between long-only portfolios (S&P-GSCI and long-only equally-weighted portfolio of all commodities) and e.g., 3-month Treasury bills.



## Appendix 1: Constituents of Hedging Pressure Portfolios and Summary Statistics on Hedging Pressure

The appendix presents the percentages of times each commodity enters the long hedgers' hedging pressure portfolios ($\omega_{Long}$) and the short hedgers' hedging pressure portfolios ($\omega_{Short}$), summary statistics on hedgers' hedging pressure and average roll yields per commodity. *t*-statistics for the hypothesis that the correlation is zero are in parentheses.

| | $\omega_{Long}$ | $\omega_{Short}$ | Hedgers' hedging pressure | | | | Average roll |
|---|---|---|---|---|---|---|---|
| | | | Average | StDev | Minimum | Maximum | yields |
| **Panel A: Individual commodities** | | | | | | | |
| Cocoa | 0.00% | 13.11% | 0.45 | 0.06 | 0.28 | 0.64 | -1.38% |
| Coffee | 5.73% | 1.89% | 0.43 | 0.07 | 0.21 | 0.62 | -1.56% |
| Copper | 4.73% | 18.53% | 0.45 | 0.10 | 0.16 | 0.67 | 0.09% |
| Corn | 0.00% | 34.75% | 0.50 | 0.07 | 0.34 | 0.69 | -2.40% |
| Cotton | 0.66% | 32.23% | 0.49 | 0.10 | 0.27 | 0.72 | -1.59% |
| Crude oil | 0.00% | 13.75% | 0.49 | 0.03 | 0.40 | 0.59 | 0.05% |
| Electricity | 0.00% | 0.00% | 0.47 | 0.03 | 0.39 | 0.52 | -2.02% |
| Feeder cattle | 1.67% | 70.17% | 0.57 | 0.12 | 0.09 | 0.84 | 0.05% |
| Gasoline | 0.00% | 3.12% | 0.45 | 0.05 | 0.31 | 0.59 | -0.55% |
| Gold | 40.81% | 27.27% | 0.39 | 0.15 | 0.16 | 0.75 | -0.55% |
| Heating oil | 0.03% | 0.39% | 0.46 | 0.04 | 0.35 | 0.55 | -0.16% |
| Lean hogs | 2.76% | 37.98% | 0.50 | 0.10 | 0.26 | 0.83 | -2.60% |
| Live cattle | 0.00% | 12.33% | 0.48 | 0.06 | 0.31 | 0.59 | -0.44% |
| Lumber | 29.48% | 24.13% | 0.40 | 0.20 | 0.00 | 1.00 | -2.06% |
| Natural gas | 0.00% | 19.65% | 0.50 | 0.06 | 0.38 | 0.68 | -1.41% |
| Oats | 52.91% | 0.00% | 0.33 | 0.09 | 0.09 | 0.57 | -1.58% |
| Orange | 13.44% | 7.17% | 0.39 | 0.11 | 0.06 | 0.65 | -1.73% |
| Palladium | 57.55% | 7.60% | 0.32 | 0.16 | 0.06 | 0.80 | -0.04% |
| Platinum | 72.62% | 0.16% | 0.26 | 0.13 | 0.04 | 0.65 | 0.29% |
| Pork bellies | 14.98% | 25.26% | 0.50 | 0.20 | 0.02 | 1.00 | -0.21% |
| Rough rice | 7.94% | 4.71% | 0.43 | 0.12 | 0.16 | 0.72 | -2.29% |
| Silver | 84.73% | 0.00% | 0.26 | 0.08 | 0.05 | 0.47 | -0.55% |
| Soybeans | 5.28% | 17.68% | 0.44 | 0.10 | 0.17 | 0.68 | -0.19% |
| Soybean meal | 6.35% | 2.52% | 0.41 | 0.07 | 0.22 | 0.63 | 0.59% |
| Soybean oil | 5.79% | 8.41% | 0.43 | 0.09 | 0.20 | 0.64 | -0.67% |
| Sugar | 6.03% | 7.86% | 0.43 | 0.08 | 0.20 | 0.67 | 0.07% |
| Wheat | 2.65% | 19.15% | 0.47 | 0.09 | 0.18 | 0.64 | -2.03% |
| **Panel B: Correlations between summary statistics for hedging pressure (roll-yields) and** | | | | | | | |
| $\omega_{Long}$ | | | -0.90 | 0.42 | -0.66 | -0.04 | 0.20 |
| | | | (-10.18) | (2.30) | (-4.37) | (-0.21) | (1.02) |
| $\omega_{Short}$ | | | 0.62 | 0.32 | -0.05 | 0.61 | -0.12 |
| | | | (3.93) | (1.68) | (-0.26) | (3.82) | (-0.58) |