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# An Update on Empirical Relationships in the Commodity Futures Markets

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# ABSTRACT

This article revisits a number of empirical relationships in the oil and commodity index futures markets. For example, the article examines how to put roll yields in proper perspective, which is that they are most properly seen as predictive of future returns over sufficiently long timeframes. But what then drives roll yields? The article examines this question primarily within the crude oil futures markets since, at least historically, oil has been the key return-generator and diversification-driver for a number of commodity indices, but most especially for the S&P GSCI index.

The paper argues that adequate OPEC spare capacity is the key variable for determining whether the global oil markets are comfortable with relatively low inventories. With adequate swing capacity, relatively large inventories are not needed in case of a supply disruption. When a commodity market has relatively low inventories, its futures curve typically trades in "backwardation" and thereby produces "positive roll yields" in commodity performance-attribution studies. Using historical data, the paper directly links both *reported* OPEC spare capacity and *reported* Saudi spare capacity with later realized oil roll yields. Clearly, one must be very careful with back-tested results in making future predictions, but at least these historical results add evidence to the paper's logical argument. In addition, the article discusses the potential for commodity indices and strategies that capitalize on backwardation to become in vogue again.

The paper also briefly covers another structural feature of the commodity futures markets that has potential for generating returns, and that is the returns due to rebalancing the components of a commodity futures portfolio or index. The article concludes by showing examples of empirical analyses where the diversification and inflation-hedging potential of oil and commodity futures indices becomes most apparent.

## INTRODUCTION

In this paper, we will provide commodity investors and traders with an update on a number of empirical relationships in the commodity futures markets. We should note at the outset that the paper has a particular focus on the crude oil futures markets. There are two reasons for this choice. First of all, the main commodity indices are heavily weighted in the petroleum complex, and so the fortunes of crude oil weigh heavily on commodity index results. For example, when one regresses S&P GSCI Total Returns against WTI Crude Oil's Excess Returns, using weekly data, from 12/30/94 to 1/24/14, the resulting R-squared is 84%. A second reason for the paper's oil focus is that in order for a commodity index to not only hedge bond investments against inflation, but also do so effectively for equity investments, then the index needs to have a concentration in the petroleum complex, as demonstrated by Kenneth Froot in a 1995 *Journal of Portfolio Management* article.

The first topic we will cover is how important the structural shape of the crude oil futures curve had been to historical returns, and how this feature could be emerging again as a dominant factor.

## ROLL YIELDS AND RELATED CONCEPTS

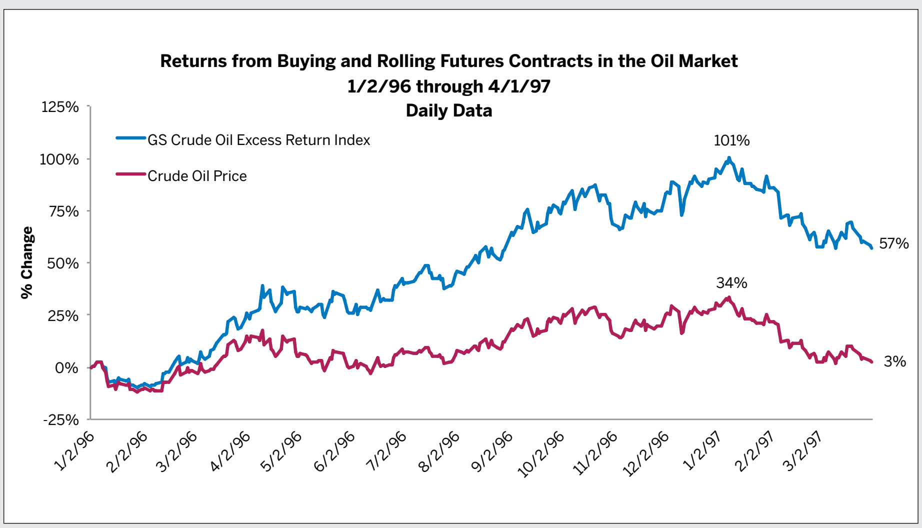
### Structural Shape of the Crude Oil Futures Curve

In the past, one could confidently discuss how crude oil futures contracts typically trade in "backwardation." By backwardation, one means that a near-month futures contract trades at a premium to deferred-delivery futures contracts. For example, a seminal 1995 *Journal of Finance* article by Robert Litzenberger and Nir Rabinowitz pointed out that the NYMEX West Texas Intermediate (WTI) crude oil futures contract's front-to-back futures spreads were backwardated at least 70% of the time between February 1984 and April 1992. This pattern was so persistent that these authors theorized why this should be the typical shape of the crude oil futures price curve.

Futures traders frequently refer to the term structure of a futures contract as a "curve": the futures prices for each maturity are on the y-axis while the maturity of each contract is plotted on the x-axis, which thereby traces out a "futures price curve."

Essentially, Litzenberger and Rabinowitz modeled oil reserves as a "call option whose exercise price corresponds to the extraction cost." As uncertainty about

**Figure 1**




*Graph based on "Backwardation in Commodity Markets," Goldman Sachs & Co., March 2003, Top Graph of Slide 6.*

Goldman Sachs: "The WTI Crude Oil Excess return index measures an investment in front month crude oil rolled forward each month to the next nearby contract keeping… [one] invested in prompt oil futures, and thereby allowing… [an investor] to take maximum potential of potential backwardation. Investment returns, as measured by the oil excess return index can be substantially higher than oil spot price changes. The cumulative effect of backwardation due to temporary price spikes can produce substantial returns. Prices do not need to be trending upwards to produce substantial returns."

the future price of oil increases, the (call option) value of reserves increases, motivating producers to leave oil in the ground. Therefore, as volatility increases, the spot price of oil needs to exceed its forward value by a sufficient margin in order to make it worthwhile for producers to extract oil in the near-term rather than leave reserves in the ground. Amongst the empirical results supporting their model, the authors found that backwardation in the oil futures markets had been significantly related to implied volatility, calculated from at-the-money oil options, from 1984 through 1992.

This structural feature of the crude oil futures market persisted for another 11 years. Goldman Sachs reported that from March 1983 through February 2003, the WTI futures contract had "been in backwardation 62% of the time[,] delivering an average yield of 0.78% per month."

Because of the persistence of backwardation in the crude oil futures market, practitioners could come up with the concept of a positive "roll yield," which is earned from continuously buying and rolling crude oil futures contracts. The idea is that even if the front-month price of a crude oil futures contract is stable, there can be a positive return since one is continuously buying deferred futures contracts at a discount to where they eventually converge to, resulting in an accumulating "roll yield" over time.

Figure 1 provides an example of this scenario using data from January 1996 to April 1997.

## ROLL YIELDS IN PERFORMANCE ATTRIBUTION

Further, in a 1998 *Journal of Alternative Investments* article by Mark Anson, one finds that from 1985 through 1997, roll yields accounted for essentially all of the futures-only returns in an investment indexed to the petroleum-complex-heavy (S&P) Goldman Sachs Commodity Index, as shown in Figure 2.

**Figure 2**

**Annual Returns (%): 1985 through 1997**

| | GSCI | | | |
|---|---|---|---|---|
| | **Total Return** | **Spot Return** | **Roll Yield** | **T-Bill Return** |
| 1985 | 9.48 | 0.26 | 1.25 | 7.97 |
| 1986 | 5.00 | -18.76 | 17.49 | 6.26 |
| 1987 | 22.60 | 3.18 | 13.21 | 6.21 |
| 1988 | 26.01 | 12.22 | 6.62 | 7.17 |
| 1989 | 34.29 | 12.39 | 13.09 | 8.82 |
| 1990 | 27.02 | 6.14 | 12.71 | 8.18 |
| 1991 | -3.73 | -19.57 | 10.19 | 5.64 |
| 1992 | 4.40 | 2.31 | -1.51 | 3.60 |
| 1993 | -12.42 | -9.64 | -5.86 | 3.08 |
| 1994 | 5.96 | 10.52 | -8.99 | 4.43 |
| 1995 | 19.52 | 12.58 | 1.11 | 5.84 |
| 1996 | 31.45 | 5.78 | 20.27 | 5.40 |
| 1997 | -13.36 | -18.41 | -0.18 | 5.23 |
| Arithmetic Mean | 12.02 | -0.08 | 6.11 | 5.99 |
| Standard Deviation | 16.08 | 12.33 | 9.16 | 1.73 |

*Table excerpted from "Spot Returns, Roll Yield, and Diversification with Commodity Futures" by Mark Anson, Journal of Alternative Investments, Winter 1998, Left-Hand-Side of Exhibit 1.*

Anson's performance-attribution table shows the total returns of a collateralized commodity futures program as being due to (1) spot return; (2) roll yield; and (3) the T-Bill return. The spot return and the roll yield account for the "futures only" return of the program. Once one includes the T-Bill return from fully collateralizing the program, one arrives at the total return of such a program. We should emphasize that both the spot return and the roll yield are artifacts of this particular method of performance attribution. In a futures program, one cannot receive the spot return separate from the roll yield; and correspondingly, one cannot directly receive the roll yield separate from the spot return. Again, though, the advantage of this type of performance attribution is it makes clear that buying and rolling a structurally backwardated commodity futures contract can have positive returns, even when its spot price is stable (or mean-reverts.) The careful reader is referred to the 2009 Credit Suisse Asset Management commodity white paper, "Capitalizing on Any Curve," for precise calculations of spot returns, roll yield, collateral returns, and total returns. In addition, the sophisticated reader is directed to the 2014 Campbell & Company white paper, "Deconstructing Futures Returns: The Role of Roll Yield," for subtle insights into the significance of roll yield across all asset classes that have futures contracts, including bonds, currencies, equities, and of course, commodities.

## ANOTHER STRUCTURAL FEATURE OF COMMODITY MARKETS: MEAN REVERSION

It is advisable for any prospective long-term commodity futures strategy to take into consideration another structural feature of commodity markets: mean reversion. Helyette Geman explained in the 2005 Commodities and Commodity Derivatives textbook that "commodity prices neither grow nor decline on average; they tend to mean-revert to a level which may be viewed as the marginal cost of production. This has been evidenced a number of times in the literature… [for both] agricultural… and… energy commodities. Hence, mean-reversion is one of the main properties that has been systematically incorporated in the literature on commodity price modeling." That said, Geman sounded a note of caution regarding crude oil, stating that modeling may need to take into consideration a trend to a higher level of crude prices around which prices would then fluctuate.

Of course, a noteworthy exception to commodity price mean-reversion is during rare times of currency devaluation such as occurred after the breakdown of the Bretton Woods accord in 1971.

In the absence of currency devaluation, the mean-reversion of commodity prices can have meaningful consequences for returns at the portfolio- or index-level. Specifically, this feature is at the root of an additional source of return, quite separate from trends in spot prices or the potential persistence of curve-structure effects: the return from rebalancing. Claude Erb and Campbell Harvey discuss in a 2006 *Financial Analyst Journal* paper how there can be meaningful returns from rebalancing a portfolio of lowly-correlated, high-variance instruments. "Commodity futures contracts happen to display… [these] characteristics…," note Dwight Sanders and Scott Irwin in a 2011 *Applied Economic Perspectives and Policy* paper. Scott Willenbrock further explains in a 2011 *Financial Analysts Journal* paper that rebalancing "forces the investor to sell assets that have appreciated in relative value and buy assets that have declined in relative value, as measured by their weights in… [a] portfolio." Erb and Harvey conclude that the returns from rebalancing are the one "reasonably reliable source of return" from owning (and rolling) a basket of commodity futures contracts.

In a sense, the potential return from rebalancing at the portfolio-level and the potential return from roll yield at the individual-commodity-futures-contract-level are related. If commodities have a tendency over long enough timeframes to mean-revert, then by construction, returns cannot be due to a long-term appreciation in spot prices. In that case, over a sufficient timeframe, the futures-only return for a futures contract would collapse to its roll yield, as explained in the 2014 Campbell & Company white paper. And then at the portfolio level, the mean reversion of individual commodity components provides the potential for a further return from rebalancing.

## ROLLING A FUTURES CONTRACT DOES NOT ACTUALLY GENERATE RETURNS

Now, both practitioners and academics have recently pointed out that one needs to be very careful in defining commodity futures "roll yields." The act of rolling from one contract to the next does not in itself generate returns, just as selling Ford stock to buy GM stock does not in itself generate returns, as explained by Sanders and Irwin. Instead, roll yields are an artifact of one type of performance attribution, as discussed above. As a result, one can readily find in the academic literature, theoretical models that identify *economic* sources of return from holding commodity futures contracts, which squeeze out a role for roll yields.

## THE COMMODITY FUTURES CURVE'S STRUCTURAL SHAPE CAN BE PREDICTIVE OF FUTURES RETURNS

That said, there is comfort in the peer-reviewed literature with treating roll yields and a commodity futures contract's curve shape as *predictive* of future returns, which we hinted at in the Campbell & Company reference above. For example, amongst the research covering this topic, Gary Gorton, Fumio Hayashi, and Geert Rouwenhorst examine 31 commodity futures over the period, 1971 to 2010, in a 2013 *Review of Finance* paper. They find that "a portfolio that selects commodities with a relatively high basis… significantly outperforms a portfolio with a low basis…" The authors define "basis" as "the difference between the current spot price and the contemporaneous futures price." In other words, the winning portfolios contain futures contracts that are relatively more backwardated than the losing portfolios. The authors provide a fundamental rationale for their results, linking relatively high-basis futures contracts with relatively low inventories (and correspondingly, relatively more scarcity.)

In related findings, other authors, starting with Daniel Nash and Boris Shrayer, have variously shown how the level and frequency of backwardation have determined returns *across individual commodity futures contracts* over approximately 15-to-20-year timeframes. For example, please see Figure 3.

**Figure 3**

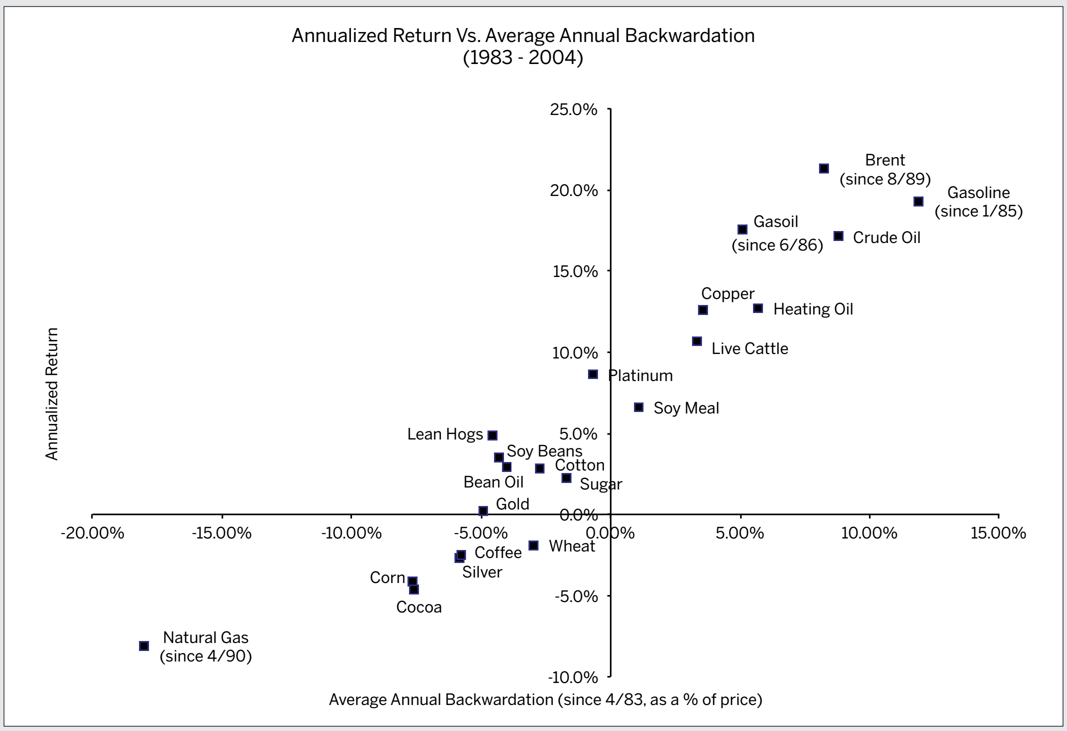
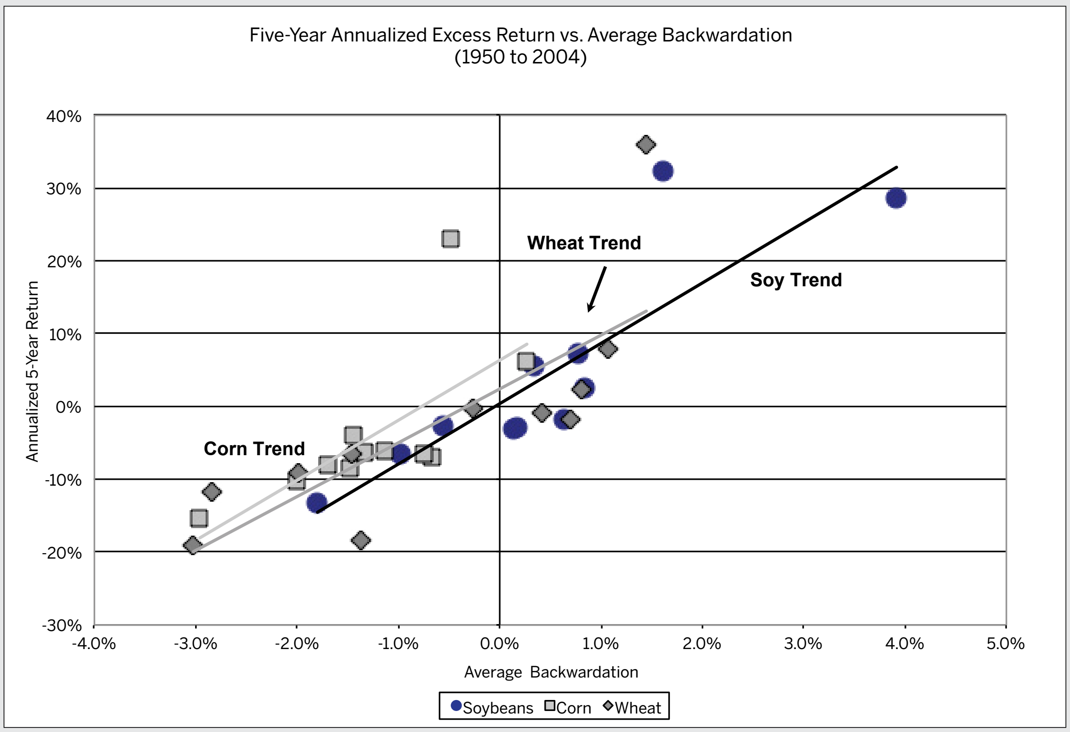



*Table based on "Investing in Commodities" by Daniel Nash and Boris Shrayer, Morgan Stanley Presentation, IQPC Conference on Portfolio Diversification with Commodities, London, May 24, 2005, Slide 2.*

Separately but related, Barry Feldman and Hilary Till discuss in a 2006 *Journal of Alternative Investments* article how, over a 50-year-plus timeframe, the returns of three agricultural futures contracts were linearly related to their curve shapes *across time*, clarifying that this result only became apparent at five-year intervals, as shown in Figure 4.

Figures 3 and 4 illustrate the connection, over sufficiently long timeframes, of a futures market's returns to the commodity's structural futures curve shape. We will now discuss the connection of a commodity's futures curve to its inventory situation. Gorton, Hayashi, and Rouwenhorst formally confirmed this relationship, which is a result that will not surprise practitioners.

**Figure 4**




*Graph based on research undertaken during the work that led to the article, "Backwardation and Commodity Futures Performance: Evidence from Evolving Agricultural Futures Markets," by Barry Feldman and Hilary Till, Journal of Alternative Investments, Winter 2006.*

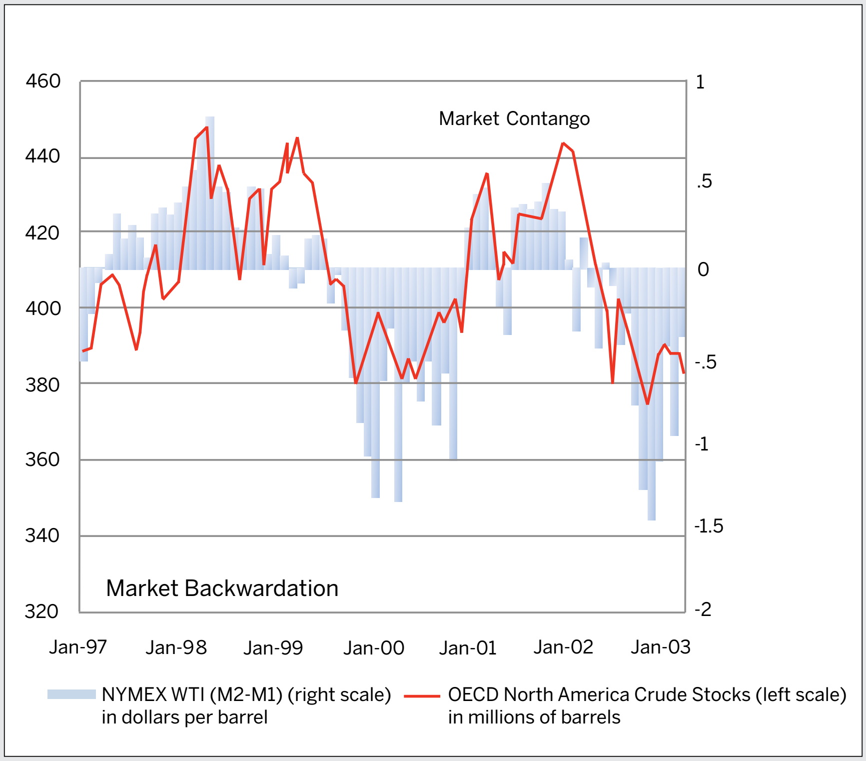
"Average backwardation" is here defined as the average *monthly* "percentage of backwardation" for each front-month agricultural futures contract, calculated over five-year time horizons.

"Excess return" refers to the futures-only returns from buying and rolling futures contracts. This return calculation excludes returns from the collateral that would be held in fully collateralizing such a program. Therefore, they are the returns in "excess" of the collateral return.

For further detail on these calculations, please refer to the journal article.

**Figure 5**

**Inventories vs. Market Contango/Backwardation**




*Graph based on "Stocks and the Oil Market: Low Stocks, Volatility, Price Levels, and Backwardation" by Harry Tchilinguirian, International Energy Agency – Oil Industry & Markets Division Presentation, Berlin, September 19, 2003, Left-Hand-Side of Slide 18.*

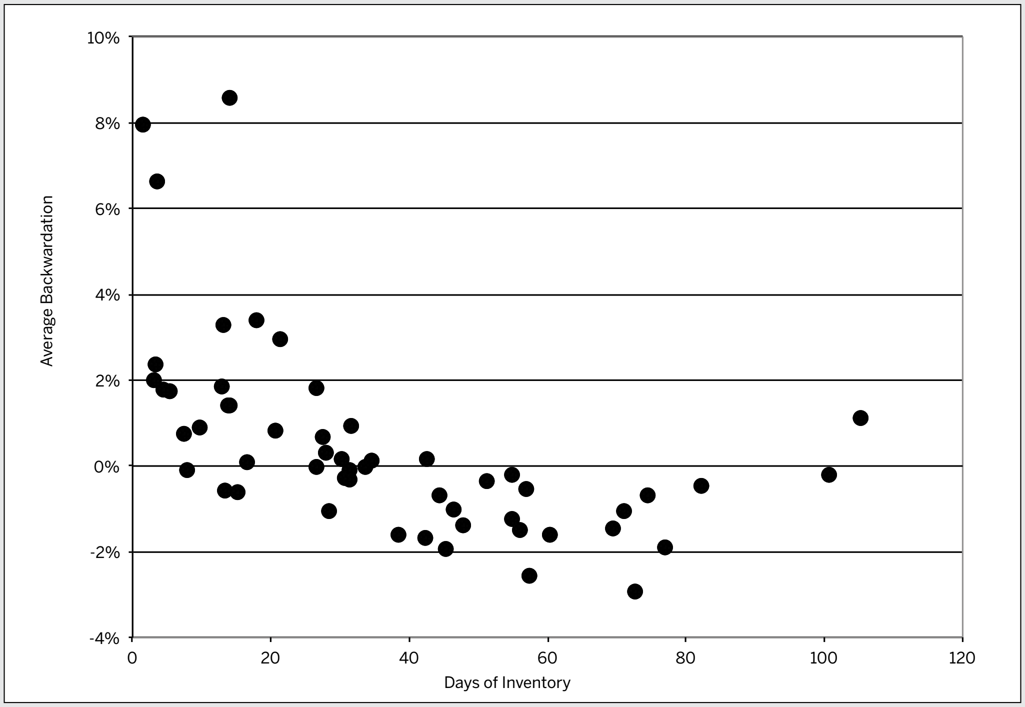
*Abbreviations: NYMEX = New York Mercantile Exchange; OECD = Organization for Economic Co-operation and Development; and M2- M1 = Second-Month Futures Contract Price Minus First-Month Futures Contract Price.*

For example, Harry Tchilinguirian, now of BNP Paribas, illustrated the relationship of the crude oil futures curve shape to inventories, across time, at a 2006 International Energy Agency (IEA) conference. This graph is reproduced in Figure 5.

Further, Feldman and Till demonstrate the familiar relationship between a commodity's futures curve shape and its inventories in a scatter plot, using long-term data in the soybean markets, as shown in Figure 6 (shown on the following page).

**Figure 6**

**Soybean Backwardation as a Function of Remaining Days of Inventory 1950–2004**




*Graph based on "Backwardation and Commodity Futures Performance: Evidence from Evolving Agricultural Futures Markets" by Barry Feldman and Hilary Till, Journal of Alternative Investments, Winter 2006, Exhibit 9.*

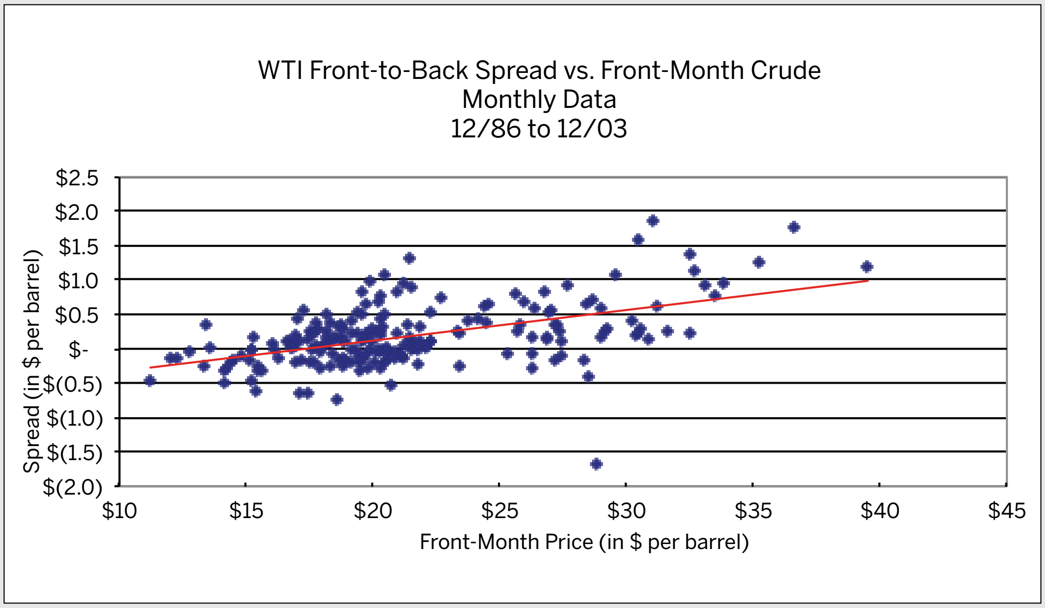


## 2004'S STRUCTURAL BREAK IN THE OIL MARKETS

There is a considerable amount of evidence, from which we have briefly sampled, that a commodity's curve shape is related to its scale of inventories; and that over sufficiently long timeframes, a number of authors have been able to find a relationship between a commodity's curve shape and its futures returns. With this understanding, we will now look into a structural break that occurred in the crude oil futures markets in 2004. After discussing this structural break, we will note how it is very plausible that we are in the midst of reverting to the state-of-the-world where roll yields could resume in their importance.

Prior to 2004, if there were scarcity in the crude-oil market, one could expect two outcomes: (1) increasing spot prices; and (2) for the front-month price to trade at an ever larger premium to deferred-delivery contracts. In this state-of-the-world, the market would be encouraging the commodity's immediate use (rather than for it to be stored.)

**Figure 7**




*Source of Data: The Bloomberg.*

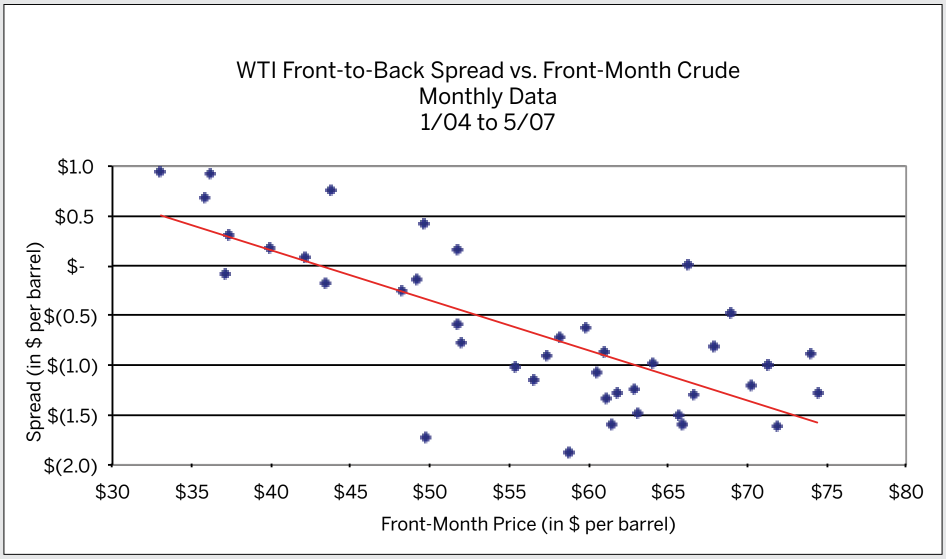
The pre-2004 relationship of crude oil to its curve is illustrated in Figure 7. There had been a +52% correlation between the level of outright crude prices and the level of front-to-back-month calendar spreads from December 1986 through December 2003.

A calendar spread is the difference in price between two different delivery months for a futures contract. The phrase, *front-to-back-month calendar spread*, refers to the difference in price between the immediately deliverable futures contract and the next deferred delivery month contract. When the front-month futures price is greater than the back-month price, the spread is positive.

As discussed at the outset of this paper, when the front-month price trades at a premium to the deferred-delivery contracts, this is known as *backwardation*. When a futures curve instead trades in contango, the front-month price trades at a discount to the deferred-delivery contract. In times of surplus, inventory holders receive a return-to-storage, as represented by the size of the contango, since they can buy the crude oil immediately at a lower price and lock in positive returns to storage by simultaneously selling the higher-priced contract for a future delivery. If inventories breach primary storage capacity, the crude curve will trade into deeper contango, so as to provide a return for placing the commodity in more expensive, secondary storage (or eventually, tertiary storage.)

In other words, the general relationship is the more crude stocks that need to be stored, the more the crude curve trades in contango. And correspondingly, the more scarce crude oil inventories are, the more the crude futures curve trades in backwardation. One would normally expect, therefore, for backwardation to be associated with a tendency for periodically higher prices.

**Figure 8**

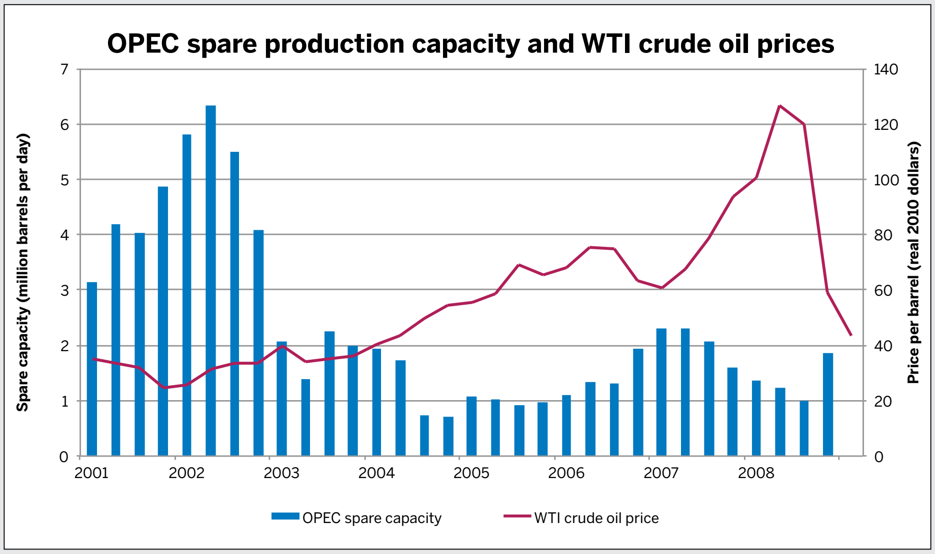



*Source of Data: The Bloomberg.*

The WTI crude curve's structural relationship changed from 2004-to-the-summer-of-2007. During that time period, the level of crude-oil prices became -75% correlated with its corresponding calendar spread. This is illustrated in Figure 8.

Through the summer of 2007, the structural rigidities in the crude oil market translated into large contangos and high flat prices. This had been very unusual based on previous experience and contrary to many market participants' understanding of the technical features of the crude oil futures markets.

Figure 9




*Graph is excerpted from "What Drives Crude Oil Prices?" U.S. Energy Information Administration Presentation, Washington, D.C., January 8, 2014, Slide 12.*

*U.S. Energy Information Administration (EIA): "The extent to which OPEC member countries utilize their available production capacity is often used as an indicator of the tightness of global oil markets... EIA defines spare capacity as the volume of production that can be brought on within 30 days and sustained for at least 90 days.... OPEC spare capacity provides an indicator of the world oil market's ability to respond to potential crises that reduce oil supplies."*

What changed during 2004? Please note Figure 9. During mid-2004, OPEC's immediately-deliverable spare capacity *collapsed*. The International Monetary Fund (IMF) later explained that this occurred because of "[s]ynchronized global growth, high oil demand (especially from China), and a series of supply disruptions..."

## WHY DOES THIS MATTER?

As explained by Kevin Harrington of Clarium Capital Management, the true inventories for crude oil should be represented as above-ground stocks *plus* excess capacity. Historically, the markets had been able to tolerate relatively low oil inventories because there was sufficient swing capacity that could be brought on stream relatively quickly in the case of any supply disruption. Indeed, as noted in a 2007 presentation by an OPEC upstream oil analyst, it has been OPEC's policy to attempt to provide sufficient spare capacity to enhance stability in the oil markets. The IMF has even referred to the "maintenance of adequate spare capacity as a public good" because of the role that spare capacity plays in reducing the volatility of oil prices.

Nevertheless during 2004, the oil market's excess supply cushion dropped to sufficiently low levels that there were two resulting market responses: (1) there were continuously high spot prices to encourage consumer conservation, and (2) the market undertook precautionary stock building, which arguably led to the persistent (but not continuous) contangos that the crude oil market began experiencing in late 2004. In this concrete example, we see how in one state-of-the-world, high prices are associated with backwardation, while in another state-of-the-world, high prices are associated with contango.

By July 2008 the excess-capacity cushion became exceptionally small relative to the risk of supply disruptions due to naturally-occurring weather events as well as due to well-telegraphed-and-perhaps-well-rehearsed geopolitical confrontations. At that point, the role of the spot price of oil was arguably to find a level that would bring about sufficient demand destruction to increase spare capacity, which did occur quite dramatically, starting in the summer of 2008, after which the spot price of oil spectacularly dropped by about $100 per barrel by the end of 2008.

The comprehensive story of 2008 is clearly one not restricted to dramatic changes in the oil markets. A brief review of the Great Recession and the Global Financial Crisis and their aftermath, along with their impact on the oil and wider commodity markets is covered in Appendix A.

In addition, Appendix B very briefly discusses how alert traders had at least two signals that the fundamental underpinnings of the oil-price rally were diminishing by late spring 2008.

Returning to the spare-capacity discussion, based on the foregoing, we would observe that a state-of-the-world, where a sufficient excess supply cushion exists, is one where (a) lower inventories can be safely held; and (b) the role of the spot price of oil would therefore not be to elicit demand destruction. It is very plausible that we are now precisely in that state-of-the-world.

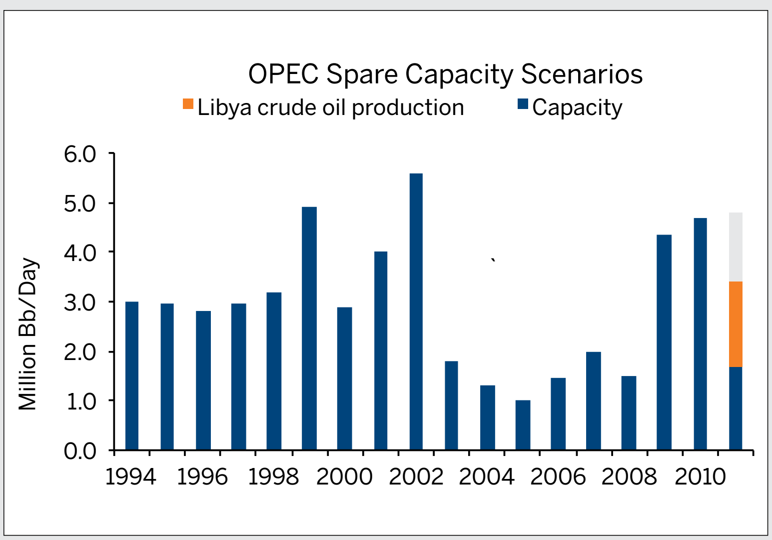
The careful reader may note a particular emphasis on OPEC spare capacity, ignoring non-OPEC producers. The IMF has explained that "non-OPEC producers do not have the incentive to maintain spare capacity as they individually lack the necessary market power to influence oil prices."

Now, a complicating factor in measuring OPEC spare capacity is if there are *potential* shutdowns in a member country. Figure 10 shows how Deutsche Bank illustrated a range of potential OPEC spare capacity scenarios in 2011, which is a logical way of presenting the uncertainty around this metric.

## POSSIBLE RETURN IN IMPORTANCE OF ROLL YIELDS

If sufficient OPEC spare capacity is in question, then the holding of precautionary stocks would be a rational response. But if it is the case that sufficient OPEC spare capacity is, instead, not in question, then we would be, once again, in a Litzenberger-and-Rabinowitz state-of-the-world. In this state-of-the-world, expensive-to-store oil inventories are left in the ground unless the spot price is at a sufficient premium to the value of forward production. The Litzenberger-and-Rabinowitz state-of-the-world is precisely one where the crude oil futures curve is reliably backwardated. And earlier in this paper, we touched on various performance results, which on average were positive, when the crude oil futures curve had been structurally backwardated (resulting in positive "roll yields.")

**Figure 10**




*Graph based on "Commodities Weekly" by Michael Lewis and Deutsche Bank Research Team, Deutsche Bank Global Markets Research, February 25, 2011, Page 1.*

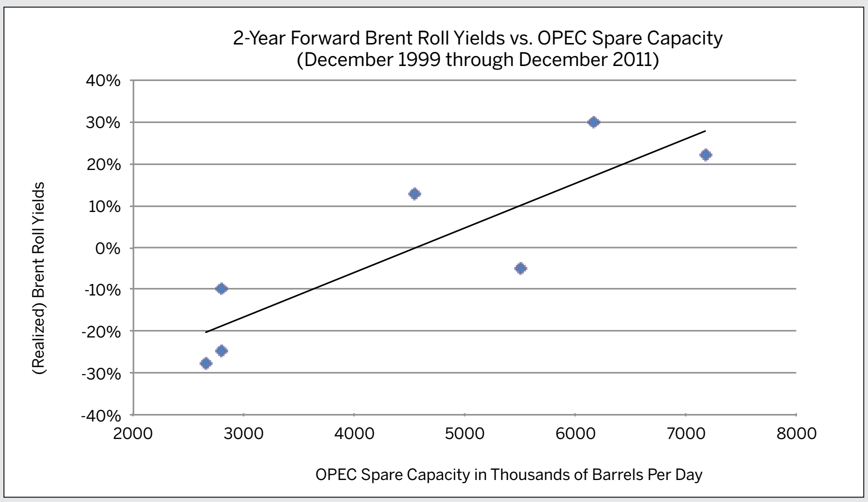
Could we be in a state-of-the-world where fears on worryingly low OPEC spare capacity are diminishing? There is definitely not universal agreement on this topic, but at least according to the International Energy Agency (IEA), "OPEC's spare crude oil production capacity will surge 25 percent in the next two years as rising U.S. shale output crimps demand for the group's supplies," reported *Bloomberg News* in May 2013. Further, "the Organization of Petroleum Exporting Countries is forecast to increase its implied spare output capacity to a peak at 7.18 million barrels per day in 2015…, the IEA said…" Lastly, "… the U.S. [could] become the world's top producer by 2020, displacing Saudi Arabia, according to the IEA." At the time, the IEA also stated in a press release that the increase "in North American oil production will be as transformative to the market over the next five years as was the rise of Chinese demand over the last 15."

More recently in January 2014, the PIRA Energy Group, a private energy information provider, predicted that "OPEC spare capacity… [will] grow over the next few years." In addition, BP's January 2014 Energy Outlook included a (base-case) forecast that by 2018, OPEC spare capacity would increase to levels last seen in the late 1980s.

## THE CASE OF BRENT

Based on the foregoing review, one might expect that the higher that OPEC spare capacity figures are, the less precautionary global oil inventories would be held, leading to structurally backwardated crude oil futures curves and positive roll yields. Figure 11 demonstrates an empirical relationship that supports this argument, at least over the time period of this data set. The figure specifically illustrates how linearly related 2-year forward *realized*

**Figure 11**




*Source of Data: The Bloomberg.*

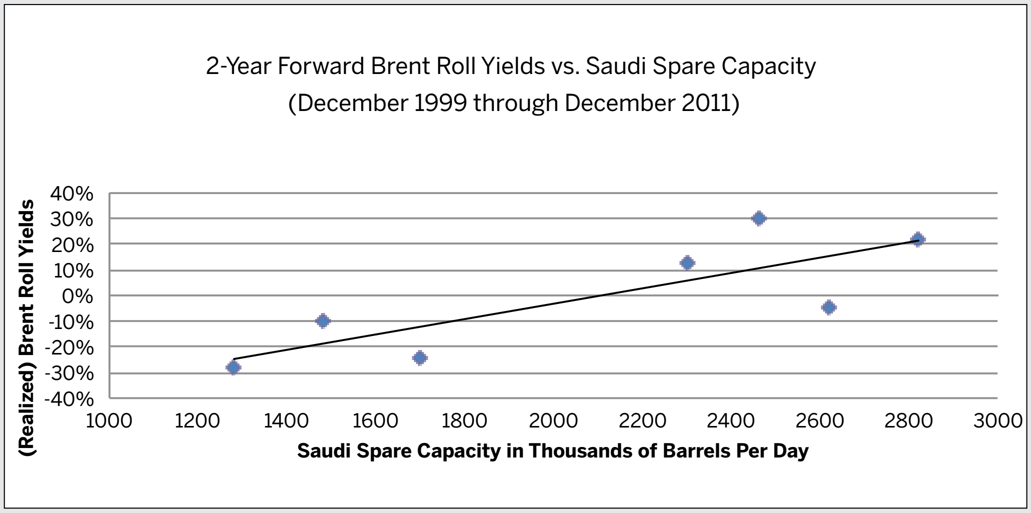
*OPEC Spare Capacity was constructed from the Bloomberg tickers: OPCRECTO <index> - OPCRTOTL <index>, where OPCRECTO is Bloomberg's "OPEC Crude Oil OPEC[-]12 Total Estimated Production Capacity Data," and OPCRTOTL is Bloomberg's "Total OPEC Crude Oil Production Output Data." Bloomberg News gathers estimates of these figures "from confidential sources within the various countries," according to Bloomberg staff.*

*Of note is that official reporting agencies and professional oil analysts use different definitions of OPEC spare capacity, including what precisely "effective" spare capacity actually is.*

*The 2-year Brent roll yields were calculated as the difference between the 2-year Brent futures excess returns and the 2-year Brent spot returns, using the following Bloomberg tickers respectively, SPGSBRP <index> and SPGSBR <index>. This calculation is consistent with the advice provided by the previously referenced Credit Suisse Asset Management white paper, which explained that "[o]ne way to calculate roll yield is to take the difference between the return of the Spot Index, which represents the static prices of the next-to-delivery futures contracts, and the return of the Excess Return Index, which takes into account the impact of rolling forward futures contracts."*

*Each data-point of the graph represents a year-end OPEC spare capacity calculation, starting in 1999, twinned with the realized Brent roll yield for the following two years. The two data series have a correlation of 87%. In December 2013, the OPEC spare capacity figure was 6,085,000 barrels per day, according to Bloomberg data.*

**Figure 12**




*Source of Data: The Bloomberg.*

*Saudi Arabian Spare Capacity was constructed from the Bloomberg tickers: OPCRECA <index> - OPCRSAUD <index>.*

*Each data-point of the graph represents a year-end reported Saudi spare capacity calculation, starting in 1999, twinned with the realized Brent roll yield for the following two years.*

*The two data series have a correlation of 80%.*

*In December 2013, the reported Saudi Arabian spare capacity figure was 2,820,000 barrels per day, according to Bloomberg data.*

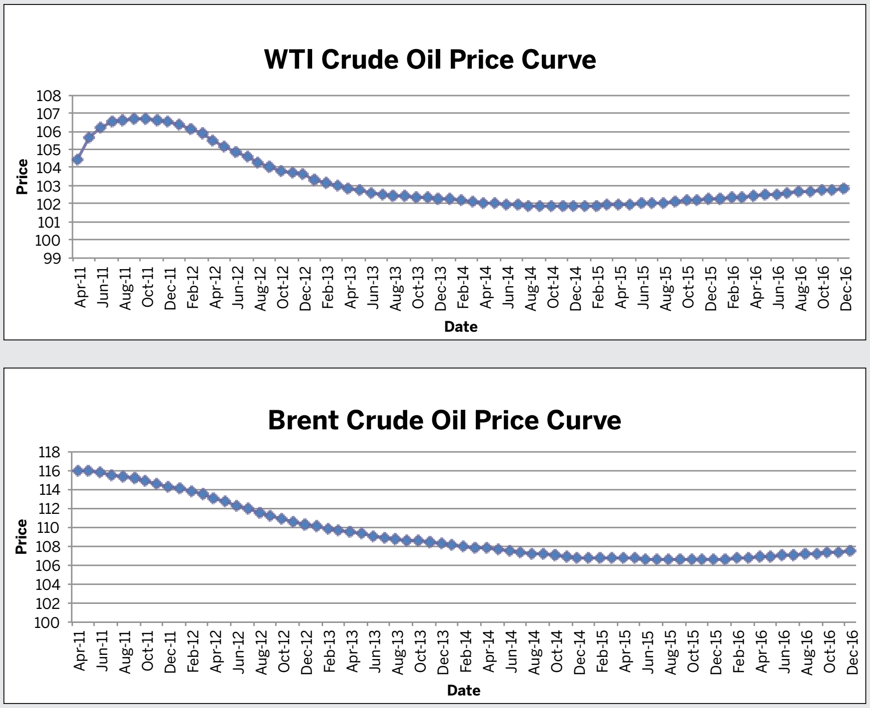
Brent crude roll yields had been to levels of OPEC spare capacity, calculated from Bloomberg data, over the time period, December 1999 through December 2011.

Now, the U.S. Energy Information Administration has cautioned that "virtually all" of the *effective* spare capacity in OPEC is in Saudi Arabia. Therefore, in order to be conservative, Figure 12 isolates the *reported* spare capacity of Saudi Arabia. This figure demonstrates a similar empirical relationship as in Figure 11, when we compare only the spare capacity of Saudi Arabia with later realized Brent roll yields.

**Figure 13**

**12/31/08 to 2/28/11 Annualized Excess Returns:**

**WTI: 3.5%** **Brent 27.4%**



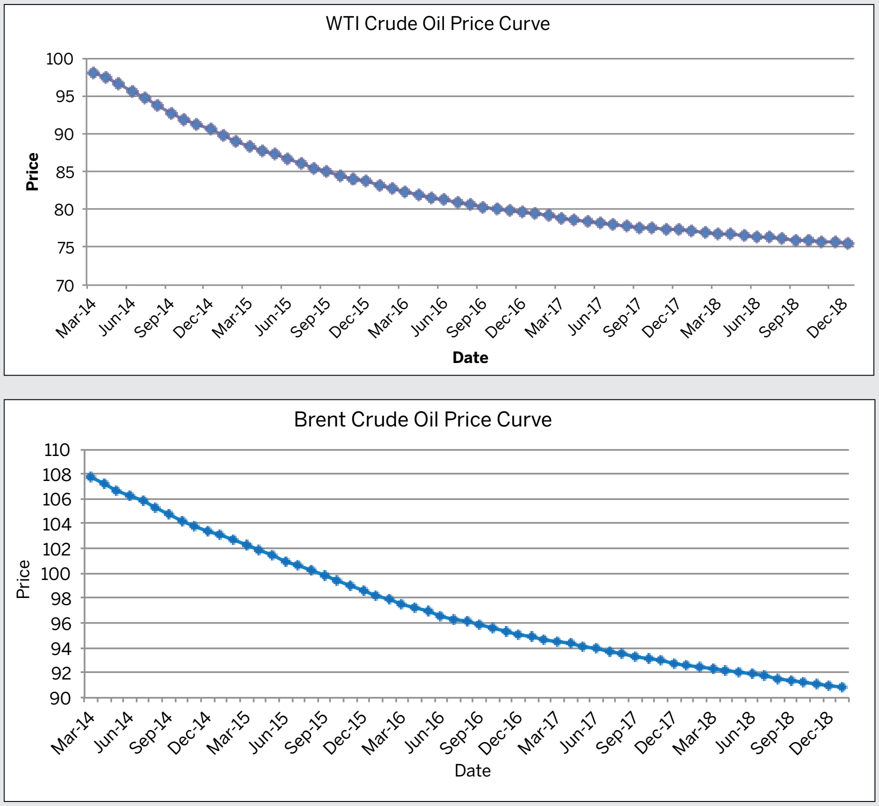

*Source of Data: The Bloomberg. Futures as of March 4, 2011.*
*(Bloomberg Tickets for Return Calculation: WTI: SPGCCLP and Brent SPGCBRP.)*

## THE CASE OF WTI

One issue with applying an analysis, such as the one above, to a particular crude oil futures curve's dynamics is that the contract would need to be seamlessly connected to the global oil markets. After all, we are using a measure of global oil market tightness, as a plausible explanatory variable for future roll yields. But, as noted in the *Financial Times* in 2011, "From time to time, the [WTI] contract [has] disconnect[ed] from the global oil market due to logistical troubles at its landlocked point of delivery in Cushing, Oklahoma." The result has been a different curve shape and different returns from buying and holding Brent crude futures contracts versus WTI crude futures contracts. For example, please see Figure 13.

Platts has noted that "many pieces of the logistical puzzle" in North America are now falling into place, due to the "ingenuity of logistical engineers," in managing the increase in U.S. domestic crude supplies. Further, JP Morgan researchers have written that: "(1) aged market structures in energy are organically evolving into new forms in order to match supply with demand, (2) the pace of change is happening more rapidly than conventional wisdom has expected, but also (3) as evidence of fundamentally-driven change mounts, energy producers, consumers, and investors are demonstrating remarkable adaptability." Essentially, "the boom in… [domestic oil] production has been well absorbed by existing U.S. infrastructure… [T]ruck, rail, and barge have all served to

**Figure 14**




*Source of Data: The Bloomberg. Futures as of March 4, 2011.*
*(Bloomberg Tickets for Return Calculation: WTI: SPGCCLP and Brent SPGCBRP.)*

move the large increase in domestic crude supplies to U.S. refineries," whom, in turn, can export petroleum *products* abroad. This has been the mechanism for connecting the U.S. oil markets to global markets since exporting crude oil *itself* is presently illegal with some minor exceptions. To the extent that this logistical ingenuity continues, one could be justified in seeing a return in the importance of roll yields as an ongoing driver of returns for holding WTI oil futures contracts, just as has been the case for Brent oil futures contracts. Figure 14 shows how both the WTI and Brent oil curves are currently trading in backwardation.

## GOING FORWARD: BACKWARDATION, ROLL YIELDS, SWING CAPACITY, AND INVENTORIES

If this paper's analysis is correct, one consequence could be that a whole host of systematic futures strategies and indexes that exploit structural backwardation might properly become in vogue again. For example, JP Morgan commodity researchers noted in December 2013 that amongst 65 commodity index products, two of the indexes, which emphasize backwardation, may have excellent prospects over the next two years.

Further, PIMCO's commodity portfolio managers noted in September 2013 that "as long as Saudi Arabia maintains the ability to manage imbalances in the market and shale extraction prospects remain good, we expect the oil market roll yield to look similar to that in the 1990s…" In other words, we may be returning to a Litzenberger-and-Rabinowitz state-of-the-world, where we should revisit the research done in the 1990s on structural drivers of oil-futures and commodity-index returns.

We had noted previously that a state-of-the-world where a sufficient excess supply cushion can be taken for granted is one where lower inventories can be safely held. Of note is that in February 2014, the IEA reported that oil inventories, at least in the OECD, stood below their five-year average, as of the end of December 2013.

***

We will now turn to examining three other empirical features of these markets: their relationship to equities and inflation and also to global monetary conditions.

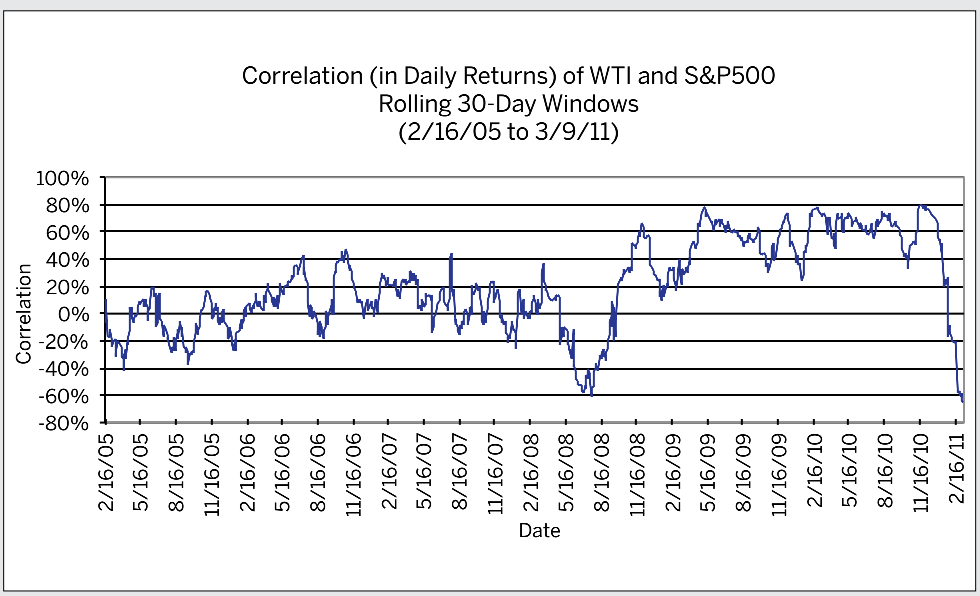
## THE EMPIRICAL RELATIONSHIP BETWEEN EQUITIES AND OIL

At least in the past, a commodity's futures contract has more effectively captured upside surprises than, for example, the stock price for a company that is involved in the production and exploration for the commodity. Part of the reason that the stock price for international natural resource companies, such as ones involved in the production and exploration of oil, can lag relative to the price of the commodity is the propensity for governments to assess windfall profit taxes on the companies, thereby limiting the upside benefit of the commodity's price rally. It might be prudent to expect that this propensity will continue.

The following is another consideration.

Arguably in the global economic recovery that ensued after the spring of 2009, investing in the U.S. equity market, as an alternative to investing in oil, seemed to be a reasonable alternative since both assets appeared to benefit from the global reflationary environment. The downside to this approach is that at sufficiently high prices of crude oil, this correlation can break down, as challenges to global economic growth become priced in. We note that this occurred in the spring of 2011 and is illustrated in Figure 15, which shows the rolling correlations of the returns for the S&P 500 vs. crude oil from February 2005 through March 2011.

**Figure 15**




*Graph based on "Oil and Equities: Correlation Breakdown" by Harry Tchilingurian, BNP Paribas Oil Market Comment, Commodity Markets Strategy Group Research, March 7, 2011, Chart 3.*

As far as the potential of commodities to diversify an equity portfolio is concerned, S&P Dow Jones Indices has pointed out the following historical fact: "In only 4 years from 1970 through 2012 did both the S&P 500 and the S&P GSCI [simultaneously] drop in value[,]" which in turn occurred in "1981, 2001, 2008, [and] 2011."

## THE EMPIRICAL RELATIONSHIP BETWEEN INFLATION AND COMMODITY PRICES

In general, a difficulty with examining the empirical relationship between inflation and commodities is that commodity prices are very volatile while reported inflation rates change in a relatively smooth fashion. Analogous to the roll-yield discussion above, one needs to carry out studies over long enough holding periods in order for the relationship to clearly manifest itself. For example, in a 2006 *Financial Analysts Journal* paper, Gorton and Rouwenhorst demonstrate how the correlation of commodities to inflation builds over ever-longer holding periods, as shown in Figure 16.

**Figure 16**

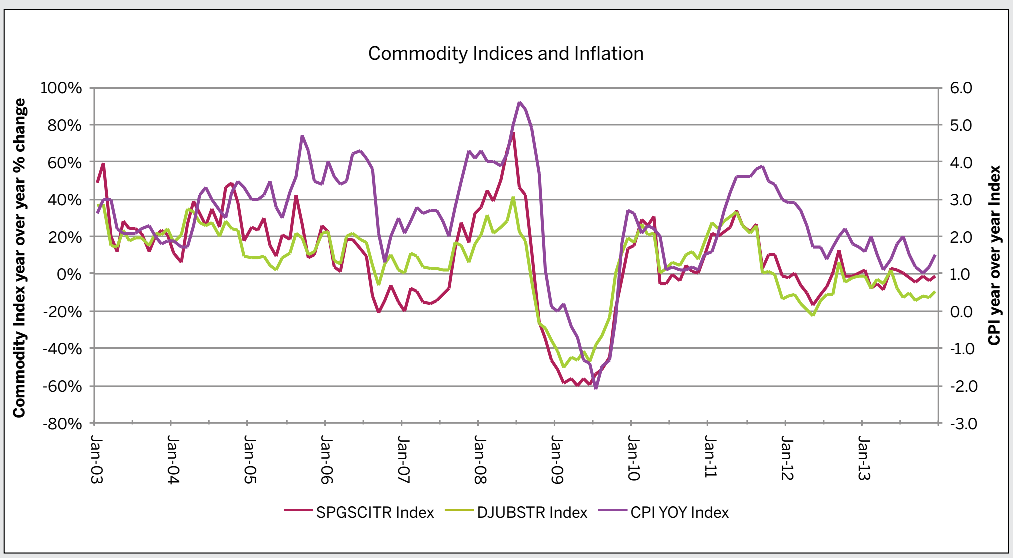
**Correlations of Assets with Inflation, July 1959 - December 2004**

| Holding Period | Stocks | Bonds | Commodity Futures |
|---|---|---|---|
| Monthly | -0.15* | -0.12* | 0.01 |
| Quarterly | -0.19* | -0.22* | 0.14 |
| One year | -0.19 | -0.32* | 0.29* |
| Five years | -0.25 | -0.22 | 0.45* |

*Significant at the 5 percent level in a Newey-West corrected test of standard errors.

Another way of demonstrating the historical relationship of commodity price changes to inflation is to compare rolling year-over-year results, which S&P Dow Jones Indices has done, and is shown in Figure 17.

**Figure 17**



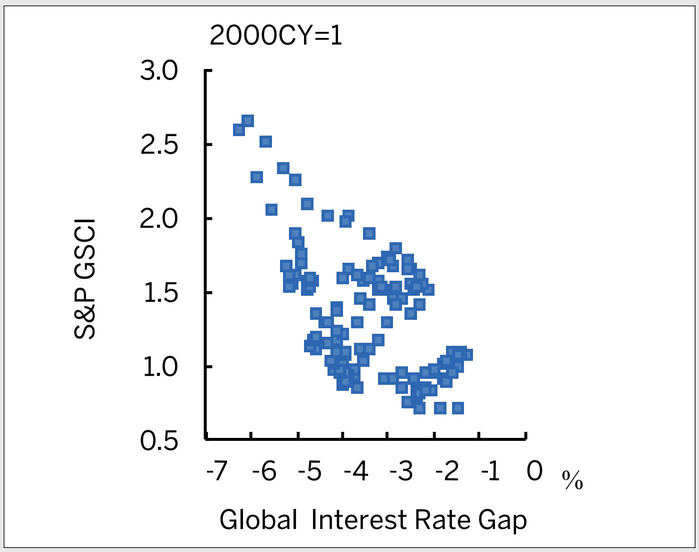

*Graph based on "Commodity and Strategic Futures Index Methods: Adjusting to a New World Economy" by Jodie Gunzberg, S&P Dow Jones Indices Presentation, October 2013, Slide 24.*

## THE EMPIRICAL RELATIONSHIP BETWEEN MONETARY CONDITIONS AND COMMODITY PRICES

Bank of Japan (BOJ) researchers have demonstrated, in a creative fashion, an empirical relationship between commodity prices and monetary conditions using recent historical data in their 2011 paper on the "Recent Surge in Global Commodity Prices." Essentially, they find that commodity prices have been positively correlated with globally lax financial conditions. This relationship is illustrated in Figure 18.

**Figure 18**

**Global Commodity Prices vs. Global Interest Rate Gap**




*Graph based on "Recent Surge in Global Commodity Prices" by Yasunari Inamura, Tomonori Kimata, Takeshi Kimura, and Takashi Muto, Bank of Japan Review, International Department, 2011-E-2, March 2011, Chart 8.*

*The explanatory notes below are excerpted directly from the article, "Recent Surge in Global Commodity Prices," and from correspondence with Takeshi Kimura (whose assistance is gratefully acknowledged.)*

*S&P GSCI*

*The S&P GSCI is shown as a relative price to the global headline Commodity Price Index.*

*The GSCI is the Goldman Sachs Commodity Index.*

*The sample period is from January 2000 to January 2011.*

*Data frequency is monthly.*

*Commodity price is not a return but an index (2000CY=1).*

*For say a data point that shows the S&P GSCI at 1.5, this means that since January 2000, the S&P GSCI had effectively increased by 50% in real terms, as of the month represented by the data-point.*

*Global Interest Rate Gap*

*The global interest rate gap is the weighted average of the interest rate gap in each country with its corresponding Gross Domestic Product (GDP) used as the weight.*

*The interest rate gap itself denotes the difference between the real interest rate, defined as the nominal short-term interest rate minus headline Consumer Price Index (CPI) inflation, and the potential growth rate of an economy.*

*If the interest rate gap is negative, it means that the financial condition is lax, as the real interest rate is lower than the potential growth rate.*

*The interest rate gap is annualized.*

## SUMMING UP

This paper provided an update on a number of empirical relationships in the commodity futures markets. The paper particularly focused on crude oil because of oil's importance in not only being a return-generator for commodity indices, but also for historically providing commodity indices their portfolio-hedging properties. The article discussed the potential for the crude oil futures curves to remain structurally backwardated, and the positive impact this could then have on the returns of commodity futures strategies and indices that capitalize on backwardation. The article also provided examples of the types of empirical analyses where the diversification and inflation-hedging potential of oil and commodity futures contracts becomes most apparent when examining past data.

## APPENDIX A

**A Brief Review of the Great Recession and Global Financial Crisis**

As recounted in a National Bureau of Economic Research paper, "by the beginning of the summer of 2008, financial distress in major players began to accelerate," starting with the collapse of the Government Sponsored Entities, Fannie Mae and Freddie Mac, and culminating in the failure of the "entire U.S. broker-dealer industry" after Lehman Brothers' disorderly bankruptcy on September 15th, 2008. At that point, "the wholesale money markets… [essentially] seized [up]." And by October 2008, "… the crisis quickly spread to the rest of the economy."

Economists at the Federal Reserve Bank of St. Louis reported that during the fall of 2008, "the largest fall in international trade since the Great Depression" occurred, "as imports and exports contracted by nearly 30 percent relative to GDP." Please see Figure A-1. And according to the IEA, oil demand in 2008 correspondingly fell for the first time since 1983.

**Figure A-1**

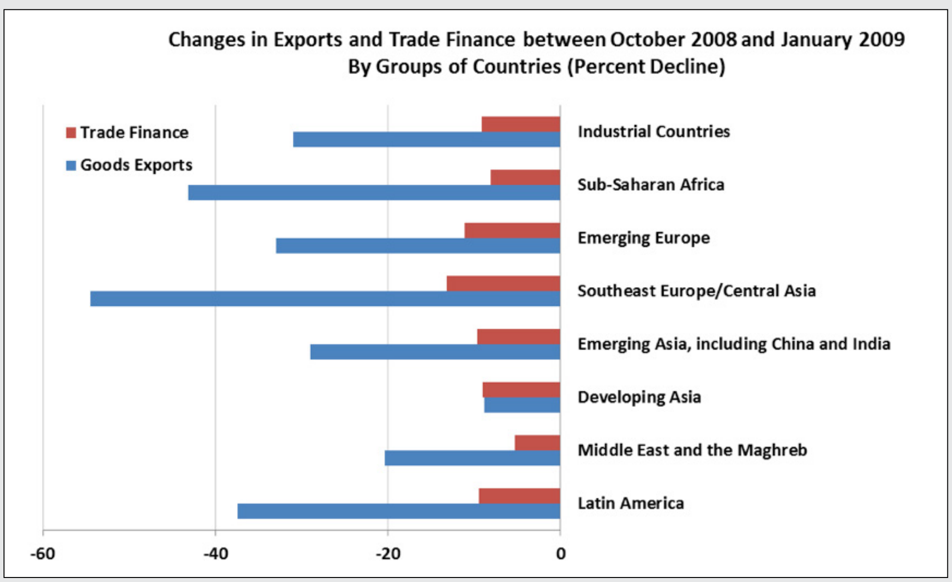



*Chart based on "The Role of Financing in International Trade during Good Times and Bad" by Silvio Contessi and Francesca de Nicola, The Regional Economist, Federal Reserve Bank of St. Louis, January 2012, Figure 1, which, in turn, is excerpted from "Trade and Trade Finance in the 2008-09 Financial Crisis" by Irena Asmondson, Thomas Dorsey, Armine Khachatryan, Ioana Niculcea, and Mika Saito, International Monetary Fund Working Paper 11/16, January 2011, Table 2, 3rd and 4th columns.*

World trade temporarily collapsed "in part due to falling demand for commodities but also because the financial crisis… [hit] the ability of importers and exporters to engage in financial transactions," explained the CME Group's "Daily Livestock Report" at the end of October 2008.

According to Bloomberg calculations, the returns on the S&P GSCI Total Return Index in 2008 were -46.5%.

For holders of oil futures contracts and oil-heavy commodity indices, the Great Recession and the Global Financial Crisis respectively created a double blow for returns in the second half of 2008 and in early 2009. The first setback was clearly the drop in spot prices. The second setback was the "supercontango" that developed in oil futures curves, reflecting the extraordinary returns that became available to any financial or trading entity that was capable of financing and storing massive amounts of crude oil, especially through supertankers. As the *Financial Times* reported in December 2008, "The credit crunch… distorted the arbitrage process as market participants – from traditional physical traders and oil companies to private equity groups and hedge funds —… [could not] secure loans to finance oil storage." In late 2008, Goldman Sachs further observed that not only was the WTI futures curve trading beyond what one would expect, given normal cost-of-carry relationships, but that normal arbitrage relationships were being violated in "other asset classes that require cash funding upfront," including in the corporate bond market when comparing pricing to related derivatives.

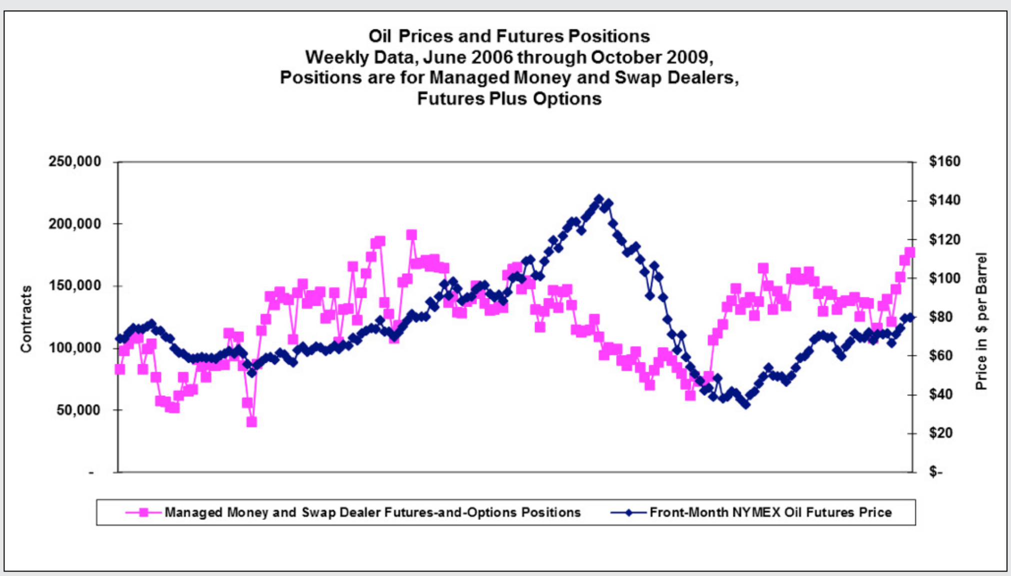
As we now know in hindsight, the extraordinary interventions by monetary and fiscal authorities did succeed in eventually reversing the widespread deflationary spiral, which had negatively impacted nearly all asset classes, excluding fixed income. Accordingly, from the end-of-2008 through the end-of-2013, the S&P GSCI Total Return Index returned +20.9%.

## APPENDIX B

### Two Useful Price Signals in 2008

One interesting historical observation regarding 2008 is that both the heating oil crack spread and the Baltic shipping indices started peaking in late-May-to-late-July of that year, so alert futures traders did have a number of warning signs that a fundamental source of demand for oil appeared to be diminishing in short order. And indeed according to CFTC data, cited by JP Morgan researchers, market participants that were classified as "managed money" and "swap dealers" did reduce their positions in the oil market in the months preceding the July 2008 peak of the oil market. Please see Figure B-1

**Figure B-1**




*Graph based on "Commodity Prices and Futures Positions" by Ruy Ribeiro, Lawrence Eagles, and Nikolaus von Solodkoff, JP Morgan Global Asset Allocation & Alternative Investments, December 16, 2009, Chart 1.*

## ENDNOTES

This article is provided for educational purposes only and should not be construed as investment advice or an offer or solicitation to buy or sell securities or other financial instruments. The views expressed in this article are the personal opinions of Hilary Till and do not necessarily reflect the views of either the CME Group or of organizations with which Ms. Till is affiliated.

Of note, some of the ideas in this article were developed jointly with Joseph Eagleeye, co-founder of Premia Capital Management, LLC.

The information contained in this article has been assembled from sources believed to be reliable, but is not guaranteed by its author. Any (inadvertent) errors and omissions are the responsibility of Ms. Till alone.

And finally, this article made liberal use of historical data and analyses in discussing past empirical relationships in the commodity futures markets. Consequently, the reader should be aware that the paper's past results are obviously not guaranteed to continue into the future. The reader should be further aware that all commodity futures trading endeavors are, in practice, quite risky. As such, please refer to the standard set of disclosures by the CME Group as regards the many risks that one takes on when engaging in commodity futures trading.

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