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 either hedgers or speculators, as well as double sorts based on both positions. We find positive and significant commodity futures risk premiums from both single and double sorts, alongside with Sharpe ratios that systematically exceed those of long-only commodity portfolios. Further tests show that the hedging pressure risk premiums rise with the lagged volatility of commodity markets and that the cross-sectional price of commodity risk is positive. Finally, the hedging pressure risk premiums are found to explain the performance of active commodity portfolios better than long-only commodity benchmarks and to act as better diversifiers of equity risk.

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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 generalised hedging pressure hypothesis of Hirshleifer (1989), (1990) where due to non-participation effects hedging pressure influences 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 Working (1949) viewpoint, to higher levels of hedgers' hedging pressure, where hedging pressure measures the propensity of market participants to be net long.

By so doing, the Hirshleifer (1990) generalized hedging pressure hypothesis synthesises 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 sort our cross section of commodity futures on each contract's hedging pressure and then implement either a single or a double sort that buys backwardated commodities (whose prices are expected to appreciate) and sells contangoed commodities (whose prices are expected to depreciate). The single sort uses as signal for asset allocation either the hedging pressure of hedgers or that of speculators,[7] while the double sort combines the positions of both types of traders. As the hedging pressure hypothesis does not specify investment horizon, we 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 the commodity futures risk premium. Over the period analysed (1992-2011), our fully-collateralized hedging pressure long-short portfolios present Sharpe ratios that range from 0.25 to 0.79 with an average at 0.51. By contrast, a long-only equally-weighted portfolio of all commodities generates a Sharpe ratio of only 0.05. That of the S&P-GSCI stands at merely 0.20.[8] The best risk-adjusted performance is achieved when the ranking and holding periods are set to

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.* (2008) 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.

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.

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).

8 The Sharpe ratios of the hedger-based portfolios (with a range of [0.43,0.70]) exceed those of long-only commodity portfolios (at most, 0.20), which gives support to the first sub-hypothesis of Chang (1985) concerning naïve speculators meeting hedging demand. The second sub-hypothesis concerning informed speculators is supported too: the Sharpe ratios of the long-short speculator-based portfolios range from 0.30 to 0.74, thus exceeding those of long-only commodity portfolios. Yet, the speculator based portfolios do not outperform the hedger-based portfolios, suggesting that speculators only earn a compensation for providing risk-bearing capacity to hedgers.

26 weeks and when the allocation is based on a double sort that uses first the hedging pressure of hedgers and second that of speculators. Then the Sharpe ratio of the long-short portfolio stands at 0.79 and its mean excess return equals 8.23% a year (t-statistic of 3.35). By contrast, a long-only equally-weighted portfolio of all commodities generates an annualized mean excess return of only 0.64% (t-statistics of 0.23). That of the S&P-GSCI merely stands at 4.28% (t-statistic of 0.84).

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 commodity risk rises. Second, the cross-sectional prices of commodity risk associated with the hedging pressure risk premiums are found to be positive and often significant, while the price of risk associated with the S&P-GSCI is zero, both statistically and economically. Third, 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 come at the cost of losing the inflation hedge that is naturally provided by commodities (Bodie and Rosansky, 1980; Bodie, 1983). Fourth, our hedging pressure risk premiums explain the performance of active commodity strategies better than long-only commodity benchmarks.

To conclude, it seems critical to use the information contained in the positions of hedgers and speculators if we are to properly model the time-series and cros-ssectional properties of the commodity futures risk premium. A failure to account for hedging pressure results in the misleading conclusion that there is no risk premium or risk transfer in commodity futures markets and to the wrong impression that active commodity strategies provide abnormal positive returns. For these reasons we suggest that our hedging pressure portfolios be used as a building block for strategic asset allocation and as benchmarks for performance evaluation of professional money managers (i.e., CTAs, CPOs and hedge funds).

The rest of the paper is organised as follows. Section 2 presents the data. Section 3 highlights the methodology used to capture the hedging pressure risk premium and looks at its time-series properties. Section 4 studies the cross-sectional pricing of the risk premium and Section 5 its role for strategic asset allocation (namely, its diversification properties and role as inflation hedge). Section 6 tests the ability of the hedging pressure risk premiums to explain the performance of active strategies commonly implemented in commodity futures markets. Finally, Section 7 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 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 (blendstock RBOB gasoline, electricity, 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. 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.

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) traders. 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.

Hedging pressure for a category (say, speculators) is defined as the number of long contracts in that category divided by the total number of contracts in the category. For example, a hedging pressure of 0.3 for hedgers means that over the previous week 30% of hedgers were long and thus 70% were short, a sign of a backwardated market. Vice versa, a hedging pressure of 0.3 for speculators means that over the previous week 30% of speculators were long and thus 70% were short, a sign of a contangoed market.

3. Time-Series Properties of the Commodity Futures Risk Premium

3.1. Methodology

Our methodology aims at capturing the risk premium predicted by the hedging pressure theory of Hirshleifer (1990). As the theory assumes that risk premiums are present in both backwardated and contangoed markets, the approach does not just buy backwardated commodity futures for which hedgers are net short or/and speculators are net long. It also shorts contangoed commodity futures for which hedgers are net long or/and speculators are net short.

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.[10] For the hedger-based portfolio, we go long the 15% of the cross section with the lowest hedgers' average hedging pressure (as this sort corresponds to backwardation) and short the 15% of the cross section with the highest average hedgers' hedging pressure (as this sort corresponds to contango). The resulting long-short portfolio is labelled $Low_{Hedg} - High_{Hedg}$, 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 (backwardation) and shorts the 15% of the cross section with the lowest average speculators' hedging pressure (contango) over the previous R weeks. Following similar notation, the resulting long-short portfolio is labelled $High_{Spec} - Low_{Spec}$. 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, Low_{Hedg} is presumably 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 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

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 - 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.

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 analyse 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% most backwardated commodities and short positions in the 15% contangoed commodities.[11] 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 collateralised, meaning that half of the trading capital is invested into risk-free assets for the long portfolios and likewise for the short portfolios. As a result, the 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 1 and 2 present summary statistics for the excess returns of the fully-collateralised backwardated, contangoed and long-short portfolios. More specifically, Table 1 summarises 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 2 reports the same information for the double-sort portfolios which combine both signals. 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.

Table 1: Single-Sort Risk Premiums Based on either the Positions of Hedgers or the Positions of Speculators

The table presents summary statistics for the fully-collateralised 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" and "SD" are the annualised mean and annualised standard deviation of the excess returns of the portfolios. Sharpe is the ratio of Mean to SD. "Significant at 5%" presents the percentage of mean excess returns that are significant at the 5% level. EW stands for equally-weighted.

	Long				Short				Long-Short			
	Mean	*t*-stat	SD	Sharpe	Mean	*t*-stat	SD	Sharpe	Mean	*t*-stat	SD	Sharpe
Panel A: Portfolios based on hedgers' positions												
R = 4, H = 4	0.0557	1.20	0.1999	0.2784	-0.0430	-1.18	0.1564	-0.2750	0.0493	1.87	0.1133	0.4356
R = 4, H = 13	0.0790	1.76	0.1931	0.4093	-0.0529	-1.42	0.1596	-0.3311	0.0660	2.58	0.1099	0.6000
R = 4, H = 26	0.1024	2.23	0.1973	0.5188	-0.0546	-1.44	0.1633	-0.3340	0.0785	2.99	0.1126	0.6965
R = 4, H = 52	0.1033	2.24	0.1981	0.5211	-0.0186	-0.49	0.1627	-0.1145	0.0609	2.36	0.1110	0.5490
R = 13, H = 4	0.0701	1.53	0.1964	0.3570	-0.0460	-1.23	0.1603	-0.2873	0.0581	2.22	0.1118	0.5193
R = 13, H = 13	0.0854	1.86	0.1960	0.4355	-0.0383	-1.04	0.1572	-0.2436	0.0618	2.38	0.1111	0.5567
R = 13, H = 26	0.0709	1.55	0.1958	0.3621	-0.0392	-1.06	0.1583	-0.2478	0.0551	2.12	0.1109	0.4965
R = 13, H = 52	0.0833	1.84	0.1942	0.4289	-0.0244	-0.68	0.1535	-0.1593	0.0539	2.11	0.1094	0.4922
R = 26, H = 4	0.0772	1.66	0.1972	0.3914	-0.0566	-1.54	0.1565	-0.3618	0.0669	2.57	0.1105	0.6055
R = 26, H = 13	0.0759	1.65	0.1957	0.3880	-0.0553	-1.49	0.1573	-0.3515	0.0656	2.51	0.1113	0.5896
R = 26, H = 26	0.0744	1.63	0.1942	0.3830	-0.0525	-1.44	0.1548	-0.3390	0.0634	2.47	0.1092	0.5808
R = 26, H = 52	0.0780	1.70	0.1948	0.4005	-0.0188	-0.54	0.1484	-0.1267	0.0484	1.89	0.1087	0.4452
R = 52, H = 4	0.0706	1.50	0.1967	0.3591	-0.0237	-0.64	0.1549	-0.1528	0.0472	1.79	0.1106	0.4264
R = 52, H = 13	0.0722	1.56	0.1942	0.3718	-0.0241	-0.66	0.1522	-0.1582	0.0481	1.85	0.1088	0.4425
R = 52, H = 26	0.0653	1.40	0.1954	0.3344	-0.0371	-1.05	0.1486	-0.2496	0.0512	2.01	0.1066	0.4804
R = 52, H = 52	0.0561	1.25	0.1889	0.2972	-0.0485	-1.34	0.1519	-0.3195	0.0523	2.09	0.1049	0.4991
Average	0.0762		0.1955	0.3898	-0.0396		0.1560	-0.2532	0.0579		0.1100	0.5260
Significant at 5%		12.50%				0%				75%		

11 - We also form portfolios with 40% (50%) of the cross section available at the time of portfolio formation, taking long positions in the 20% (25%) most backwardated commodities and short positions in the 20% (25%) most contangoed commodities. The conclusions of the paper remain unchanged and the results are available upon request.

Panel B: Portfolios based on speculators' positions												
R = 4, H = 4	0.0453	1.00	0.1939	0.2334	-0.0467	-1.11	0.1810	-0.2582	0.0460	1.76	0.1124	0.4091
R = 4, H = 13	0.0247	0.58	0.1834	0.1346	-0.0402	-0.95	0.1823	-0.2207	0.0325	1.28	0.1087	0.2986
R = 4, H = 26	0.0552	1.22	0.1940	0.2845	-0.0517	-1.20	0.1850	-0.2797	0.0535	2.03	0.1133	0.4720
R = 4, H = 52	0.0602	1.41	0.1830	0.3290	-0.0393	-0.95	0.1784	-0.2204	0.0498	2.00	0.1071	0.4647
R = 13, H = 4	0.0329	0.77	0.1838	0.1791	-0.0606	-1.38	0.1883	-0.3218	0.0468	1.79	0.1120	0.4176
R = 13, H = 13	0.0545	1.26	0.1854	0.2941	-0.0656	-1.48	0.1898	-0.3454	0.0600	2.28	0.1128	0.5321
R = 13, H = 26	0.0718	1.63	0.1887	0.3808	-0.0480	-1.14	0.1810	-0.2654	0.0599	2.26	0.1137	0.5272
R = 13, H = 52	0.0399	0.94	0.1814	0.2199	-0.0632	-1.46	0.1856	-0.3402	0.0515	1.98	0.1114	0.4624
R = 26, H = 4	0.0840	1.94	0.1839	0.4566	-0.0667	-1.50	0.1895	-0.3521	0.0753	2.93	0.1092	0.6899
R = 26, H = 13	0.0616	1.40	0.1867	0.3302	-0.0692	-1.59	0.1847	-0.3747	0.0654	2.48	0.1120	0.5842
R = 26, H = 26	0.0775	1.75	0.1886	0.4110	-0.0790	-1.88	0.1789	-0.4417	0.0783	3.13	0.1062	0.7366
R = 26, H = 52	0.0575	1.42	0.1726	0.3334	-0.0222	-0.52	0.1815	-0.1224	0.0399	1.63	0.1041	0.3831
R = 52, H = 4	0.0521	1.15	0.1905	0.2737	-0.0728	-1.68	0.1811	-0.4020	0.0625	2.42	0.1080	0.5784
R = 52, H = 13	0.0370	0.81	0.1912	0.1934	-0.0476	-1.10	0.1810	-0.2627	0.0423	1.69	0.1050	0.4024
R = 52, H = 26	0.0412	0.90	0.1924	0.2140	-0.0338	-0.77	0.1827	-0.1849	0.0375	1.50	0.1044	0.3590
R = 52, H = 52	0.0509	1.17	0.1820	0.2799	-0.0663	-1.56	0.1780	-0.3727	0.0586	2.52	0.0974	0.6018
Average	0.0529		0.1863	0.2842	-0.0546			-0.2978	0.0537		0.1086	0.4949
Significant at 5%		0%				0%				62.50%		
Panel C: Long-only portfolios												
EW	0.0064	0.12	0.2273	0.0529								
S&P-GSCI	0.0428	0.22	0.8448	0.1965								

Table 2: Double-Sort Risk Premiums Based on the Positions of both of Hedgers and Speculators
The table presents summary statistics for the fully-collateralised 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" and "SD" are the annualised mean and annualised standard deviation of the excess returns of the portfolios. Sharpe is the ratio of Mean to SD. "Significant at 5%" presents the percentage of mean excess returns that are significant at the 5% level. EW stands for equally-weighted.

	Long				Short				Long-Short			
	Mean	*t*-stat	SD	Sharpe	Mean	*t*-stat	SD	Sharpe	Mean	*t*-stat	SD	Sharpe
Panel A: Portfolios based on the positions of first hedgers and second speculators												
R = 4, H = 4	0.0390	0.87	0.1924	0.2028	-0.0496	-1.19	0.1799	-0.2757	0.0443	1.72	0.1108	0.3998
R = 4, H = 13	0.0143	0.34	0.1823	0.0787	-0.0404	-0.95	0.1824	-0.2215	0.0274	1.09	0.1078	0.2539
R = 4, H = 26	0.0330	0.74	0.1911	0.1729	-0.0612	-1.43	0.1836	-0.3333	0.0471	1.82	0.1116	0.4222
R = 4, H = 52	0.0443	1.04	0.1836	0.2412	-0.0307	-0.75	0.1764	-0.1739	0.0375	1.55	0.1041	0.3601
R = 13, H = 4	0.0258	0.59	0.1854	0.1389	-0.0740	-1.70	0.1864	-0.3968	0.0499	1.94	0.1099	0.4537
R = 13, H = 13	0.0513	1.19	0.1841	0.2788	-0.0791	-1.79	0.1886	-0.4194	0.0652	2.49	0.1119	0.5825
R = 13, H = 26	0.0669	1.52	0.1879	0.3559	-0.0715	-1.73	0.1769	-0.4042	0.0692	2.67	0.1108	0.6243
R = 13, H = 52	0.0373	0.88	0.1819	0.2051	-0.0686	-1.62	0.1807	-0.3796	0.0530	2.10	0.1081	0.4899
R = 26, H = 4	0.0737	1.73	0.1808	0.4073	-0.0691	-1.57	0.1870	-0.3696	0.0714	2.82	0.1074	0.6648
R = 26, H = 13	0.0459	1.05	0.1859	0.2471	-0.0774	-1.83	0.1803	-0.4296	0.0617	2.41	0.1090	0.5660
R = 26, H = 26	0.0686	1.58	0.1852	0.3706	-0.0959	-2.30	0.1774	-0.5404	0.0823	3.35	0.1044	0.7883
R = 26, H = 52	0.0436	1.09	0.1706	0.2557	-0.0298	-0.70	0.1809	-0.1648	0.0367	1.54	0.1014	0.3620
R = 52, H = 4	0.0840	1.84	0.1910	0.4396	-0.0831	-1.97	0.1769	-0.4699	0.0836	3.27	0.1072	0.7797
R = 52, H = 13	0.0594	1.31	0.1903	0.3120	-0.0525	-1.24	0.1779	-0.2952	0.0560	2.23	0.1049	0.5334
R = 52, H = 26	0.0389	0.86	0.1907	0.2041	-0.0401	-0.92	0.1816	-0.2206	0.0395	1.58	0.1045	0.3779
R = 52, H = 52	0.0538	1.24	0.1817	0.2960	-0.0527	-1.22	0.1803	-0.2920	0.0532	2.26	0.0986	0.5399
Average	0.0487		0.1853	0.2629	-0.0610		0.1811	-0.3367	0.0549		0.1070	0.5124
Significant at 5%		0%				12.50%				56.25%		
Panel B: Portfolios based on the positions of first speculators and second hedgers												
R = 4, H = 4	0.0579	1.25	0.1991	0.2907	-0.0362	-0.96	0.1623	-0.2229	0.0470	1.77	0.1140	0.4123
R = 4, H = 13	0.0783	1.74	0.1939	0.4036	-0.0501	-1.29	0.1668	-0.3001	0.0642	2.43	0.1133	0.5663
R = 4, H = 26	0.1006	2.19	0.1978	0.5087	-0.0484	-1.25	0.1667	-0.2902	0.0745	2.80	0.1144	0.6512
R = 4, H = 52	0.1080	2.39	0.1939	0.5571	-0.0267	-0.69	0.1660	-0.1608	0.0674	2.69	0.1076	0.6257
R = 13, H = 4	0.0604	1.32	0.1961	0.3077	-0.0325	-0.85	0.1630	-0.1992	0.0464	1.78	0.1118	0.4153
R = 13, H = 13	0.0681	1.50	0.1942	0.3507	-0.0321	-0.86	0.1592	-0.2015	0.0501	1.97	0.1087	0.4609
R = 13, H = 26	0.0704	1.55	0.1946	0.3619	-0.0486	-1.28	0.1621	-0.3000	0.0595	2.31	0.1101	0.5407
R = 13, H = 52	0.0798	1.75	0.1950	0.4090	-0.0322	-0.87	0.1576	-0.2043	0.0560	2.18	0.1098	0.5100
R = 26, H = 4	0.0784	1.68	0.1979	0.3962	-0.0486	-1.29	0.1603	-0.3030	0.0635	2.42	0.1113	0.5701
R = 26, H = 13	0.0712	1.56	0.1944	0.3662	-0.0467	-1.22	0.1630	-0.2866	0.0589	2.22	0.1129	0.5222
R = 26, H = 26	0.0686	1.50	0.1938	0.3540	-0.0474	-1.25	0.1616	-0.2936	0.0580	2.21	0.1117	0.5194

R = 26, H = 52	0.0561	1.22	0.1951	0.2876	-0.0232	-0.65	0.1509	-0.1535	0.0396	1.55	0.1090	0.3637
R = 52, H = 4	0.0616	1.31	0.1965	0.3134	-0.0475	-1.24	0.1599	-0.2973	0.0546	2.04	0.1120	0.4869
R = 52, H = 13	0.0662	1.43	0.1946	0.3403	-0.0389	-1.04	0.1570	-0.2480	0.0526	1.99	0.1109	0.4739
R = 52, H = 26	0.0638	1.36	0.1970	0.3239	-0.0368	-0.98	0.1573	-0.2337	0.0503	1.90	0.1109	0.4533
R = 52, H = 52	0.0553	1.21	0.1923	0.2878	-0.0496	-1.30	0.1599	-0.3103	0.0525	2.03	0.1082	0.4850
Average	0.0715		0.1954	0.3662	-0.0403		0.1608	-0.2503	0.0559		0.1110	0.5036
Significant at 5%		12.50%				0%				75%		
Panel C: Long-only portfolios												
EW	0.0064	0.12	0.2273	0.0529								
S&P-GSCI	0.0428	0.22	0.8448	0.1965								

Irrespective of whether the sorting is based on hedgers' or speculators' positions, the excess returns of the single-sort long-short portfolios in Table 1 are always positive and often significant at the 5% level. The mean performance stands at 5.79% a year in Panel A and at 5.37% a year in Panel B. 75% (62.5%) of the 16 risk premiums are positive and significant at the 5% level in Panel A (Panel B). By contrast, none of the long-only portfolios earn positive and significant mean excess returns in Panel C. In both panels A and B, and in line with the prediction of the hedging pressure hypothesis, the fully-collateralised backwardated (contangoed) portfolios earn positive (negative), albeit insignificant, mean excess returns.

Table 2 presents summary statistics for the fully-collateralised double-sort portfolios, with Panel A sorting on the positions of first hedgers and second speculators and Panel B reversing the sorting order. The fully-collateralised longshort portfolios earn on average annualised mean excess returns of 5.49% (Panel A) and 5.59% (Panel B). 56.25% (75%) of the 16 risk premiums are positive and significant at the 5% level in Panel A (Panel B). By contrast, none of the long-only portfolios earn positive and significant mean returns in Panel C, suggesting that long-only positions in commodity futures markets are ill-suited to capturing a risk premium. As backwardation predicts, the backwardated portfolios earn positive (albeit insignificant) mean excess returns. As contango predicts, the annualised mean excess returns earned from consistently holding a long position in contangoed markets is negative, although often insignificant.

The average annualised volatility of the long-short portfolios (at 0.1092 across Panels A and B of Tables 1 and 2) is substantially less than that of long-only or shortonly portfolios: the long backwardated and short contangoed portfolios in Panels A and B have average annualised volatilities of 0.1906 and 0.1690, respectively; the long-only benchmarks in Panels C present an average annualised volatility of 0.5360. Thus, the Sharpe ratios of the long-short portfolios substantially exceed those of long-only benchmarks. The former range from 0.30 to 0.74 with a mean at 0.51 in Table 1 and from 0.25 to 0.79 with a mean of 0.51 in Table 2, while the later merely stand at 0.05 for the equally-weighted portfolio of all commodities and at 0.20 for the S&PGSCI (Panels C). While all long-short portfolios present higher Sharpe ratios than the long-only benchmarks of Panels C, the double-sort portfolio with R=H=26 weeks in Table 2, Panel A is particularly noteworthy (mean return of 8.23%, associated *t*-statistic of 3.35, Sharpe ratio of 0.79). This suggests that the best performance is achieved when the allocation is based on the hedging pressure of first hedgers and second speculators and when the ranking and holding periods are set to 26 weeks.

Clearly, allowing for short, as well as long, positions is important when it comes to capturing the risk premium present in commodity futures markets. Clearly also, dynamic trading beyond simple rebalancing 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 price of commodity risk or to assess the performance of active commodity portfolios. Not only do these benchmarks fail to recognise 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 (Litzenberger and Rabinowitz, 1995; Pindyck, 2004) suggest that changes in volatility could affect commodity price levels. Thus it seems fair to hypothesise 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

$$\begin{aligned} r_{Pt} &= \mu + \varepsilon_{Pt} \\ h_{Pt} &= \omega + \gamma\varepsilon^2_{Pt-1} + \eta I_{t-1}\varepsilon^2_{Pt-1} + \theta h_{Pt-1} \end{aligned} \tag{1}$$

where r_{Pt} is the excess return of an equally-weighted portfolio of all futures, $\varepsilon_{Pt} \sim N(0, h_{Pt})$, h_{Pt} is the conditional variance of returns, μ, ω, γ, η and θ are parameters to estimate and $I_{t-1} = 1$ if $\varepsilon_{Pt} < 0$ (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.[12]

$$RP_t = \alpha + \beta h_{Pt-1} + u_t \tag{2}$$

where RP_t are the hedging pressure risk premiums modelled in Section 3.1., α and β 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 β. t-tests, with a Newey and West (1987) correction of the standard errors, are then performed on the resulting vector of β 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 the hedging pressure risk premium and conditional volatility does not suffer from a look-ahead bias.

Table 3 reports the averages of the β coefficients from (2) for each of the hedging pressure risk premiums modelled in Section 3.1. It is clear from the table that, irrespective of the criterion used to allocate commodities to portfolios, higher conditional volatility leads to higher risk premium. On average, a 1% rise in weekly conditional volatility leads to a 0.96% rise in weekly risk premium across the various single and double sorts. This is consistent with the idea that in periods of high
volatility in commodity markets hedgers are willing to pay a higher cost for their insurance. Likewise, speculators in commodity futures markets demand a risk premium that is proportionate to the price risk they take on. If in place of the long-short hedging pressure risk premium 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 β coefficient relative to a long-only equally-weighted portfolio of all commodities (the S&P-GSCI) stands at 0.1710 (-0.7513) with an associated t-statistic at 0.54 (-1.27).

12 - 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.

Table 3: The Relationship between the Hedging Pressure Risk Premiums and the Conditional Volatility of Commodity Markets The table presents slope coefficients of regressions of the time-varying commodity 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 5%" presents the percentage of coefficients on lagged conditional volatility that are positive and significant at the 5% 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	0.6830	(1.56)	1.4906	(2.82)	1.1631	(2.81)	0.6917	(1.61)
R = 4, H = 13	0.4254	(1.37)	1.2744	(4.48)	1.2004	(4.17)	0.6205	(1.99)
R = 4, H = 26	0.7532	(2.01)	1.2363	(3.26)	1.7197	(4.40)	1.0381	(2.47)
R = 4, H = 52	1.3526	(2.74)	1.3244	(2.62)	1.4620	(2.99)	1.2348	(2.44)
R = 13, H = 4	0.8781	(2.04)	1.2910	(3.41)	1.3569	(3.64)	0.7184	(1.96)
R = 13, H = 13	0.4719	(1.16)	1.4078	(2.49)	1.7550	(3.08)	0.1778	(0.50)
R = 13, H = 26	0.6744	(1.65)	1.1071	(1.94)	1.7030	(3.04)	0.5798	(1.41)
R = 13, H = 52	0.7797	(2.18)	1.4528	(2.49)	1.3728	(2.56)	1.2579	(3.22)
R = 26, H = 4	0.4568	(0.88)	1.6495	(2.94)	1.8959	(3.82)	0.9890	(1.96)
R = 26, H = 13	0.3848	(0.79)	1.8443	(2.76)	1.7798	(2.98)	0.5053	(0.98)
R = 26, H = 26	0.5315	(1.21)	1.7644	(3.03)	1.2970	(2.88)	0.6852	(1.51)
R = 26, H = 52	0.5666	(1.35)	0.0382	(0.08)	0.1768	(0.51)	0.4196	(0.95)
R = 52, H = 4	0.4906	(1.12)	0.7971	(0.98)	0.9056	(1.73)	0.6658	(1.27)
R = 52, H = 13	0.4573	(1.03)	0.8155	(1.11)	0.7686	(1.60)	0.6152	(1.12)
R = 52, H = 26	0.4968	(1.09)	0.8010	(1.10)	1.2652	(2.67)	0.9493	(1.72)
R = 52, H = 52	0.4758	(1.13)	0.6790	(0.99)	0.9673	(2.33)	0.7709	(1.47)
Average	0.6174		1.1858		1.2993		0.7449	
Positive and significant at 5%		25%		62.50%		81.25%		31.25%

4. Cross-Sectional Pricing of Commodity Futures Returns

While the evidence presented thus far centre around the time-series properties of the commodity risk premiums, this section focuses on its cross-sectional properties. We assume that commodity futures returns are driven by the linear factor model

$$R_t = E(R) + \mathrm{B} \times RP_t + t_t \tag{3}$$

where R_t is a N-vector of commodity futures excess returns, E(.) is the expectation operator, B is the N-vector of sensitivities of commodity futures excess returns to the hedging pressure risk premium RP_t modelled in Section 3, t_t is an N-vector of error terms. Given a set of simplifying assumptions and under the no-arbitrage condition, the following risk-return relationship holds

$$E(R) = B\lambda \tag{4}$$

where λ is the price of commodity risk associated with the hedging pressure risk premium RP_t. Combining (3) and (4) yields

$$R_t = B\lambda + \mathrm{B} \times RP_t + \varepsilon_t \tag{5}$$

We use NLSUR (non-linear seemingly unrelated regression) developed by McElroy *et al.* (1985) to estimate both the quantities of risk, *B*, and the price of risk, l, in (5). This approach has two major advantages relative to the traditional Fama and MacBeth (1973) approach traditionally employed in the asset pricing literature (e.g., Bessembinder, 1992). First, NLSUR simultaneously estimates *B* and λ and consequently eliminates the errors-in-variables (EIV) problem present in the two-step methodology of Fama and McBeth (1973). This is critical as the construction of portfolios to solve the EIV problem is impossible given our limited cross section.[13]

13 - Besides, in the case of commodity futures, the choice of a criterion to sort contracts into portfolios is not obvious. NLSUR solves this problem as the methodology can be directly applied to individual assets instead of portfolios of assets (as in Fama and MacBeth, 1973).

Second, NLSUR allows for the residuals variance-covariance matrix to be non-diagonal; i.e., allows for some weak cross-sectional co-variations in idiosyncratic commodity returns. This feature is important in our setting as modelling the impact of idiosyncratic shocks on commodity returns is likely to matter for commodities that belong to the same family or have the same style (e.g., soy complex, energy, precious metals).

Table 4 presents the prices of risk associated with the hedging pressure risk premium for each of the two single sorts and each of the two double sorts. In total, since we have 16 combinations of ranking and holding periods, we end up with 16 estimates of the price of commodity risk for each of the single or double sorts; or 64 estimates. The price of commodity risk is always positive and significant 53% of the time at the 1% level and 84% at the 5% level. Interestingly when the S&P-GSCI is used as RP_t in place of the hedging pressure risk premiums in (5), the weekly price of commodity risk is zero both in economic and statistical terms (-0.00 with a t-statistic of -0.28). This result highlights the need to take both long and short positions (based on hedging pressure) to accurately capture the commodity futures risk premium. A failure to take the positions of hedgers and speculators into account results in the misleading conclusion that there is no risk premium in commodity futures markets.

Table 4: Cross-Sectional Pricing of the Commodity Risk Premiums

The table reports the prices of commodity risk associated with the hedging pressure risk premiums. The numbers in parentheses are the associated t-statistics. R (H) is the number of weeks in the ranking (holding) period. "Positive and significant at 5%" presents the percentage of prices of risk that are positive and significant at the 5% 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	0.0012	(2.16)	0.0024	(2.71)	0.0023	(2.71)	0.0013	(2.29)
R = 4, H = 13	0.0011	(2.05)	0.0033	(3.46)	0.0034	(3.64)	0.0011	(2.05)
R = 4, H = 26	0.0016	(2.79)	0.0037	(3.69)	0.0036	(3.73)	0.0016	(3.00)
R = 4, H = 52	0.0009	(1.46)	0.0028	(2.60)	0.0030	(2.77)	0.0009	(1.45)
R = 13, H = 4	0.0010	(1.90)	0.0031	(3.43)	0.0032	(3.64)	0.0012	(2.32)
R = 13, H = 13	0.0011	(2.31)	0.0024	(2.87)	0.0025	(2.98)	0.0012	(2.37)
R = 13, H = 26	0.0014	(2.50)	0.0030	(3.62)	0.0029	(3.43)	0.0013	(2.41)
R = 13, H = 52	0.0011	(1.92)	0.0017	(1.85)	0.0018	(1.96)	0.0010	(1.88)
R = 26, H = 4	0.0010	(1.98)	0.0025	(2.74)	0.0028	(3.04)	0.0012	(2.27)
R = 26, H = 13	0.0006	(1.27)	0.0026	(3.40)	0.0027	(3.52)	0.0010	(1.89)
R = 26, H = 26	0.0010	(2.06)	0.0026	(2.95)	0.0026	(3.04)	0.0015	(2.68)
R = 26, H = 52	0.0012	(2.46)	0.0026	(3.06)	0.0026	(3.15)	0.0014	(2.78)
R = 52, H = 4	0.0016	(3.14)	0.0016	(2.20)	0.0016	(2.26)	0.0016	(2.97)
R = 52, H = 13	0.0017	(3.50)	0.0019	(2.46)	0.0019	(2.55)	0.0016	(3.22)
R = 52, H = 26	0.0013	(2.80)	0.0021	(3.11)	0.0021	(3.20)	0.0013	(2.59)
R = 52, H = 52	0.0005	(1.11)	0.0019	(2.46)	0.0019	(2.46)	0.0004	(0.83)
Average	0.0011		0.0025		0.0026		0.0012	
Positive and significant at 5%		68.75%		93.75%		100%		75%

5. Strategic Role of the Hedging Pressure Commodity 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). Figures 1, 2 and 3 report correlations between the total returns of long-short or long-only fully-collateralised commodity portfolios and those of three traditional asset classes (3-month Treasury-bill rate, Barclays Capital US Aggregate Bond Index and S&P500 Composite Index).[14] Figure 4 reports the correlations between monthly unexpected inflation[15] and monthly total returns of either long-short or long-only fully-collateralised commodity portfolios.

Figure 1: Return correlation between commodity portfolios and 3 month T-bill rate

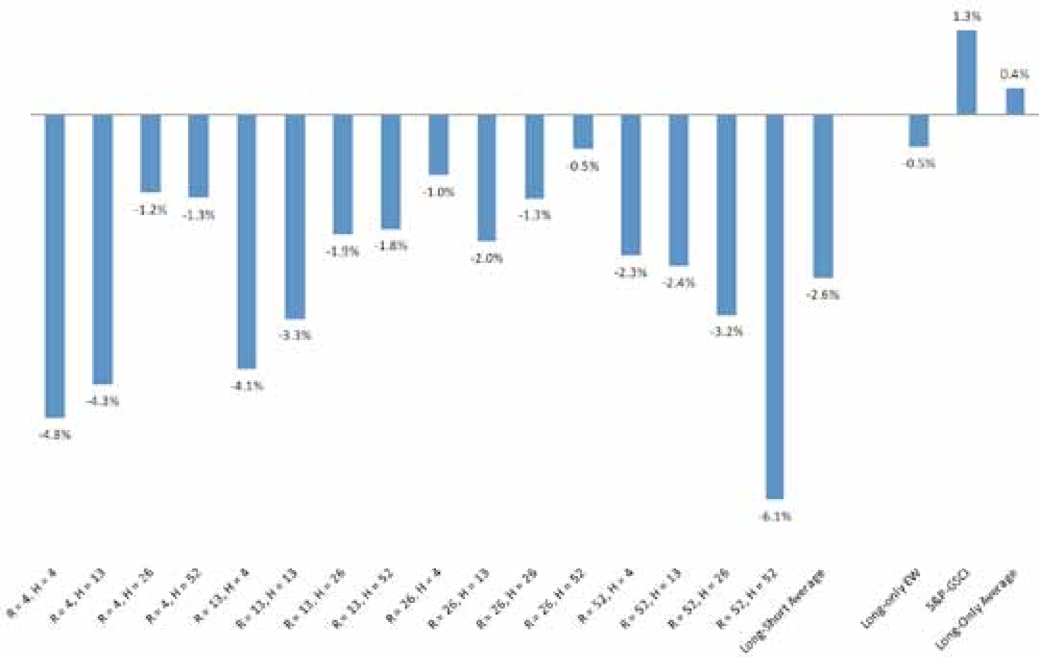
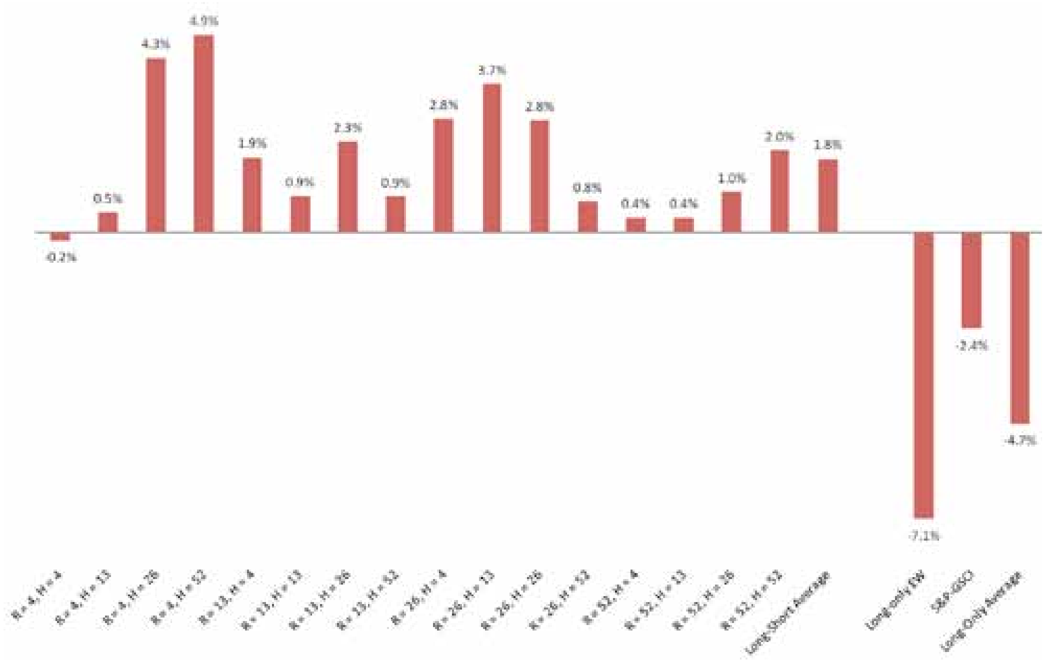


Figure 2: Return correlation between commodity portfolios and Barclays US Aggregate Bond Index



14 - While the results presented in Figures 1 to 4 focus on the hedger-based long-short portfolios, similar results, available upon request, were obtained with the other hedging pressure risk premiums.
15 - 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.

Figure 3: Return correlation between commodity portfolios and S&P500 Composite Index

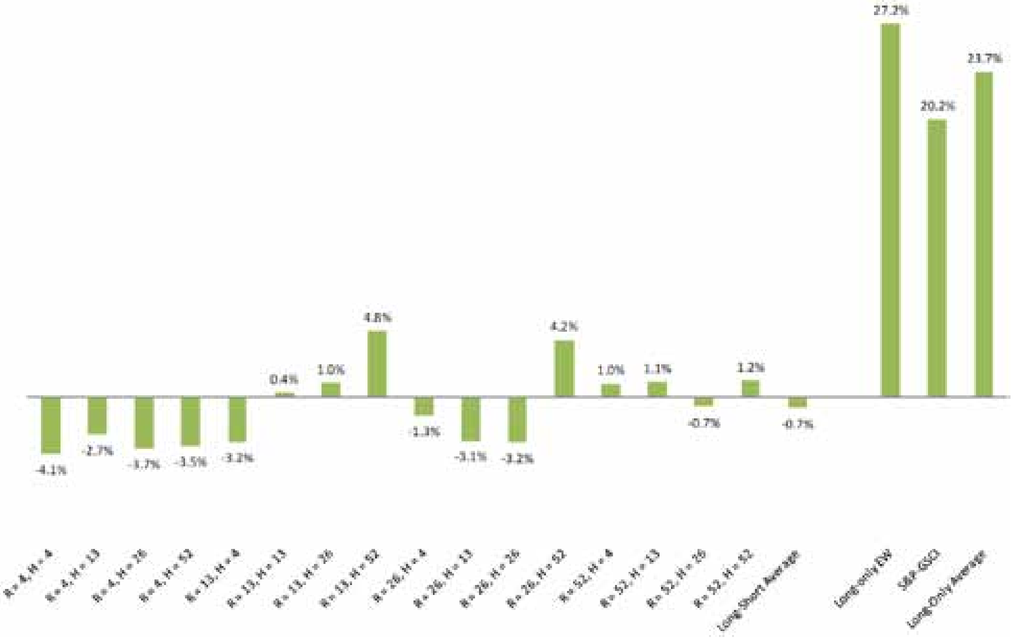
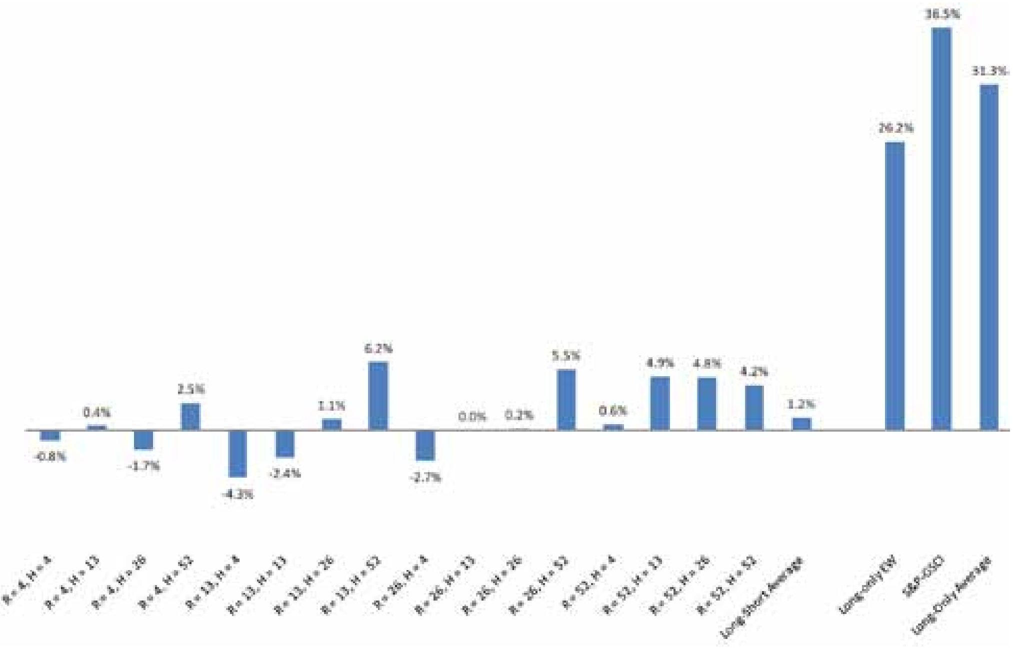


Figure 4: Correlation between commodity returns and inflation shocks



Figures 1 to 4 report correlation coefficients between the total returns of hedger-based portfolios and three traditional asset classes or unexpected inflation. The correlations relative to two long-only commodity portfolios are also reported on the right-hand sides of the figures. R (H) is the number of weeks in the ranking (holding) period of the hedger-based long-short portfolio.

Figures 1 shows that the correlations between 3-month Treasury bill returns and commodity returns are of similar magnitude irrespective of whether investors take long-only or long-short positions in commodity futures markets. A similar conclusion applies to Figure 2 when the total returns of Barclays bond index is used in place the 3-month Treasury bill rate. Figure 3, however, shows that the correlations between the S&P500 index and long-short commodity portfolios (at -0.7% on average) are much lower than those measured relative to long-only commodity indices (at 23.7% on average). Altogether the three figures indicate that, while both long-only and long-short commodity indices act as good diversifiers to 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 indices present a clear advantage relative to their long-short counterparts. Figure 4 indeed shows that the correlations between the total returns of the long-short hedging pressure portfolios and unexpected inflation average out at 1.2%, while the correlations between the total returns of long-only commodity benchmarks and unexpected inflation exceed 26%. 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.

6. Revisiting the Performance of Active Commodity Strategies

The profitability of commodity-based momentum strategies is now well documented (Erb and Harvey, 2006; Miffre and Rallis, 2007; Shen *et al.*, 2007; Szakmary *et al.* 2010). Gorton *et al.* (2008) argue that the momentum returns are a compensation for bearing inventory risk. It is thus natural to analyse whether our hedging pressure risk premiums explain these returns too, particularly as Miffre and Rallis (2007) report that momentum portfolios go long backwardated commodities and short contangoed ones. Along the same line, we test whether our hedging pressure risk premiums explain part of the performance of two other active strategies that have been shown to work well in commodity markets: 1. the term structure strategy of Erb and Harvey (2006) and Gorton and Rouwenhorst (2006) and 2. the double-sort strategy based on momentum and term structure of Fuertes *et al.* (2010). Section 6 starts with a brief description of the methodologies employed to form these active portfolios.

6.1. Methodology

The single-sort momentum portfolios consist of long positions in the 15% of commodity futures with the best mean returns over the previous *R* weeks (winners) and short positions in the 15% 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.

Following Erb and Harvey (2006) or Gorton and Rouwenhorst (2006), the single-sort term structure portfolios consist of long positions in the 15% of commodity futures with the highest average roll-returns over the previous *R* weeks and short positions in the 15% of commodity futures with the lowest average roll-returns over the previous *R* weeks. 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.

The double-sort strategy that combines the momentum and term structure signals follows from Fuertes *et al.* (2010). The available cross section is first split into winner and loser portfolios based on mean returns over the previous *R* weeks using the 50% breakpoint. We then form two portfolios: the first one, called *Winner-High*, contains the 30% of the constituents of the winner portfolio with the highest average roll-returns over the ranking period and the second one, called *Loser-Low*, containing the 30% of the constituents of the loser portfolio with the lowest average roll-returns over the ranking period. The double-sort portfolio buys *Winner-High*, shorts *Loser-Low* and holds the position over the next *H* weeks. Since it was arbitrary to sort on, first, momentum and, second, roll-returns, we reverse the sorting order, buying the *High-Winner* portfolio and shorting the *Low-Loser* portfolio.

For the sake of consistency with the hedging pressure risk premiums modeled in Section 3, all the active portfolios of Section 6 present the following characteristics. They are formed from permutations of 4 ranking and 4 holding periods (set to 4, 13, 26 or 52 weeks). As before, these combinations generate 16 single-sort portfolios based on momentum, 16 single-sort portfolios based on term structure and 32 double-sort portfolios. As in Section 3, the constituents of the long-short portfolios are equally-weighted and the active long-short portfolios are fully collateralised.

6.2. Preliminary Results

Table 5 presents summary statistics on the performance of active portfolios. As previously reported (e.g., Fuertes *et al.*, 2010), the momentum and term structure strategies convey useful signals on which to tactically allocate wealth. On a fully-collateralised basis, the momentum portfolios perform the worst (mean excess returns of 2.35% a year), followed by the term structure portfolios (mean excess return of 4.35%) and double-sort portfolios (mean excess return of 5.05%). 12.5% of the momentum portfolios, 37.50% of the term structure portfolios and 46.88% of the double-sort portfolios offer positive mean excess returns that are significant at the 5% level or better. On a risk-adjusted basis, the double-sort strategies that combine momentum and term structure signals are confirmed to be the most profitable, with average Sharpe ratios of 0.43 (compared to 0.28 for the strategies that use either one of the two signals in isolation).

Table 5: Summary Statistics for Active Portfolios

The table presents summary statistics for four types of fully-collateralised active commodity strategies, based on a momentum signal, the term structure (TS) of commodity futures prices or a combination of the two signals. R (H) is the number of weeks in the ranking (holding) period."Mean" is the annualised mean of the excess returns of the portfolio. Sharpe is the ratio of Mean to the standard deviation of these excess returns. "Significant at 5%" presents the percentage of mean excess returns that are significant at the 5% level.

	Momentum strategy			Term structure (TS) strategy			Double-sort strategy based on first momentum and then TS			Double-sort strategy based on first TS and then momentum		
	Mean	*t*-stat	Sharpe	Mean	*t*-stat	Sharpe	Mean	*t*-stat	Sharpe	Mean	*t*-stat	Sharpe
R = 4, H = 4	0.0065	0.20	0.0465	0.0519	1.98	0.4611	0.0565	2.07	0.4807	0.0636	2.16	0.5016
R = 4, H = 13	0.0183	0.59	0.1380	0.0514	1.99	0.4637	0.0408	1.55	0.3611	0.0665	2.34	0.5448
R = 4, H = 26	-0.0073	-0.25	-0.0593	0.0829	3.36	0.7810	0.0485	1.95	0.4540	0.0621	2.28	0.5298
R = 4, H = 52	-0.0190	-0.65	-0.1516	0.0793	2.95	0.6870	0.0557	2.20	0.5110	0.0616	2.29	0.5326
R = 13, H = 4	0.0844	2.49	0.5819	0.0419	1.64	0.3836	0.0893	3.22	0.7527	0.0879	2.92	0.6820
R = 13, H = 13	0.0587	1.85	0.4334	0.0587	2.27	0.5306	0.0763	2.90	0.6772	0.0923	3.12	0.7300
R = 13, H = 26	-0.0128	-0.42	-0.0985	0.0422	1.62	0.3775	0.0399	1.52	0.3553	0.0323	1.14	0.2668
R = 13, H = 52	-0.0238	-0.76	-0.1769	0.0488	1.88	0.4383	0.0294	1.11	0.2597	0.0049	0.17	0.0399
R = 26, H = 4	0.0452	1.35	0.3172	0.0486	1.90	0.4460	0.0570	2.13	0.5022	0.0694	2.21	0.5204
R = 26, H = 13	0.0180	0.55	0.1303	0.0543	2.10	0.4940	0.0491	1.83	0.4307	0.0386	1.26	0.2968
R = 26, H = 26	-0.0100	-0.32	-0.0747	0.0398	1.49	0.3511	0.0182	0.66	0.1555	0.0309	1.02	0.2393
R = 26, H = 52	0.0242	0.79	0.1856	0.0182	0.65	0.1532	0.0211	0.75	0.1758	0.0199	0.66	0.1545
R = 52, H = 4	0.0799	2.47	0.5900	0.0294	1.13	0.2706	0.0640	2.44	0.5819	0.0930	3.07	0.7336
R = 52, H = 13	0.0464	1.46	0.3480	0.0170	0.64	0.1520	0.0408	1.57	0.3756	0.0657	2.24	0.5356
R = 52, H = 26	0.0341	1.08	0.2572	0.0134	0.51	0.1215	0.0222	0.86	0.2061	0.0376	1.29	0.3087
R = 52, H = 52	0.0328	1.08	0.2569	0.0173	0.69	0.1641	0.0394	1.60	0.3808	0.0419	1.52	0.3622
Average	0.0235		0.1703	0.0435		0.3922	0.0468		0.4163	0.0543		0.4362
Significant at 5%		12.50%			37.50%			37.50%			56.25%	

Table 6, Panel A presents the average hedgers' hedging pressures of the long and short active portfolios, where these hedging pressures are measured over the holding periods of the active strategies considered. Table 6 Panel B presents the same information for the speculators' hedging pressure. For the hedging pressure benchmarks to explain the performance of active strategies, the long active portfolios should have over the holding periods low hedgers' hedging pressure and high speculators' hedging pressure, as these are characteristics of backwardated assets. Vice versa, the short active portfolios should have high hedgers' hedging pressure and low speculators' hedging pressure, as these are characteristics of contangoed assets.

Table 6: Average Hedging Pressure of Active Long and Short Portfolios

Panel A presents the average over the holding periods of the hedgers' hedging pressure of the long (L) and short (S) active portfolios. Panel B presents the same information but with regards to speculators' hedging pressure. R (H) is the number of weeks in the ranking (holding) period of the active strategies. The column labelled H_0: L=S presents t-statistics for the null hypothesis that the hedging pressure of the long portfolio equals that of the short portfolio. "Positive (Negative) at 5%" presents the percentage of active strategies for which the difference in these hedging pressures is positive (negative) and significant at the 5% level.

	Momentum strategy			Term structure (TS) strategy			Double-sort strategy based on first momentum and then TS			Double-sort strategy based on first TS and then momentum		
	Long (L)	Short (S)	H_0: L=S	Long (L)	Short (S)	H_0: L=S	Long (L)	Short (S)	H_0: L=S	Long (L)	Short (S)	H_0: L=S
Panel A: Hedgers' Hedging Pressure												
R = 4, H = 4	0.3890	0.4711	-26.16	0.4420	0.4412	0.26	0.4108	0.4651	-18.37	0.3944	0.4681	-22.57
R = 4, H = 13	0.4144	0.4603	-14.79	0.4490	0.4413	2.62	0.4321	0.4507	-5.94	0.4076	0.4555	-13.06
R = 4, H = 26	0.4278	0.4465	-6.17	0.4415	0.4447	-1.21	0.4240	0.4523	-9.36	0.4096	0.4625	-15.99
R = 4, H = 52	0.4347	0.4446	-3.27	0.4419	0.4418	0.02	0.4406	0.4483	-2.56	0.4079	0.4596	-16.46
R = 13, H = 4	0.3881	0.4832	-31.31	0.4456	0.4414	1.52	0.4081	0.4626	-17.92	0.3972	0.4761	-24.70
R = 13, H = 13	0.4068	0.4678	-17.70	0.4432	0.4400	1.23	0.4102	0.4538	-14.37	0.4085	0.4624	-15.57
R = 13, H = 26	0.4148	0.4531	-10.73	0.4411	0.4353	2.27	0.4164	0.4432	-9.16	0.4163	0.4487	-9.51
R = 13, H = 52	0.4152	0.4570	-12.03	0.4501	0.4405	3.02	0.4177	0.4414	-7.68	0.4089	0.4437	-10.05
R = 26, H = 4	0.4011	0.4804	-25.86	0.4462	0.4382	2.99	0.4146	0.4591	-14.87	0.3995	0.4721	-22.51
R = 26, H = 13	0.4145	0.4627	-15.47	0.4470	0.4375	3.56	0.4226	0.4480	-9.05	0.4108	0.4579	-14.44
R = 26, H = 26	0.4274	0.4527	-7.83	0.4503	0.4344	5.51	0.4260	0.4383	-4.37	0.4154	0.4518	-11.42
R = 26, H = 52	0.4191	0.4568	-11.06	0.4495	0.4425	2.50	0.4168	0.4400	-7.70	0.4113	0.4481	-10.09
R = 52, H = 4	0.4061	0.4670	-18.39	0.4464	0.4406	2.15	0.4262	0.4505	-8.57	0.4091	0.4663	-17.16
R = 52, H = 13	0.4187	0.4554	-10.77	0.4499	0.4388	4.15	0.4308	0.4441	-4.44	0.4168	0.4582	-12.00
R = 52, H = 26	0.4234	0.4447	-6.26	0.4541	0.4408	4.86	0.4429	0.4400	0.99	0.4225	0.4503	-8.23
R = 52, H = 52	0.4287	0.4380	-3.06	0.4526	0.4382	5.16	0.4501	0.4330	5.38	0.4325	0.4441	-3.58
Average	0.4144	0.4588		0.4469	0.4398		0.4244	0.4482		0.4105	0.4578	
Negative at 5%			100%			0%			87.50%			100%
Positive at 5%			0%			68.75%			6.25%			0%
Panel B: Speculators' Hedging Pressure												
R = 4, H = 4	0.7136	0.5102	40.43	0.6442	0.5829	13.56	0.6947	0.5328	35.07	0.7073	0.5160	40.54
R = 4, H = 13	0.6726	0.5291	27.36	0.6346	0.5791	12.06	0.6551	0.5458	23.23	0.6709	0.5323	26.94
R = 4, H = 26	0.6370	0.5564	15.71	0.6355	0.5761	12.30	0.6527	0.5633	19.90	0.6550	0.5415	22.87
R = 4, H = 52	0.6164	0.5778	7.86	0.6247	0.5840	7.46	0.6306	0.5687	12.52	0.6511	0.5550	19.93
R = 13, H = 4	0.7255	0.4700	54.58	0.6338	0.5762	12.94	0.6972	0.5215	39.97	0.7085	0.4820	49.65
R = 13, H = 13	0.6972	0.5182	35.28	0.6371	0.5809	12.26	0.6812	0.5382	29.86	0.6840	0.5233	32.29
R = 13, H = 26	0.6834	0.5577	23.08	0.6366	0.5987	7.88	0.6639	0.5617	21.83	0.6731	0.5552	23.20
R = 13, H = 52	0.6588	0.5819	12.83	0.6134	0.5931	3.77	0.6446	0.5803	12.81	0.6640	0.5894	14.01
R = 26, H = 4	0.7045	0.4721	49.39	0.6323	0.5797	11.24	0.6788	0.5271	36.07	0.6978	0.4884	45.96
R = 26, H = 13	0.6762	0.5105	32.82	0.6252	0.5842	8.50	0.6598	0.5528	23.03	0.6738	0.5268	28.87
R = 26, H = 26	0.6460	0.5396	19.53	0.6174	0.5994	3.39	0.6506	0.5745	16.28	0.6592	0.5485	22.54
R = 26, H = 52	0.6360	0.5544	15.12	0.5974	0.6120	-2.81	0.6307	0.5973	6.79	0.6361	0.5782	11.41
R = 52, H = 4	0.6844	0.4921	43.96	0.6125	0.5921	4.21	0.6496	0.5486	22.83	0.6744	0.4989	41.79
R = 52, H = 13	0.6529	0.5184	28.23	0.6054	0.5955	2.00	0.6378	0.5614	16.50	0.6496	0.5184	27.94
R = 52, H = 26	0.6374	0.5471	17.36	0.5926	0.6014	-1.89	0.6131	0.5793	7.08	0.6325	0.5403	18.31
R = 52, H = 52	0.6211	0.5791	7.55	0.5930	0.6054	-2.68	0.6097	0.5991	1.99	0.6152	0.5666	8.50
Average	0.6664	0.5322		0.6210	0.5900		0.6531	0.5595		0.6658	0.5350	
Negative at 5%			0%			12.50%			0%			0%
Positive at 5%			100%			81.25%			100%			100%

The evidence presented in Table 6 support these hypotheses for the single-sort momentum strategy and for the two double-sort strategies. For example, the hedgers' hedging pressure of the long momentum portfolios at 0.41 on average in Panel A is less than that of the short momentum portfolios at 0.46, with the difference that is negative and significant for all of the 16 momentum strategies studied. Similarly, the speculators' hedging pressure of the long momentum portfolios in Panel B exceeds that of the short momentum portfolios by an average of 0.13, a difference that is positive and significant for all of the momentum portfolios considered. This indicates that the hedging pressure benchmarks are good candidates for capturing part of the performance of momentum portfolios. The same conclusion applies to the two double-sort strategies based on momentum and term structure but does not extend to the single-sort term structure strategy for which the hedgers' hedging pressures of the long portfolios (at 0.45 on average in Panel A) significantly exceed those of the short portfolios (at 0.44 on average) for 68.75% of the term structure strategies considered. These results hint toward the conclusion that the hedger-based risk premiums are likely to explain the returns of the momentum and double-sort portfolios better than those of the term structure portfolios. We now turn our attention to this specific point.

6.3. Performance of Active Commodity Strategies

Table 7 compares the performance of these active portfolios to that of six sets of benchmarks. The first four sets are long-short, where we compare the performance of an active strategy with a given *R* and *H* to that of the hedging pressure benchmark with the same *R* and *H*. These long-short benchmarks are: 1. the single-sort hedger-based risk premiums; 2. The single-sort speculator-based risk premiums; 3. The double-sort risk premiums based on the positions of, first, hedgers and, second, speculators; and 4. The double-sort risk premiums based on the positions of, first, speculators and, second, hedgers. The last two benchmarks are long-only: these are a long-only equally-weighted portfolio of all commodities and the S&P-GSCI.

Table 7: Performance of Active Strategies Relative to a Set of Selected Benchmarks
Panel A reports the average difference in Sharpe ratios between the active portfolios and 6 sets of benchmarks (4 of which are long-short and the later 2 are long-only). Panel B reports the average annualised alphas of regressions of the excess returns of the active portfolios on either one of the 6 benchmarks excess returns. "% Positive" stands for the percentage of active portfolios that outperform their benchmark (at the 5% level if in italics).

	Momentum strategy		Term structure (TS) strategy		Double-sort based on first momentum and then TS		Double-sort based on first TS and then momentum		All active strategies	
	Average	% Positive	Average	% Positive	Average	% Positive	Average	% Positive	Average	% Positive
Panel A: Difference in Sharpe ratios between the active portfolios and the benchmarks										
Hedger benchmark	-0.3557	12.50%	-0.1338	18.75%	-0.1097	25%	-0.0898	31.25%	-0.1722	21.88%
Speculator benchmark	-0.3247	12.50%	-0.1027	25%	-0.0787	37.50%	-0.0588	50%	-0.1412	31.25%
Hedger-Speculator benchmark	-0.3421	6.25%	-0.1202	25%	-0.0961	37.50%	-0.0762	43.75%	-0.1587	28.13%
Speculator-Hedger benchmark	-0.3333	12.50%	-0.1114	25%	-0.0873	25%	-0.0674	31.25%	-0.1498	23.44%
Long-only EW portfolio	0.1174	62.50%	0.3393	100%	0.3634	100%	0.3833	93.75%	0.3009	89.06%
S&P-GSCI	-0.0263	43.75%	0.1957	75%	0.2198	87.50%	0.2397	87.50%	0.1572	73.44%
Panel B: Alphas relative to selected benchmarks										
Hedger benchmark	0.0080	*0%*	0.0371	*18.75%*	0.0341	*18.75%*	0.0359	*18.75%*	0.0288	*14.06%*
Speculator benchmark	0.0022	*6.25%*	0.0322	*12.50%*	0.0303	*12.50%*	0.0313	*31.25%*	0.0240	*15.63%*
Hedger-Speculator benchmark	0.0019	*0%*	0.0337	*12.50%*	0.0310	*18.75%*	0.0316	*25%*	0.0245	*14.06%*
Speculator-Hedger benchmark	0.0083	*6.25%*	0.0360	*18.75%*	0.0334	*12.50%*	0.0358	*18.75%*	0.0284	*14.06%*
Long-only EW portfolio	0.0230	*12.50%*	0.0433	*37.50%*	0.0465	*37.50%*	0.0539	*56.25%*	0.0417	*35.94%*
S&P-GSCI	0.0199	*12.50%*	0.0394	*25%*	0.0424	*37.50%*	0.0500	*56.25%*	0.0379	*32.81%*

Performance measurements are based on Sharpe ratios (Panel A) and on alphas from regressions of the active excess returns on the excess returns of either one of the selected benchmarks (Panel B). For example, the first entry in Panel A, -0.35, stands for the average difference in Sharpe ratios between the active momentum portfolios and the corresponding hedger-based benchmarks with 12.5% of the 16 active portfolios offering Sharpe ratios that exceed those of the corresponding 16 hedgerbased benchmarks. Similarly, the first entry in Panel B, 0.0080, measures the average alpha of the 16 momentum portfolios relative to the corresponding 16 hedger-based benchmarks, with none of these 16 alphas that is positive at the 5% level.

Irrespective of the panel considered, the conclusion from Table 7 is as follows: while it is rather easy to beat a long-only benchmark through active trading, it is fairly difficult to outperform an efficient benchmark that takes into account the propensity of futures markets to be either in backwardation or in contango. Take, for example, the difference in Sharpe ratios between the active portfolios and the benchmarks as reported on the right-hand side of Panel A. On average the Sharpe ratios of the active portfolios exceed that of the long-only equally-weighted benchmark (S&P-GSCI) by 0.30 (0.16) or 89.06% (73.44%) of the time. Based on this previously reported result (Fuertes *et al.*, 2010), one may be tempted to conclude that active trading is a source of outperformance in commodity futures markets. In fact, the active strategies do not look nearly as profitable relative to long-short benchmarks that take backwardation and contango into account. Then the Sharpe ratios of the active portfolios are higher than those of the corresponding long-short benchmarks only 26.17% of the time with a now negative average difference in Sharpe ratios (-0.16).

The same conclusion applies when we look at annualised alphas in Panel B. The alphas calculated relative to hedging pressure benchmarks tend to be smaller (at 2.64% a year on average) than those calculated relative to long-only benchmarks (3.98%). The percentage of alphas that are positive and significant at the 5% level drops from 34.38% (relative to long-only benchmarks) to 14.45% (relative to long-short hedging pressure benchmarks). This clearly suggests that our long-short risk premiums are better suited than long-only benchmarks to explain the performance of active strategies in commodity futures markets. Part of the performance of active portfolios in fact relates to systematic exposure to commodity risk.

7. Conclusions

We construct factor-mimicking portfolios to capture the effect of systematic hedging pressure on the risk premium of commodity futures. These long-short portfolios buy backwardated commodities and sell contangoed commodities, where the decision to allocate a commodity to either portfolio is based on the positions of hedgers, the positions of speculators or a double sort that combines both positions. Our fully-collateralised hedging pressure portfolios present Sharpe ratios that range from 0.25 to 0.79 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 presents a Sharpe ratio of only 0.05. The Sharpe ratio of the S&P-GSCI stands at merely 0.20. These results suggest that systematic hedging pressure is a significant determinant of commodity futures risk premium.

Further results can be summarised 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, our cross-sectional results show that the price of commodity risk based on hedging pressure is positive and often significant, while the price of risk associated with the S&P-GSCI is zero, both statistically and economically. Third, since investors traditionally use commodities for risk diversification and inflation hedging, it is important to test whether the return enhancement comes at the cost of losing the risk diversification and inflation hedge that are naturally provided by commodities. We find increased benefits in terms of diversification of equity risk, but an absence of inflation hedge, for our hedging pressure benchmarks. Fourth, our dynamic long-short portfolios better explain the performance of active strategies commonly implemented in commodity futures markets than long-only benchmarks.

Bringing all these results together, it appears essential to use the information contained in the positions of hedgers and speculators to properly model the time-series and cross-sectional properties of the risk premium present in commodity futures markets. A failure to account for hedging pressure results in the misleading conclusion that there is no risk premium or risk transfer and to the wrong impression that active strategies perform remarkably well. For these reasons we suggest that our hedging pressure benchmarks be used as building blocks for strategic asset allocation or to appraise the performance of tactical commodity traders.

Overall our paper contributes to the recent literature (Gorton *et al.*, 2008; Acharya *et al.*, 2010; Hong and Yogo, 2012; Tang and Xiong, 2010) that examines the role of systematic factors which influence the cross section of commodity prices. It would be interesting to analyse 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 analysing 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.

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