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How Could We Have Been So Wrong? The Puzzle of Disappointing Returns to Commodity Index Investments

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Practitioner's Abstract

Investments into commodity-linked investments have grown considerably since their popularity exploded—along with commodity prices—in 2006 through 2008. Numerous individuals and institutions have embraced alternative investments for their purported diversification properties and "equity-like" returns; yet, real-time performance has been disappointing. As an example, Morningstar reports that the iShares S&P GSCI Commodity Index Trust lost an annualized 9.1% in the 5 years ending December 31, 2012. The puzzling aspect of this poor performance is that it occurred at a time when the overall trend in commodity prices was sharply upward. In this paper, we explicitly show that the disappointing returns for commodity index investments were not directly caused by the futures market structure, i.e., "contango." Rather, the implicit—and unavoidable—cost of holding physical commodities is inherent in futures prices and thereby creates a necessary performance "gap" between the returns to long-only futures positions and observed spot market prices.

Key Words: commodity index funds, commodity investments, futures prices

"The relative frequency of contango and backwardated markets, combined with the steepness of the future's curve will determine whether the average return associated with simply maintaining investment in the commodities market will be positive, negative, or zero." (Phillips, 2008, p.10).

"When the futures contracts that commodity funds own are about to expire, fund managers have to sell them and buy new ones; otherwise they would have to take delivery of billions of dollars' worth of raw materials. When they buy the more expensive contracts—more expensive thanks to contango—they lose money for their investors." (Robison, Loder, and Bjerga, 2010).

Introduction

Long-only investment in commodity futures markets rose from relative obscurity a decade ago to become a common feature in today's investing landscape. Blue-ribbon investment companies, such as the Vanguard Group, have come to view commodities as a potentially valuable alternative investment that should be considered in any serious discussion about the portfolio mix for investors (Stockton, 2007). These commodity investments include Exchange Traded Funds (ETFs) that track broad commodity indices as well as those focused on particular market segments, such as agriculture. Large institutional investors generally gain exposure to the commodity "space" through direct holdings of futures contracts as well as the use of over-the-counter derivatives and swaps (Irwin and Sanders, 2011). The Commodity Futures Trading Commission (CFTC) estimates that commodity index investments in U.S. futures markets totaled $159.8 billion as of March 28, 2013, a very large figure by historical standards.

Several influential studies published in the last decade (e.g., Gorton and Rouwenhorst, 2006a; Erb and Harvey, 2006) claim that portfolios of long-only commodity futures positions generate "equity-like" returns and this undoubtedly contributed to the surge in commodity-linked investments. However, returns to commodity index investments have generally disappointed since the initial surge of investments during 2004-2007. For example, Sanders and Irwin (2012) document that the iShares S&P GSCI Commodity Index Trust declined in value over the five years ending September 2011 with a capital loss of 39.6%. The puzzling aspect of this poor performance is that it occurred at a time when the overall trend in commodity prices was generally upward. Moreover, as shown in Table 1, underperformance among long-only commodity index funds is widespread. Table 1 provides the 1-, 3-, and 5-year returns for 25 largest futures-based commodity ETF's. As of May 15, 2013 the funds represented a notional value of over $16.0 billion. Of the 25 funds, only 6 have positive 1-year returns, just 2 have a positive total returns over the last 5 years, and the weighted average 5-year return is a loss of 40%.

As indicated in the opening quotes, the poor returns to long-only commodity investments are often blamed on "contango" (e.g. Robison, Loder, and Bjerga, 2010), which refers to the situation in commodity futures markets where the term structure of prices is positive. More specifically, contango occurs when futures contracts further from expiration on a given date have a higher price than those contracts closer to expiration (also referred to as a "normal carry" or "carrying charge" market). When a futures market is in contango fund managers claim they are forced to "roll" or switch their long positions from relatively lower priced nearby futures prices to relatively higher priced deferred futures prices.

The process of rolling from low-priced nearby to high-priced deferred contracts is said to create a negative "roll yield." It is now widely-accepted within the investment industry that the roll yield is a key part of the return generating process in commodity index investments. Fund managers have even attempted to minimize the so-called negative roll-yield attributed to contango with "enhanced" index products that avoid contango markets (e.g., Barclays Capital, 2010).

Three studies have challenged the conventional wisdom that the term structure of a futures market has a direct impact on long-only futures investment returns. Burton and Karsh (2009) and Sanders and Irwin (2012) rely on informal arguments. Bessembinder et al. (2012) provide a formal theoretical analysis based on the standard cost of carry model of futures pricing. Their empirical analysis is limited to only one market—WTI crude oil futures. The objective of this paper is to take a deeper look at the disappointing returns to commodity index investments. We first use the model of Bessembinder et al (2012) to concisely demonstrate that the popular discussion around "contango" and "roll yields" is a fantasy. The model clearly shows that the returns to long-only futures positions are independent of the carry or term structure of futures market. We next use daily futures prices over 2006-2012 in four markets—WTI crude oil, corn, gold, and natural gas—to calculate implied spot prices and estimate the components of futures returns. This analysis focuses on explaining the apparent performance gap between the spot price level and ETF prices. The final part of the empirical analysis uses daily futures prices for a broad cross-section of 20 commodity futures markets over 1990-2012 to determine whether risk premiums have declined in recent years.

Background and Performance

The flow of money into commodity investments in the last decade was boosted by academic research that showed “equity-like” returns for a portfolio of commodity futures while also providing diversification benefits relative to traditional asset classes (Gorton and Rouwenhorst, 2006b; Erb and Harvey, 2006). Prior to these key studies, other academics had found evidence of positive returns to long-only futures portfolios (e.g., Bodie and Bosansky, 1980; Greer, 20000). Following the publication of Gorton and Rouwenhorst’s (2006) work—and coinciding with a general upward move in commodity prices—commodity-linked investments grew rapidly (see Figure 1).

Despite the historical-based evidence and academic endorsement, actual returns to commodity investments have been disappointing. The iShares S&P GSCI Commodity Index Trust is an exchange traded fund (ETF) designed to mimic the performance of the Goldman Sachs Commodity Index (GSCI)—one of the most widely followed commodity indices. The ETF was initially offered to the public in July of 2006 at a price near $50 per share. Since then, the share price has generally declined (see Figure 2) and an initial investment of $10,000 in the fund at its inception would now be worth around $6,684 (as of December 31, 2012).

Surprising to investors, the negative return has occurred over a period of time when there has been a general upward trend in overall commodity prices. Figure 2 also shows the “spot” GSCI which simply reflects the nearby prices of the component markets. The GSCI spot index actually increased over the same time period and a $10,000 investment in the index would have grown to $13,414, creating what appears to be a $6,730 performance “gap” or wedge between the performance ETF share price and the spot price index.

Funds that track individual commodities provide the clearest evidence of investor disappointment and the perceived performance gap between ETF share price and the underling spot commodity price. For example, the U.S. Crude Oil Fund (USO) is an ETF designed to give investors exposure to daily price changes of the front month crude oil futures contract. The futures holdings are rolled on a monthly basis to the next contract two weeks prior to expiration. The USO was launched April 10, 2006 at a price of $68.02 while the crude oil implied spot price on that day settled at $68.31. By December 31, 2012 the price of crude oil implied spot price had risen to $91.51 with the closing net asset value (NAV) of the USO had falling to $33.37 (see Figure 2). So, investors experienced a 51% loss on their investment while watching the nearby crude oil spot price increase by 34%.

The chasm between changes in spot prices and returns to futures-linked investments has led market observers to search for possible explanations. One such explanation is “contango.” Contango occurs when futures contracts further from expiration on a given date have a higher price than those contracts closer to expiration (also referred to as a “normal carry” or “carrying charge” market). When a futures market is in contango fund managers claim they are forced to “roll” or switch their long positions from relatively lower priced nearby futures prices to relatively higher priced deferred futures prices. The process of rolling from low-priced nearby to high-priced deferred contracts is said to create a negative “roll yield.” It is now widely-accepted within the investment industry that the roll yield is a key part of the return generating process in commodity index investments.

A surprising number of investment professionals take the contango argument as fact. But, perhaps more surprising, contango arguments have not been strongly rebuked by academic researchers. Sanders and Irwin (2012) provide an intuitive critique of roll returns and conclude: "the idea that the 'roll return' is realized futures return is fiction." Bessembinder et al. (2012) provide a more rigorous framework and reach a similar conclusion: "… the cost of carry has no direct implication for futures returns…In particular, the fact that rolling a futures position in a contango market involves buying the second contract at a price higher than the selling price for the expiring contract has no direct implication for returns to roll strategies."

A more plausible explanation for the poor performance of commodity investments is a reduction in the market-based risk premium. That is, the popularization of commodities as an investment—or the "financialization" of commodity markets (Domanski and Heath, 2007)—has reduced the historical risk premium. Hamilton and Wu (2012) essentially argue that the large influx of investment money decreased risk premiums available to long position holders. The authors find supporting evidence in the crude oil futures market, documenting a decline in risk premium when comparing 1990-2004 with 2005-2011 data. The timing of this change in risk premia is consistent with a period of large structural shifts in the commodity futures markets starting around 2004 (Irwin and Sanders 2012).

Here, we use the model of Bessembinder et al (2012) to concisely demonstrate that the popular discussion around "contango" and "roll yields" is fantasy. Indeed, the performance gap depicted in Figures 1 and 2 are an illusion stemming from the physical cost of storing commodities. The "spot" strategies depicted by the price of the underlying commodities are not replicable as they do not account for the physical cost of holding commodities. The futures return reflects the spot return adjusted for the market-implied cost of storage. The futures return is independent of the whether the market is in contango or not. Absent a risk premium, the expected futures return for an individual commodity futures market is zero.

A Theoretical Model of Returns

Following Bessembinder et al. (2012) we present a model of spot (cash) prices and futures prices to demonstrate the source of returns to holding futures contracts. Let P_t represent the spot price at date t and $F_t(m)$ represent the futures price at date t for delivery at t+m. C_t is the per period cost of carry which includes interest and other storage costs. The no-arbitrage cost of carry model can be expressed as follows:

$$(1)\quad F_t(m) = P_t e^{C_t m}.$$

Using (1) for delivery dates t+m and t+n (m>n) the market-implied cost of carry per period can be expressed as:

$$(2)\quad C_t = \frac{\ln\left[\frac{F_t(m)}{F_t(n)}\right]}{(m-n)}.$$

That is, the cost of carrying inventory is revealed in the term structure of the futures market, where C_t consists of forgone interest (r_t), physical storage costs (c_t), and the convenience yield (y_t)

associated with having stocks on hand such that $C_t = r_t + c_t - y_t$. Under normal circumstances, C_t is dominated by interest and physical storage costs ($r_t + c_t > y_t$) in which case the futures market is in a normal carry or contango ($F_t(m) > F_t(n)$ and $C_t > 0$). Other times, the convenience of having stocks on-hand dominates such that ($r_t + c_t < y_t$) in which case the futures market is inverted ($F_t(m) < F_t(n)$ and $C_t < 0$).

Using the two nearest-to-expiration futures prices, equation (2) can be used to calculate the daily cost of carry, C_t. Then, the implied spot price on day t can be calculated based on the observed futures price by simply solving (1) for $P_t = \frac{F_t(m)}{e^{C_t m}}$. Each day, t+1, there is an expected spot price based on the previous day's cost of carry model ($P_t e^{C_t}$) and there is an actual implied spot price based on the same day's cost of carry model (P_{t+1}). The return between the actual spot price, P_{t+1}, and the expected spot price, $P_t e^{C_t}$, (as forecasted by the term structure) can be expressed as follows:

$$(3)\quad U_{t+1} = ln\left[\frac{P_{t+1}}{P_t e^{C_t}}\right].$$

Note, the spot price in the equilibrium model is expected to increase (or decrease) by the daily cost of carry. U_t, then, is composed of all other sources of price changes including random supply and demand shocks (μ_t) and possibly a systematic or time varying risk premium (π_t) such that $U_t = \pi_t + \mu_t$, where $E(\mu_t)=0$ and $E(\pi_t)\neq 0$. Thus, $E(U_t)\neq 0$ only in the presence of a risk premium, π_t. Moreover, equations (1), (2), and (3) can be used to express the continuously compounded returns to holding spot and futures positions,

$$(4)\quad ln\left[\frac{P_{t+1}}{P_t}\right] = U_t + C_t$$

$$(5)\quad ln\left[\frac{F_{t+1}(m-1)}{F_t(m)}\right] = U_t + (m-1)\Delta C \text{ , where } \Delta C = C_{t+1} - C_t.$$

The return to the holder of the cash or spot commodity in (4) is the sum of the ex post premium, U_t, and the market-implied cost of carrying the inventory, C_t. If there is no risk premium ($\pi_t=0$), then the expected return on spot prices is the cost of carry. This can be positive or negative depending on if the term structure of the market is in contango or inverted.

The return to a long futures position in (5) is the sum of the ex post premium, U_t, and the 1-period *change* in the cost of carrying the inventory, ΔC. If there is no risk premium ($\pi_t=0$), then the expected return on a long futures position is the *change* in the cost of carrying the inventory, ΔC. Equations (4) and (5) reveal a few important facts regarding returns. First, if there is a risk premium ($\pi_t\neq 0$), then it appears in both the spot and futures returns. Second, if there is no risk premium ($\pi_t=0$) and carrying costs are static ($\Delta C = 0$), then cash prices will change by exactly those carrying costs (C_t) and futures returns will be zero as they perfectly anticipate the change in spot prices due to those carrying costs.

Finally, and most importantly to this research, the futures returns in (5) are independent of the carry structure of the futures markets or the *level* of C_t. Specifically, the futures return is not a function of whether the futures market is in contango ($C_t > 0$) or inverted ($C_t < 0$). The much discussed "return to roll" or "roll yield" is irrelevant in determining the return to a long futures position. The slope of the futures term structure does not determine futures returns.[1]

In the absence of a risk premium, the return on a long futures position is the *change* in the cost of carrying the inventory, ΔC. Note, an increase in carrying costs ($\Delta C > 0$)—or a market moving into a greater contango—will generate positive futures returns and a decrease in carrying costs ($\Delta C < 0$)—or a market moving into an inverted structure—will generate negative futures returns.[2] This result is somewhat counterintuitive, but it is important to highlight that random shocks and risk premiums, U_t, occur in both spot and futures prices.[3] So, for a given spot price, an increase in carry costs ($\Delta C > 0$) necessitates a higher futures price (or positive futures returns). Conversely, for a given spot price, a decrease in carry costs ($\Delta C < 0$) results in a lower futures price (or negative futures returns).

The apparent underperformance of futures-based ETF's when compared to the spot commodity price—i.e., the performance gap in Figures 1 and 2—can easily be seen by looking at the difference in spot price returns in (4) and futures returns in (5). That is, the expected spot commodity returns minus futures returns is expressed as follows,

(6) $$C_t - (m-1)\Delta C.$$

In (6), if carrying costs are positive and static ($C_t > 0, \Delta C = 0$) then spot prices will appreciate while futures prices are unchanged. As a result, an apparent performance "gap" will develop between the price of the spot commodity and the price of a futures-based ETF. Conversely, if carrying costs are negative and static ($C_t < 0, \Delta C = 0$) then this apparent performance gap will narrow. But, the narrowing is only due to spot price declines; the futures return is still zero.

The above model leads to the following assertions regarding futures returns and the performance of futures-based ETFs. First, in the absence of a risk premium, the expected futures return and return to futures-based funds is zero. Second, a perceived performance "gap" will accumulate between the underlying spot price and the ETF price at a rate essentially equal to the cost of carry, C_t (assuming ΔC is on average zero). For commodities with stable and positive levels of C_t, the gap will persist and grow at a steady rate. Third, futures returns are independent of the structure of the futures market or the *level* of C_t. However, if the structure of the futures market changes from an inverse (C_t<0) to contango (C_{t+1}>0) such that $\Delta C > 0$, then periods of positive futures returns can occur and the performance gap will narrow. On the other hand, if the structure of the futures market

[1] The model clearly demonstrates that futures return computations are not directly impacted by the market carry structure or the level of carrying costs (C_t). However, this does not preclude the possibility that C_t may serve as a signal for a time-varying risk premium or other factor related to market returns (Gorton, Hayashi, and Rouwenhorst, 2007).

[2] This relationship may generate some of the common confusion among market participants. That is, a futures market that is in an inverse and then changes to a normal carry structure will generate positive returns to long positions. Market participants may wrongly attribute the positive returns with "rolling" long positions in the inverted market structure as opposed to a possible change in the structure.

[3] The result is counterintuitive because a market that moves to an inverse is usually associated with low inventories and high prices and a market in contango is typically characterized by abundant stocks and low prices.

changes from an carry (C_t>0) to an inverse (C_{t+1}<0) such that $\Delta C < 0$, then futures returns may be negative and the performance gap will widen.[4]

In the following section, daily futures prices for a cross-section of 20 markets are used to calculate implied spot prices and estimate the components of returns. The ex post spot premium (U_t) is calculated and the historical average provides an estimate of the risk premium (π_t). The performance of ETF's (and simulated ETF's) are compared implied spot prices to demonstrate that the performance gap relation to the estimated cost of storage (C_t).

Empirical Estimates

Daily futures data were gathered from 1990 through 2012 for New York Mercantile Exchange (NYMEX) energy and metals markets (WTI crude oil, RBOB gasoline, heating oil, natural gas, copper, gold, and silver), the Intercontinental Exchange (ICE) energy and softs markets (Brent crude oil, cocoa, coffee, sugar, and cotton), the Chicago Board of Trade (CBOT) grains (corn, wheat, soybeans, soybean meal, soybean oil, oats, and rough rice), and the Kansas City Board of Trade (KCBT) hard red winter wheat contracts.

For each market the front two nearest-to-expiration futures contracts are used to estimate the cost of storage (C_t) and the corresponding implied spot price. An example of the calculations for a hypothetical market is presented in Table 2. Simplistically, the spread between the two futures prices are used to calculate the implied cost of storage which is then used to impute an implied spot price for the current period and the next period. Then, using the implied spot prices, the ex post spot premium (U_t) can be calculated for each day.

The Performance Gap

The first set of results focuses on explaining the apparent performance gap between the spot price level and ETF prices. Following Bessembinder et al. (2012), the performance gap is best illustrated by WTI crude oil and the U.S. oil fund (USO) in Figure 2. In this example, it is very clear that there is what appears to be an underperformance of USO relative to the spot price of crude oil. However, as shown in (6), the difference between the spot price return and the futures market return is simply a function of the cost of storage (C_t) that drives a rational wedge between the two price series. Indeed, the price series would coincide in the absence of storage costs ($C_t = 0$). In simple terms, the spot price series is not a replicable benchmark because it does not include storage costs; whereas, the futures strategy automatically imposes storage costs through the term structure.

The components of the returns for this same sample period are shown in Table 3. For crude oil, the average cost of storage (C_t) is 14.1% per year, the ex post spot premium (U_t) is -9.5%, and because average storage costs increased over the sample period ($\Delta C_t > 0$), the futures return was slightly higher at -6.6% ($U_t + \Delta C_t$). Note, the implied spot price increased by an average of 4.6% while the futures returns were -6.6% and the difference (11.2%) is equal to $C_t - (m-1)\Delta C$=14.1%-2.9%=11.2% and represents the annualized underperformance displayed in Figure 2.

[4] The actual change in the performance gap depends on whether or not the ΔC in (6) is large enough to offset the effect of C_t.

Perhaps the most vivid example of the performance gap is with gold, where storage costs are very stable (essentially just interest costs) at 2.0%. Although both the spot and futures show a positive average return over this sample, the difference between the implied spot price and the futures returns is a very consistent 1.1% per year. The difference manifests itself as a performance gap that accumulates in a very stable fashion as shown in Figure 3.

Table 3 also shows the results for natural gas and the corn futures market. In the corn futures market, the cost of storage (C_t) averaged 9.6%; but, the ex post spot premium (U_t) is 6.3% and an increase in the average storage cost (ΔC_t=0.3%) resulted in a positive futures return 6.6% ($U_t + \Delta C_t$). In contrast, the natural gas futures market was a veritable disaster for the long-only investor with seeing a futures return of -49.5% made up of a -53% ex post spot premium and a positive 3.4% change in storage costs ($U_t + \Delta C_t$). Overall, these results clearly show the nature and source of futures returns emanate from the ex post spot premium and change in market-implied storage rates. The storage costs (C_t) explain the observed performance gap between futures returns and spot prices; however, the level of (C_t) or market contango has no direct bearing on the calculated futures return.

Financialization and Premiums

Hamilton and Wu (2011) suggest that the financialization of commodity futures markets may have led to a decline in market risk premiums. Following Hamilton and Wu (2011), we sample our data set into two periods: 1990-2004 and 2005-2012. The ex post spot premiums (U_t) are calculated and averaged in each subsample for a cross-section of 20 futures markets. The average U_t serves of an estimate for risk premium (π_t). The results are presented in Table 4.

Consistent with the results for Hamilton and Wu (2011), the energy markets in general—and WTI crude oil in particular—show a marked decline in the ex post spot premium in the second sample. However, most other markets which underwent a similar financialization process show no consistent pattern of declining risk premiums. Indeed, the average estimated risk premium was a negative 0.7% in the first sample and increased to 2.7% in the later sample. The difference in mean risk premiums between the two samples is not statistically different from zero. While U_t provides a noisy estimate for any market risk premium (π_t), there is certainly no evidence that risk premiums across markets declined in a systematic fashion from 2005 forward. The average estimated risk premium across the 20 markets and 23 years of data is 0.5%. As shown in Table 5, this is relatively close to the average expense ratio of diversified funds and casts some doubt on the expectation for positive investor returns.

Summary, Conclusions, and Discussion

The performance of futures-based commodity funds has been disappointing. Of the 25 largest funds, only 2 show a positive total return over the 5-year period ending May 15, 2013. The salt in investors' wounds is that this performance occurred over a period of generally rising commodity prices. From 2008-2012, the iShares S&P GSCI Commodity Index Trust booked a total loss of 38% while the spot prices underlying the S&P GSCI recorded an increase of 6%. This abysmal performance is often blamed on a negative "roll yield" associated with the futures market being in contango.

In this paper, the model presented by Bessembinder et al (2012) is used to examine these issues in a rigorous fashion. Specifically, the theoretical model is used to demonstrate that futures returns are not directly related to the structure of the futures market or contango. The much discussed "roll return" does not exist. The model shows that in the absence of a risk premium, the expected return to a long futures position is zero. Moreover, the performance gap observed between ETF share price and the spot price of the underlying commodity is simply a rational reflection of storage costs.

An alternative explanation for the poor returns to long commodity investments is a systematic decline in risk premiums following the financialization of commodity markets around 2005 (Hamilton and Wu, 2012). Empirical estimates of the ex post spot premiums do not support the notion that risk premiums declined post-2005. The average risk premium estimated across 20 markets from 1990-2012 is a statistically insignificant 0.5%. Expense ratios for diversified commodity funds range from 0.75%-1.25% which are likely to absorb any market risk premium, if one exists at all.

Commodity investments are on the ropes. Staggered by their actual performance in the investment ring, these futures-based investments seemed to have been over-hyped. As a portfolio diversification tool, their performance in real-time has been poor (Daskalaki and Skiadopoulos, 2010). The mythical "return to roll" has been largely debunked (Burton and Karsh 2009; Sanders and Irwin 2012; Bessembinder et al. 2012) and the mystical portfolio level returns or the turning of "water into wine" (Erb and Harvey, 2006) have also been questioned (Willenbrock 2011). The inability to identify a reliable source of returns suggests that futures-based commodity investments may have weak legs. How could we have been so wrong?

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Table 1. Returns to Commodity-Linked Exchange Traded Funds, May 15, 2013

Symbol	Name	(millions) Assets	-----Total Return (%)----- 1 Year	3 Year	5 Year
DBC	DB Commodity Index Tracking Fund	5,618	-1%	16%	-33%
DJP	Dow Jones-UBS Commodity Index TR ETN	1,738	-1%	-1%	-41%
DBA	DB Agriculture Fund	1,663	-3%	8%	-29%
USO	United States Oil Fund	1,301	-6%	-7%	-67%
GSG	GSCI Commodity-Indexed Trust Fund	1,072	-2%	6%	-54%
UNG	United States Natural Gas Fund LP	927	25%	-64%	-95%
RJI	Rogers Intl Commodity ETN	632	0%	15%	-35%
GCC	Continuous Commodity Index Fund	453	-1%	8%	-20%
DBO	DB Oil Fund	439	-2%	3%	-43%
OIL	S&P GSCI Crude Oil Tot Ret Idx ETN	341	-5%	-3%	-70%
DBB	DB Base Metals Fund	311	-11%	-15%	-32%
DBP	DB Precious Metals Fund	265	-13%	9%	44%
DBE	DB Energy Fund	195	1%	11%	-42%
DGL	DB Gold Fund	184	-11%	8%	47%
UCI	E-TRACS UBS Bloomberg CMCI ETN	144	-1%	9%	-24%
JJG	DJ-UBS Grains Total Return Sub-Index ETN	113	15%	45%	-19%
GSP	S&P GSCI Total Return Index ETN	107	-2%	12%	-53%
JJC	DJ-UBS Copper Total Return Sub-Index ETN	105	-9%	-6%	-23%
JJA	DJ-UBS Agriculture Subindex Total Return ETN	92	2%	35%	-12%
RJN	Rogers Intl Commodity Enrgy ETN	70	0%	8%	-57%
GSC	GS Connect S&P GSCI Enh Commodity TR ETN	67	-3%	10%	-44%
GSC	GS Connect S&P GSCI Enh Commodity TR ETN	67	-3%	10%	-44%
UGA	United States Gasoline Fund LP	59	9%	57%	-5%
COW	DJ-UBS Livestock Total Return Sub-Index ETN	53	-5%	-15%	-41%
RJZ	Rogers Intl Commodity Metal ETN	49	-8%	-7%	-13%
	Weighted Average	**16,065**	**-1%**	**4%**	**-40%**

Note: Returns for the 25 largest futures-based funds as reported by ETF Database (http://etfdb.com/). It does not include returns to leveraged funds, short funds, or funds that did not have a 5-year performance record.

Table 2. Hypothetical Calculation of Market Returns

Time	m	(m-n)	$F_t(n)$ Nearby Futures (n)	$F_t(m)$ Next Futures (m)	C_t Cost of Storage	P_t Implied Spot Price(t)	$P_t(e^{ct})$ Implied Spot Price (t+1)	U_t Ex Post Premium	Change in Spot Price	Change in Cost of Storage	Change in Futures
1	59	30	100.00	101.00	0.0332%	99.04	99.08				
2	58	30	102.00	103.00	0.0325%	101.08	101.11	2.00%	2.03%	-0.0006%	1.96%
3	57	30	102.00	104.00	0.0647%	100.23	100.30	-0.87%	-0.84%	0.0322%	0.97%
4	56	30	101.00	101.00	0.0000%	101.00	101.00	0.70%	0.76%	-0.0647%	-2.93%
5	55	30	100.00	99.00	-0.0335%	100.84	100.81	-0.16%	-0.16%	-0.0335%	-2.00%

Table 3. Average Annualized Return Components, April 10, 2006 to December 31, 2012.

Variable	WTI Crude	Corn	Gold	Natural Gas
Cost of Storage (C_t)	14.1%	9.6%	2.0%	42.8%
Ex Post Spot Premium (U_t)	-9.5%	6.3%	13.4%	-53.0%
Appreciation in Implied Spot (C_t+U_t)	4.6%	15.9%	15.5%	-10.2%
Change in Cost of Storage [(m-1)*ΔC_t]	2.9%	0.3%	0.9%	3.4%
Futures Return (U_t+ [(m-1)*ΔC_t])	-6.6%	6.6%	14.3%	-49.5%
Performance Gap (C_t- [(m-1)*ΔC_t])	11.2%	9.3%	1.1%	39.4%
ETF Return	-10.5%	5.2%	12.7%	-50.1%

Note, the ETF returns are the actual returns for the U.S. Oil Fund for WTI crude oil. For the other markets, it is a simulated return based on nearby futures returns and an annual expense ratio of 0.45%.

Table 4. Estimated Ex Post Spot Risk Premiums, 1990-2012

	1990-2012		1990-2004		2005-2012		Subsample	
Market	Average	t-stat.	Average	t-stat.	Average	t-stat.	Difference	t-stat.
WTI Crude Oil	5.9%	0.71	11.6%	1.11	-4.8%	-0.35	-16.4%	-0.96
Brent Crude Oil	11.5%	1.50	13.3%	1.35	8.4%	0.68	-4.9%	-0.31
Heating Oil	3.9%	0.48	4.7%	0.45	2.4%	0.20	-2.4%	-0.15
RBOB Gasoline	17.6%	1.44	27.1%	1.31	11.8%	0.78	-15.3%	-0.61
Natural Gas	-21.0%	-1.69	-6.5%	-0.40	-46.2%	-2.38	-39.7%	-1.59
Gold	3.3%	0.97	-2.8%	-0.80	14.7%	2.03	17.5%	2.18
Silver	4.4%	0.72	-2.3%	-0.37	16.8%	1.26	19.1%	1.31
Copper	7.4%	1.26	4.7%	0.75	12.5%	1.03	7.8%	0.57
Corn	-5.5%	-0.98	-10.6%	-1.82	4.0%	0.33	14.6%	1.09
CBOT Wheat	-6.3%	-0.96	-8.1%	-1.11	-3.1%	-0.23	5.0%	0.33
KCBT Wheat	0.6%	0.10	-1.2%	-0.19	3.9%	0.33	5.1%	0.38
Soybeans	4.8%	0.91	1.4%	0.24	11.2%	1.06	9.8%	0.81
Soybean Meal	10.5%	1.85	6.8%	1.06	17.4%	1.58	10.7%	0.84
Soybean Oil	-0.5%	-0.09	-2.9%	-0.52	4.2%	0.45	7.1%	0.65
Rough Rice	-7.0%	-1.19	-9.8%	-1.29	-1.8%	-0.19	8.0%	0.68
Oats	-3.7%	-0.49	-5.2%	-0.56	-0.8%	-0.06	4.4%	0.28
Cotton	-5.7%	-0.91	-8.3%	-1.15	-0.9%	-0.07	7.5%	0.54
Cocoa	-3.5%	-0.51	-6.0%	-0.71	1.2%	0.11	7.2%	0.51
Coffee	-4.8%	-0.58	-4.5%	-0.40	-5.2%	-0.47	-0.7%	-0.04
Sugar	5.1%	0.64	3.2%	0.33	8.6%	0.61	5.4%	0.32
All	0.5%	0.33	-0.7%	-0.36	2.7%	0.98	3.4%	1.01

Note: RBOB Gasoline data start in January, 2000 and natural gas data start in 1991.

Table 5. Exchange Traded Fund Returns and Expenses, Annualized, 2008-2012.

				"Enhanced"
Index	**"GSCI"**	**"DJ-UBS"**	**"CRB"**	**GSCI**
Ticker Symbol	**GSG**	**DJP**	**GCC**	**GSC**
Mean Return	-9.07	-5.96	-1.79	-5.42
Expense Ratio	0.75	0.75	0.85	1.25

Note, the funds are defined as follows:
(GSG) iShares S&P GSCI Commodity-Indexed Trust
(DJP) iPath DJ-UBS Commodity Index Trust, Exchange Traded Note
(GCC) GreenHaven Continuous Commodity Index (data starts in February, 2008).
(GSC) GS Connect S&P GSCI Enhanced Commodity Trust, Exchange Traded Note

Figure 1. Commodity-Linked Investments, April, 2006 – February, 2011

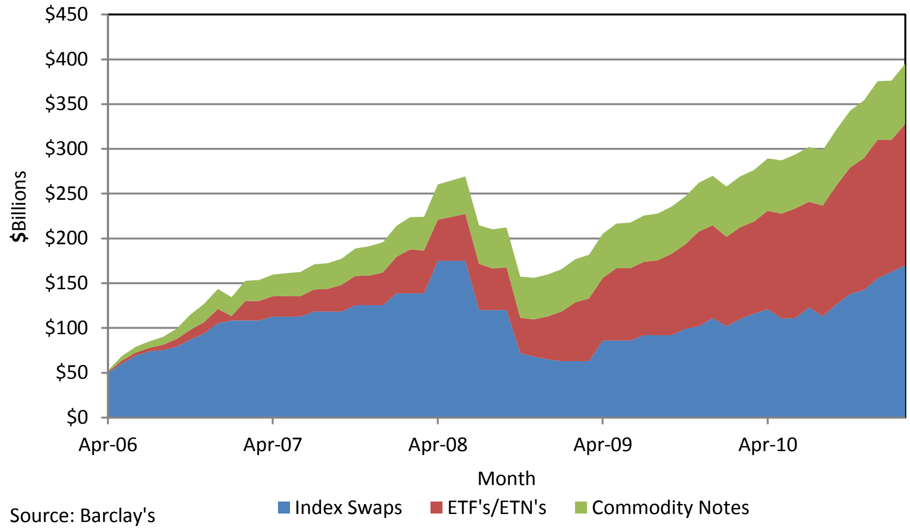

Figure 2. iShares S&P GSCI Commodity Index Trust, 2006-2012

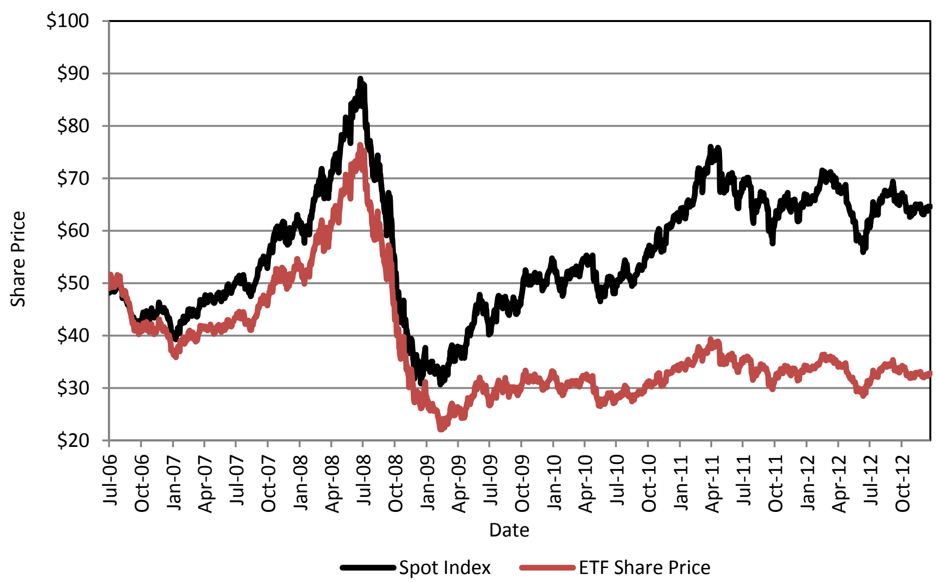

Figure 3. U.S. Oil Fund Share Price and Implied Spot Price, 2006-2012

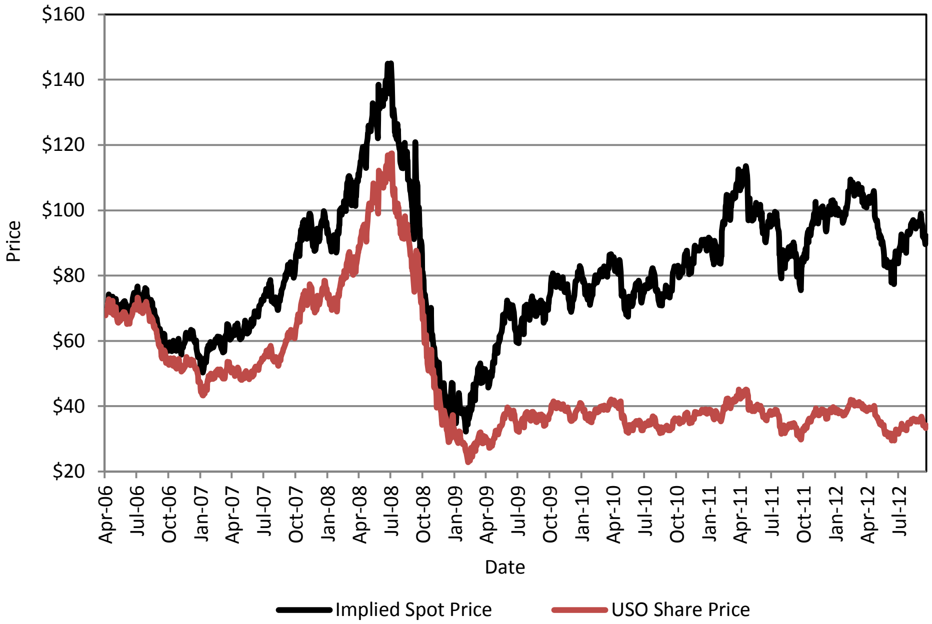

Figure 4. Simulated Gold ETF Share Price and Implied Spot Price, 2006-2012