The Optimal Approach to Futures Contract Roll in Commodity Portfolios

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Commodity investing has gained a lot of traction in the last few years. More and more investors have come to realize the potential benefits of commodity investing. These benefits are well discussed in the literature, notably in Erb and Harvey [2006] and Gorton and Rouwenhorst [2006].[1] As pointed out by Feldman and Till [2006], the recent performance of commodities has caused many researchers (e.g., Anson [1998], Greer [2000], Nash and Smyk [2003], Heaney [2006], and Zulauf et al. [2006]) to re-examine the sources of return in commodity futures investing (see Exhibit 1).

This article focuses on the third component of commodity investment return: roll yield. The roll yield, which can be positive or negative, results from the fact that futures expire. With futures contract expiration, the investor has to roll his position by selling expiring futures and buying new futures with a later expiration. If the futures contract to be purchased is priced lower (higher) than the futures contract to be sold, then the roll yield is positive (negative). This roll component of return is of particular importance to a passive commodity investor as it can provide profit even if the spot price is not changing.

It is possible to improve on the basic approach to roll typically followed by most passive commodity indices. We document the link between roll yield and the shape of futures curves and show how the roll-over of futures should optimally be conducted in order to maximize gains (or minimize losses) associated with the necessity to roll futures. The historical gains that would have been obtained by optimally rolling the futures are illustrated from the point of view of long-only and short-only investors. An optimally rolled long–short strategy is also proposed.

THE TERM STRUCTURE OF FUTURES PRICES AND THE ROLL YIELD

The "normal backwardation" theory from Keynes [1930] suggests that commodity producers typically prefer to hedge their production against price fluctuation. They lock in the price by selling futures. Thus, the producers are transferring the price risk to the counterparty. To bear this price risk, the latter will command a return, akin to an insurance premium. This premium will take the form of a price differential between the expected price at expiration of the futures contract and the price set on the futures contract. The futures contract price should converge to the expected spot price at the expiration of the futures contract, leading to a profit for the risk bearer. Note that the size of the premium increases with the maturity of the futures contract, as a longer maturity implies more uncertainty.

Exhibit 1

Return on a Commodity Future Investment = Change in the Spot Price + Return on the Collateral + Roll Yield + Rebalancing Bonus

The normal backwardation theory assumes that the majority of those willing to hedge price risk will be commodity sellers. Therefore, the hedger (i.e., the producer) will have a short futures position and the speculator (i.e., the insurer) will hold a long position. Unfortunately, this theory cannot explain term structure in contango.

The "hedging pressure hypothesis" generalizes the "normal backwardation theory" to both normal backwardation and contango term structures. The "hedging pressure hypothesis" also allows the insurance seeker to be either a producer (e.g., wheat farmer) or a consumer (e.g., cereal maker). While the producer looks to protect himself from falling prices, the consumer wants to protect himself from a rise in his input price. It is thus necessary to determine the net hedging position between these two groups. If there is greater hedging pressure from the producer (consumer), the speculator providing insurance will buy (sell) the futures contract at a lower (higher) price than the expected price of the commodity; the term structure will then be in normal backwardation (contango).

The term structure of commodities can also be explained by the storage theory and the convenience yield. Under this framework, the roll yield could be defined as shown in Exhibit 2. The owner of a physical commodity incurs interest rate and storage costs. On the other side, the owner benefits from holding the inventory, resulting in a positive convenience yield. Indeed, unlike the holder of a futures contract for future delivery of the commodity, the holder of the physical commodity benefits from having a secured supply, therefore eliminating the risk of stock-outs. From the equation shown in Exhibit 2, a convenience yield higher than the sum of the interest rate and the storage costs implies a positive roll yield (the spot price is higher than the future price, this is backwardation). Conversely, if the convenience yield is lower than the sum of the interest rate and the storage costs, the roll yield is negative, which corresponds to a term structure in contango. There is a negative relationship between the convenience yield and the level of inventories: the convenience yield trends higher when the level of inventories is decreasing. Thus, a commodity with a tight (loose) supply, where the consumers attach a greater (lesser) importance to the ownership of the physical commodity, tends to have a higher (lower) convenience yield and hence a more backwardated (contango) term structure (see Gorton et al. [2007]).

To continuously maintain a position in a commodity, an investor has to roll his position by selling a futures contract approaching its expiration and buying a later-expiring futures contract. If the term structure of a futures contract price is in backwardation, then the roll operation will lead to a gain. The term structure of the futures contract price is sometimes in contango. In this case, the investor has to sell the nearest contract at a lower price than a later-expiring contract, thereby leading to an automatic loss.

Commodity indices take the form of a basket of futures contracts that are rolled periodically according to some pre-determined methodology, independently of the term structure shape (e.g., systematically buying futures that are two months away from expiration and selling them one month before their expiration). See Exhibit 3 for a description of the approach followed by six commodity indices.

Systematic rolling that does not take into account the curvature of the term structure can lead to losses when the term structure is in contango. The case of crude oil provides a good example. Rolling crude oil futures has been beneficial for many years because the term structure was in general in backwardation. The situation changed recently to contango. Because of this

Exhibit 2

Roll Yield = Spot Price − Future Price = Interest Rate − Convenience Yield + Storage Costs

Exhibit 3
Major Commodity Indices and Their Approach to Roll

Index	# of Constituents	Roll Approach
S&P GSCI Commodity Index	24	First nearby contract
Dow Jones-AIG Commodity Index	19	First nearby contract
Reuters-Jeffries/CRB Index	19	First nearby contract
Merrill Lynch Commodity Index Extra	18	2nd to 3rd
Lehman Brothers Commodity Index	20	First nearby contract
Deutsche Bank Liquid Commodity Index-Optimum Yield	6	Future that generates the maximum implied roll return

reversal, most indices now suffer losses each month when the crude oil futures are rolled.

Rather than mechanically rolling futures as is done in most indices, we suggest taking into account the curvature of the term structure so as to determine the optimal maturity for the futures contract to be bought on a roll date. This idea is in line with Erb and Harvey [2006] and Gorton and Rouwenhorst [2006], who suggest taking a long position in the nearby futures contract of commodities where the term structure is the most backwardated and a short position in the nearby futures contract of those commodities that are the most contango. The results of both studies show that the resulting portfolio outperforms a portfolio with a long position in all the commodities.

We similarly try to profit from the information contained in the commodity term structure, but rather than determining for each commodity whether it should be bought or sold, we determine the best maturity to choose for a long-only or short-only portfolio. We also examine the case of a long–short portfolio where both long and short positions are taken in each commodity, but with different maturities. In order to choose the futures contract, we calculate the slopes between two successive futures in the following way:

$$\mathrm{Slope}_{t,[T_k,T_{k-1}]} = \frac{f_{t,T_k} - f_{t,T_{k-1}}}{T_k - T_{k-1}} \tag{1}$$

where

$\mathrm{Slope}_{t,[T_k,T_{k-1}]}$ = the slope, at date t, between the futures maturing in T_k and T_{k-1}

f_{t,T_k} = the price, at date t, of the futures contract expiring at date T_k

$f_{t,T_{k-1}}$ = the price, at date t, of the futures contract expiring at T_{k-1} (the contract expiring just before f_{t,T_k})

A positive (negative) slope corresponds to a contango (backwardated) term structure. If we consider a long-only portfolio, the futures contract with the lowest slope should be bought. For a short position, the contract with the highest slope should be sold. Take for example three available maturities at a given date for a specific commodity. We assume that the prices for maturities of one, two, and three months are respectively \$50, \$65, and \$60. We suppose that we have to conduct the roll operation by selecting either the two-month or three-month futures contract. The contract with the two-month maturity has a slope of 15, while the three-month contract has a slope of −5. Therefore, a long position should be implemented with the three-month contract. If the price for the different maturities remains the same one-month later, the three-month contract (which will then have became a two-month contract) will be sold at \$65, for a potential gain of \$5. If the investor had bought the three-month contract at the initiation of the trade, he would have sold it for \$50, incurring a loss of \$15. Buying the futures contract with the lowest slope maximizes (minimizes) the gain (loss) due to roll. If the investor wishes to sell it short, then he could maximize his potential gain by selling the two-month contract at \$65 and covering the position one month later at \$50.

When two or more futures contracts are optimal (having the same slope), we take a position on the future with the nearest maturity.

DATA AND METHODOLOGY

To construct the long-only, the short-only, and the long–short portfolios according to the slope, we need the monthly term structure for each commodity. Using Bloomberg data, we reconstructed the term structures that were observable at the beginning of each month.[2] The completeness of the different term structures varies with the availability of data. We constructed the term structures for the following commodities:

- Energy: crude oil, natural gas, and heating oil (from January 1994 to April 2006)
- Precious Metals: gold and silver (from January 1994 to April 2006)
- Industrial Metals: aluminum and copper (from January 1998 to April 2006)
- Grains: corn (from January 1994 to April 2006); soybeans and wheat (from January 2000 to April 2006)

The universe of investable commodities is broader, but these represent the most important and most liquid commodities from the four major commodity segments. As of January 2007, these commodities represented roughly 80% of the S&P/GSCI Commodity Index and roughly 70% of the Dow Jones AIG Commodity Index.

Our strategy determines for each futures contract the best maturity to choose for a long or short position.[3] For example, if a long position is to be taken, then the futures contract with the lowest slope should be bought. If a short position is desired, the contract with the highest slope should be sold. The objective is to maximize the gains and minimize the losses that are attributable to the rolling of futures contracts. We determine at the beginning of each month the optimal maturity to hold, and we roll from the contract held in the previous month to the new desired maturity. We set the maximum acceptable maturity for a contract to be held at 12 months to ensure an acceptable level of liquidity. For a long-only portfolio, we also discuss the tracking error implied by following such a strategy rather than the standard nearest-contract approach applied by most major commodity indices.

RESULTS ANALYSIS

The *optimized long-only strategy* consists of maximizing the roll yield (if the term structure is in backwardation) or minimizing the loss due to the rolling (if the term structure is in contango) by determining the most favorable maturity to buy when the time has come to roll the futures contract. This strategy is compared to the standard approach that consists of systematically replacing the next contract to reach maturity by the following contract to do so. Results are presented in Exhibit 4.

EXHIBIT 4

Historical Performance of the Optimized Long-Only Strategy by Commodity

	Optimized Long-Only Strategy					Long Nearest Contract							
	Annualized Excess Return	Annualized Volatility	Return per Unit of Risk	Min Monthly Return	Max Monthly Return	Annualized Excess Return	Annualized Volatility	Return per Unit of Risk	Min Monthly Return	Max Monthly Return	Annual Value Added	Annual Tracking Error	Information Ratio
Energy													
Crude Oil	25.4%	27.0%	0.94	–14.5%	19.5%	21.8%	31.6%	0.69	–23.8%	34.2%	3.6%	10.7%	0.34
Natural Gas	12.0%	30.5%	0.39	–15.6%	28.0%	–1.9%	55.1%	–0.03	–27.4%	51.6%	13.8%	31.9%	0.43
Heating Oil	17.9%	25.3%	0.71	–22.0%	22.1%	15.4%	32.3%	0.47	–22.6%	33.5%	2.5%	12.4%	0.21
Industrial Metals													
Aluminum	6.0%	15.8%	0.38	–7.8%	16.4%	2.4%	17.1%	0.14	–8.4%	14.9%	3.6%	3.7%	0.97
Copper	17.1%	22.0%	0.78	–11.3%	21.6%	14.7%	22.7%	0.65	–11.5%	22.1%	2.4%	2.9%	0.82
Precious Metals													
Gold	–0.2%	13.3%	–0.01	–9.6%	19.3%	–0.5%	13.4%	–0.04	–9.6%	19.3%	0.3%	0.5%	0.68
Silver	3.6%	22.9%	0.16	–25.1%	20.1%	2.0%	23.7%	0.08	–25.4%	20.1%	1.6%	3.4%	0.49
Grains													
Corn	–5.9%	17.4%	–0.34	–17.7%	15.6%	–11.6%	22.2%	–0.52	–17.7%	15.5%	5.7%	7.8%	0.73
Soya	9.0%	23.6%	0.38	–17.5%	21.0%	5.0%	26.6%	0.19	–17.5%	21.0%	4.0%	9.1%	0.44
Wheat	0.6%	16.3%	0.04	–11.5%	11.0%	–9.4%	22.0%	–0.43	–14.8%	15.1%	10.1%	10.0%	1.01

Notes: All figures are presented for long-only positions following either an optimized roll strategy (left-hand side) or a nearest futures contract roll strategy (right-hand side). The last three columns show the value added, tracking error, and information ratio of the optimized strategy relative to the nearest futures approach.

For all 10 commodities, the optimized long-only strategy posts a higher return than the standard approach. On average, the return differential between the optimal and standard approaches is 4.8% a year in favor of the former. The worst case is that of gold (where the curve is almost straight and in contango during the entire period—see Exhibit 5, Panel A) with a value-added of only 0.3% per year. At the other extreme, the optimized approach adds 13.8% per year in the case of natural gas (where the curve exhibits seasonal patterns—see Exhibit 5, Panel B). The fact that the optimal approach to roll often allows the capture of seasonal patterns, as in the case of natural gas, could be seen as an added benefit of the approach. In terms of risk, the standard deviation of returns is lower for all the commodities. Overall, the return per unit of risk is increased in all cases, going in the most spectacular cases from −0.03 to 0.39 for natural gas and from −0.43 to 0.04 for wheat. By looking at the worst monthly returns, we note that the optimized long-only strategy reduces the risk of extreme losses as compared to the standard approach (the minimum monthly return is lower or equal in all cases). With the exception of natural gas, tracking error relative to the standard approach is within acceptable bounds (around 10% or lower). The long-only strategy posts a positive information ratio for each commodity and greater than 0.5 for 5 of the 10 commodities.

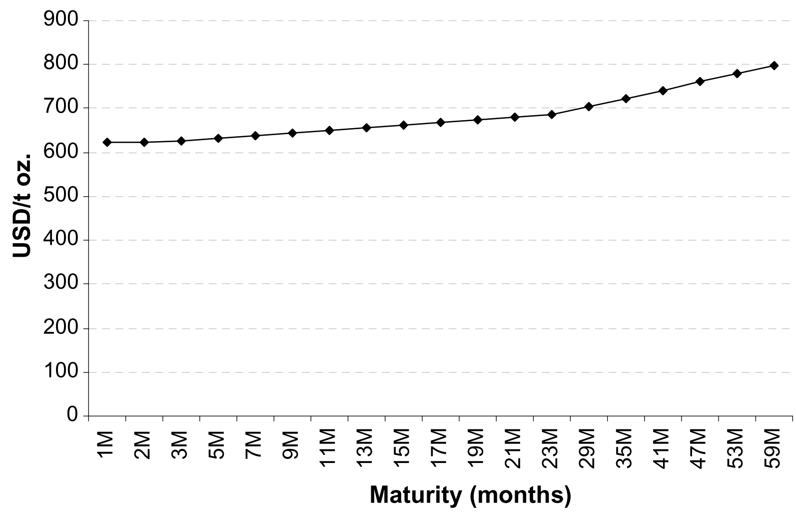
The *optimized short-only strategy* sells the futures contract along the curve that maximizes the gain (minimizes the loss) due to rollover for a term structure in contango (backwardation). The standard approach simply rolls its short position by purchasing the held futures contract and selling the next maturing contract. Exhibit 6 compares the optimized and standard approaches of the 10 commodities: 4 (crude oil, natural gas, heating oil, and soybeans) post a higher return with the optimized short-only strategy than with the standard approach, 4 (aluminum, copper, gold, and silver) post an almost identical return, and 2 post a significantly lower return (corn and wheat). In the worst case (wheat), the short-only strategy lagged the standard approach by 6.3%, while the maximum value added is 7.7% a year in the case of natural gas. The optimized strategy is less volatile than the standard one with volatility sometimes being a third lower (35.4% vs. 55.1% in the case of natural gas).

The *optimized long–short strategy* combines the long-only and short-only strategy. This strategy seeks to hold both a short and a long position in every commodity.

EXHIBIT 5

Typical Term Structure for Gold and Natural Gas through the Sample Period (Data as of August 15, 2006, Used for Illustrative Purposes)

Panel A: Term Structure for Gold



Panel B: Term Structure for Natural Gas

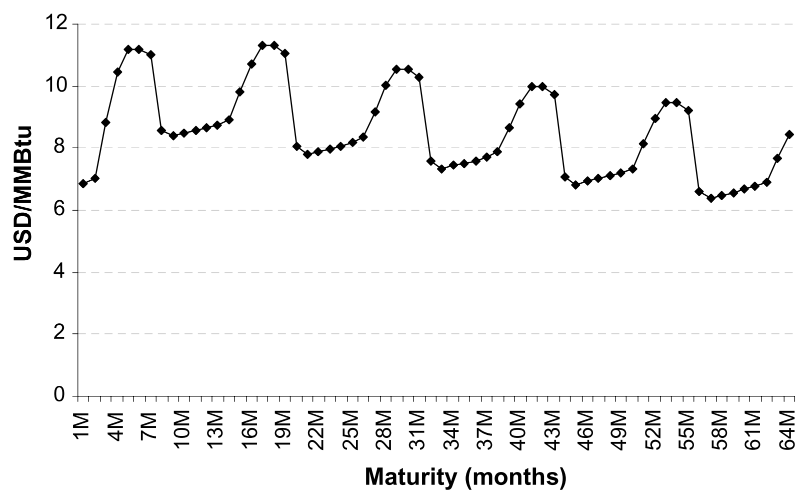


EXHIBIT 6
Historical Performance of the Optimized Short-Only Strategy by Commodity

	Optimized Short-Only Strategy					Short Nearest Contract				
	Annualized Excess Return	Annualized Volatility	Return per Unit of Risk	Min Monthly Return	Max Monthly Return	Annualized Excess Return	Annualized Volatility	Return per Unit of Risk	Min Monthly Return	Max Monthly Return
Energy										
Crude Oil	–20.4%	25.4%	–0.80	–34.2%	23.8%	–26.1%	31.6%	–0.83	–34.2%	23.8%
Natural Gas	–18.3%	35.4%	–0.52	–36.9%	21.1%	–26.0%	55.1%	–0.47	–51.6%	27.4%
Heating Oil	–17.7%	26.5%	–0.67	–26.6%	22.6%	–22.3%	32.3%	–0.69	–33.5%	22.6%
Industrial Metals										
Aluminum	–5.4%	17.0%	–0.32	–14.9%	9.7%	–5.2%	17.1%	–0.30	–14.9%	8.4%
Copper	–17.4%	23.2%	–0.75	–22.1%	11.5%	–17.4%	22.7%	–0.77	–22.1%	11.5%
Precious Metals										
Gold	–1.1%	13.2%	–0.08	–17.8%	9.5%	–1.3%	13.4%	–0.10	–19.3%	9.6%
Silver	–7.5%	23.6%	–0.32	–19.6%	25.4%	–7.4%	23.7%	–0.31	–20.1%	25.4%
Grains										
Corn	6.9%	19.7%	0.35	–14.2%	15.0%	7.6%	22.2%	0.34	–15.5%	17.7%
Soyabeans	–9.9%	24.5%	–0.41	–19.4%	15.9%	–11.3%	26.6%	–0.42	–21.0%	17.5%
Wheat	–1.1%	20.1%	–0.05	–14.2%	14.8%	5.2%	22.0%	0.24	–15.1%	14.8%

Notes: All figures are presented for short-only positions following either an optimized roll strategy (left-hand side) or a nearest futures contract roll strategy (right-hand side). Negative excess return for a short position implies that it was not a good idea to have this short position over the period.

EXHIBIT 7
Historical Performance of the Optimized Long–Short Strategy by Commodity

	Optimized Long–Short Strategy				
	Annualized Excess Return	Annualized Volatility	Return per unit of Risk	Min Monthly Return	Max Monthly Return
Energy					
Crude Oil	4.2%	19.0%	0.22	–31.0%	17.9%
Natural Gas	–3.1%	24.1%	–0.13	–23.1%	18.5%
Heating Oil	5.0%	12.9%	0.39	–10.1%	16.4%
Industrial Metals					
Aluminum	2.9%	5.5%	0.52	–4.2%	5.1%
Copper	0.8%	6.9%	0.12	7.1%	5.9%
Precious Metals					
Gold	0.8%	1.2%	0.69	–1.0%	1.6%
Silver	1.8%	3.3%	0.54	–3.7%	3.3%
Grains					
Corn	3.9%	6.5%	0.60	–6.3%	6.7%
Soyabeans	3.7%	8.2%	0.45	–6.5%	6.3%
Wheat	2.7%	7.1%	0.38	–6.8%	6.6%

Notes: All figures are presented for long–short positions—that is, both a long and a short position are held for each commodity.

Thus, two optimal maturities need to be identified every month for each commodity (one short and one long). The results of this strategy are presented in Exhibit 7. The return is positive for all commodities, with the exception of natural gas. Returns range from –3.1% for natural gas to 5.0% for heating oil.

Portfolio Performance

The factors driving the returns of the different futures contracts are clearly not the same. As a result, there is a very low correlation between the different pairs of commodities. Accordingly, it seems appropriate to investigate the previous results in a portfolio context. Indeed, holding a portfolio of commodity futures rather than a single commodity allows for better diversification, which should lead to a lower risk and a higher return per unit of risk. Exhibit 8 presents the performance of two different portfolios for each of the three strategies discussed in the previous section. The first portfolio (EW or equally weighted) allocates 1/10 of the funds to each of the 10 commodities. The second portfolio (Sector-EW, sector equally weighted) allocates 1/4 of the funds to each category of commodities (Energy, Precious Metals, Industrial Metals, and Grains). The commodities are equally weighted inside of each of the four categories. For example, crude oil receives a third of the weight allocated to the Energy

EXHIBIT 8

Historical Performance of the Long-Only, Short-Only, and Long–Short Strategies at the Portfolio Level

Panel A: Long-Only Strategies

	Long-Only			
	Equally Weighted	Nearest Contract Equally Weighted	Sector Equally Weighted	Nearest Contract Sector Equally Weighted
Annualized Excess Return	9.0%	6.3%	7.9%	5.1%
Annualized Standard Deviation	11.7%	15.0%	11.0%	13.3%
Return per Unit of Risk	0.77	0.42	0.72	0.39
Min Monthly Return	–8.2%	–10.4%	–7.6%	–8.3%
Max Monthly Return	9.0%	10.5%	9.0%	9.2%

Panel B: Short-Only Strategies

	Short-Only			
	Equally Weighted	Nearest Contract Equally Weighted	Sector Equally Weighted	Nearest Contract Sector Equally Weighted
Annualized Excess Return	–6.7%	–8.0%	–5.8%	–6.6%
Annualized Standard Deviation	12.2%	15.0%	11.5%	13.3%
Return per Unit of Risk	–0.55	–0.53	–0.51	–0.49
Min Monthly Return	–8.7%	–10.5%	–8.8%	–9.2%
Max Monthly Return	10.4%	10.4%	8.3%	8.3%

Panel C: Long–Short Strategies

	Long–Short	
	Equally Weighted	Sector Equally Weighted
Annualized Excess Return	3.0%	2.9%
Annualized Standard Deviation	4.5%	3.4%
Return per Unit of Risk	0.68	0.85
Min Monthly Return	–4.8%	–2.9%
Max Monthly Return	4.2%	3.3%

EXHIBIT 9

Historical Optimal Maturities by Commodity for a Long Position, 1994–2005 (in Months)

	94	95	96	97	98	99	00	01	02	03	04	05	Avg	Std Dev
Crude Oil	4.3	2.2	2.4	5.3	11.2	4.7	3.1	6.4	5.0	3.0	4.4	10.3	5.2	3.8
Natural Gas	6.3	7.9	5.8	7.7	10.2	8.8	5.4	7.3	8.8	6.8	7.6	7.8	7.5	3.4
Heating Oil	6.3	7.9	5.8	7.7	10.2	8.8	5.4	7.3	8.8	6.8	7.6	7.8	7.5	3.4
Aluminum	N/A	N/A	N/A	N/A	7.7	7.5	7.8	6.0	6.3	5.6	7.7	5.7	6.8	3.7
Copper	N/A	N/A	N/A	N/A	5.8	9.3	9.5	7.8	10.3	7.0	4.3	2.9	7.1	4.0
Gold	2.7	2.9	5.8	4.6	8.0	6.3	9.3	7.4	6.3	7.5	3.2	2.3	5.5	3.6
Silver	6.3	4.7	7.6	6.4	9.4	8.3	10.5	10.2	9.8	10.2	8.4	9.9	8.5	3.6
Corn	8.3	10.4	7.8	7.8	8.5	12.1	10.9	11.5	11.4	7.4	8.7	11.9	9.7	3.0
Soyabeans	N/A	N/A	N/A	N/A	N/A	N/A	8.3	7.4	8.3	6.7	7.3	9.0	7.8	3.5
Wheat	N/A	N/A	N/A	N/A	N/A	N/A	11.1	10.3	10.2	8.8	9.5	10.5	10.1	2.8

Notes: The last two columns present the average optimal maturity and standard deviation calculated from the times series of monthly optimal maturities.

category (1/3 × 1/4 = 8.3%) while gold receives half of the weight of the Precious Metals category (1/2 × 1/4 = 12.5%).

When the long-only and short-only strategies are applied to individual commodities, the annualized volatility is typically around 20%. For the two portfolios, the average volatility falls to roughly 11%, with the Sector-EW portfolio being slightly less risky. For the long–short strategy, the volatility falls from an average of 9.2% at the individual commodity level to 4.5% (EW) and 3.4% (Sector-EW). The aggregation of the 10 commodities in a portfolio greatly reduces risk, which would make the three strategies easier to consider using. The return of the long-only strategy is interesting at 9.0% (EW) and 7.9% (Sector-EW) for a return per unit of risk of 0.77 (EW) and 0.72 (Sector-EW). The long–short strategy greatly reduces the risk while maintaining a positive excess return. For the EW portfolio, the long–short strategy leads to a return per unit of risk of 0.68, while it posts an even more convincing figure of 0.85 with the Sector-EW version.

Historically Optimal Maturities by Commodity and Desired Position

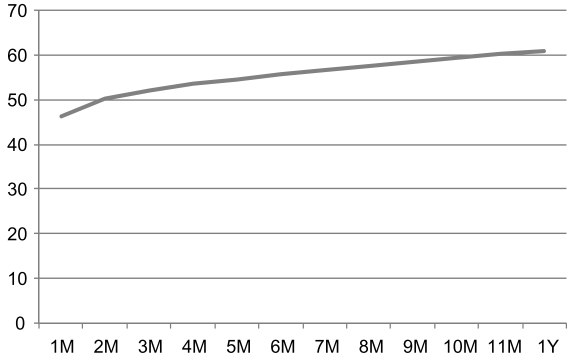
We now examine the extent to which the maturity of the chosen futures by the optimized long-only strategy differs from that of the standard approach followed by most commodity providers. The historical optimal maturities by commodities for a long position are presented in Exhibit 9 for each year. We focus on the long position since commodity indices in the market are all long-only. Of the 100 cases (commodity *X* in year *Y*) presented in Exhibit 7, only five show an average optimal maturity of less than three months for the roll-overs. In fact, the average optimal maturity is higher than five months for all commodities. The shortest average optimal maturity is 5.2 months for crude oil, and the longest is 10.1 months for wheat. Looking at the standard deviation of the monthly series of optimal maturities, we note that the optimal maturity changes the most from month to month in the case of copper. At the other extreme, wheat presents the most stable optimal maturity. An important point regarding optimal maturities is that while the gain (loss) associated with roll is maximized (minimized), the futures contract involved presents a much lower liquidity than the nearest contract traded with the standard approach. However, as mentioned earlier, we capped the maximum allowed maturity at 12 months to assure a minimum level of liquidity. Moreover, it should be noted that liquidity farther in the term structure has greatly increased in the last few years, making it easier to implement the proposed approach on a larger scale.

BEHAVIOR OF THE OPTIMAL APPROACH DURING THE 2008 TURMOIL

The prices of commodities were highly volatile in 2008. Many commodities reached historical highs before violently falling back by more than 50%. These extreme price movements altered the term structure of most commodity futures. Without exception, all term structures end up in a deep contango. Consequently, the

EXHIBIT 10

Term Structure and Slope for WTI Oil (as of January 2, 2009)



Contract Maturity	Slope
2 months	8.4%
3 months	4.0%
4 months	2.7%
5 months	2.0%
6 months	2.0%
7 months	1.8%
8 months	1.7%
9 months	1.5%
10 months	1.5%
11 months	1.4%
12 months	1.3%

negative roll yield has considerably increased, particularly on the short-term part of the curve where most index providers conduct their roll operations. In comparison, the slope remained flatter between longer maturities on the term structure. Exhibit 10 presents the case of crude oil. The standard approach of rolling over into the next maturing contract would have led to a negative monthly roll yield of about –8.4%. The optimal approach would have limited this negative monthly roll yield to –1.3% by rolling farther on the term structure (12-month contract). The optimal approach suggests the same strategy for each commodity: execute long positions by buying the farthest contracts and short positions selling the nearest contracts. It is worth mentioning that liquidity during the extremely volatile 2008 (as measured by open interest and volume) was similar to its previous five-year average.

CONCLUSION

We argue that commodity indices are correctly positioned to capture the return from price appreciation, collateral return, and rebalancing. However, the standard approach to rollover by index providers does not capture the full extent of the roll yield and worse can lead to systematic losses. We show that, on an ex ante basis, it is preferable to conduct rollovers by taking into account the curvature of the term structure for the different commodities. An optimized long-only (short-only) strategy posts a higher return than the standard approach for all 10 (8 out of 10) commodities. An optimized long–short strategy that targets two futures for each commodity (one short and one long) at the beginning of each month posts an excess return of 6.7% per year with an annualized volatility of 6.6%. The optimal maturity for a long futures position rollover is on average higher than seven months, which contrasts with the practice of rolling over into the next maturing futures contract (typically maturing in two months).

This article demonstrates how return could be improved by conducting the roll operation differently than the standard approach typically followed by most commodity index providers. In light of the explosion over the last few years in the demand for passive commodity investing, an interesting question for future study would be to examine how it could have affected the opportunities presented in this article.

ENDNOTES

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[1]This question was also examined in Ankrim and Hensel [1993], Lummer and Siegel [1993], Schneeweis and Spurgin [1997], Abanomey and Mathur [2001], Anson [2002], Georgiev [2001], and Jensen, Johnson, and Mercer [2002].

[2]We use actual historical contract price rather than relying on the generic term structure proposed by Bloomberg, which frees us from any roll conventions used in these generic term structures.

[3]This article does not answer the question of whether a particular commodity should be bought or sold. The choice of the direction of the trade is presumed to have already been made and the current article simply tries to better implement this choice.

REFERENCES

Abanomey, W.S., and I. Mathur. "International Portfolios with Commodity Futures and Currency Forward Contracts." *The Journal of Investing*, Vol. 10, No. 3 (2001), pp. 61–68.

Ankrim, E., and C.R. Hensel. "Commodities in Asset Allocation: A Real-Asset Alternative to Real Estate?" *Financial Analysts Journal*, Vol. 49, No. 3 (1993), pp. 20–29.

Anson, M. "Spot Returns, Roll Yield, and Diversification with Commodity Futures." *The Journal of Alternative Investments*, Vol. 1, No. 3 (1998), pp. 16–32.

——. *Handbook of Alternative Assets*. New York, NY: Wiley Finance, 2002.

Erb, C.B., and C.R. Harvey. "The Tactical and Strategic Value of Commodity Futures." *Financial Analysts Journal*, Vol. 62, No. 2 (2006), pp. 69–97.

Feldman, B., and H. Till. "Backwardation and Commodities Performance: Evidence from Evolving Agricultural Markets." *The Journal of Alternative Investments*, Vol. 9, No. 3 (2006), pp. 24–39.

Georgiev, G. "Benefits of Commodity Investment." *The Journal of Alternative Investments*, Vol. 4, No. 1 (2001), pp. 40–48.

Gorton, G., F. Hayashi, and K.G. Rouwenhorst. "The Fundamentals of Future Commodity Returns." Yale ICF Working Paper, 2007.

Gorton, G., and K.G. Rouwenhorst. "Facts and Fantasies about Commodity Futures." *Financial Analysts Journal*, Vol. 62, No. 2 (2006), pp. 47–68.

Greer, R.J. "The Nature of Commodity Index Returns." *The Journal of Alternative Investments*, Vol. 3, No. 1 (2000), pp. 45–53.

Heaney, R. "An Empirical Analysis of Commodity Pricing." *Journal of Futures Markets*, Vol. 26, No. 4 (2006), pp. 391–415.

Jensen, G.R., R.R. Johnson, and J.M. Mercer. "Tactical Asset Allocation and Commodity Futures." *The Journal of Portfolio Management*, Vol. 28, No. 4 (2002), pp. 100–111.

Keynes, J.M. *A Treatise on Money*. London, U.K.: Macmillan, 1930.

Lummer, S.L., and L.B. Siegel. "The GSCI Collateralized Futures: A Hedging and Diversification Tool for Institutional Investors." *The Journal of Investing*, Vol. 2, No. 2 (1993), pp. 75–82.

Nash, D., and Y. Smyk. "Backwardation of Commodities and Returns on the GSCI Investment." Morgan Stanley Global Pensions Group, New York, 2003.

Schneeweis, T., and R. Spurgin. "Energy Based Investment Products and Investor Asset Allocation." Working Paper, CISDM/SOM, University of Massachusetts, 1997.

Zulauf, C.R., H. Zhou, and M. Robert. "Updating the Estimation of the Supply of Storage." *Journal of Futures Markets*, Vol. 26, No. 7 (2006), pp. 657–676.