What's Price Got To Do With Term Structure?

An Introduction to the Change in Realized Roll Yields: Redefining How Forward Curves Are Measured

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Historically, investors have been drawn to the systematic return opportunities, or beta, of commodities due to their potentially inflation-hedging and diversifying properties. However, because contango was a persistent market condition from 2005 to 2011, occurring in 93% of the months during that time, roll yield had a negative impact on returns. As a result, it may have seemed to some that the liquidity risk premium had disappeared.

However, as discussed in our paper published in September 2013, entitled "Identifying Return Opportunities in A Demand-Driven World Economy," the environment may be changing. Specifically, the world economy may be shifting from one driven by expansion of supply to one driven by expansion of demand, which could have a significant impact on commodity performance. This impact would be directly related to two hallmarks of a world economy driven by expansion of demand: the increasing persistence of backwardation and the more frequent flipping of term structures.

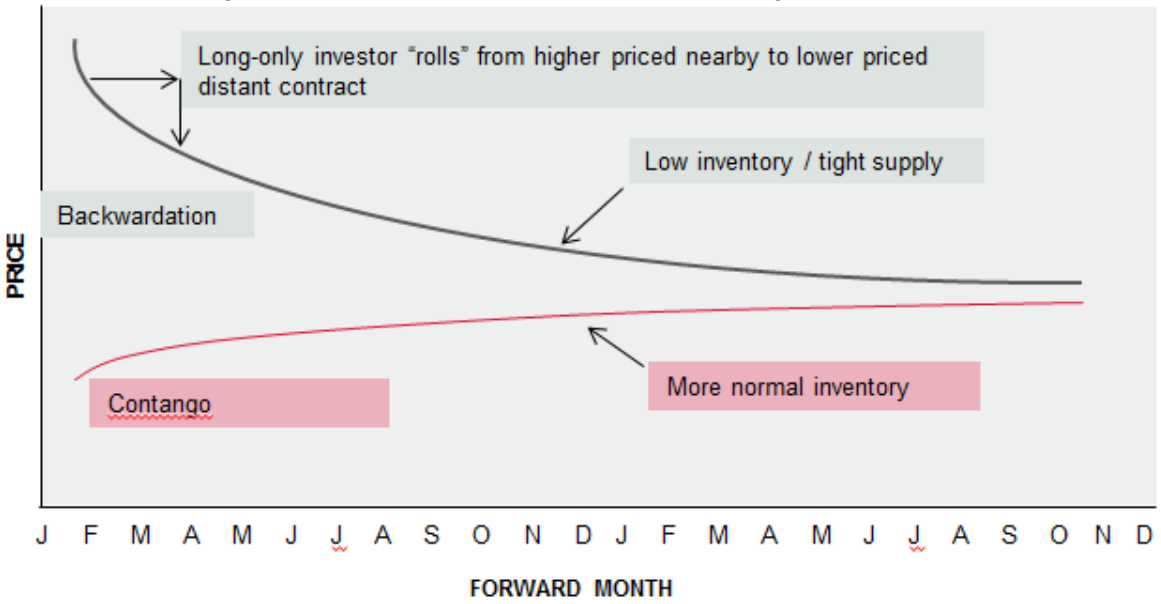
In order to benefit in this changing economic environment, the key is to implement *flexibility* to keep pace with the quickly changing term structures. To achieve flexibility, there are two primary ways to modify the first-generation flagship index, the S&P GSCI®. The first method allows an index to select contracts with expirations that are either near- or longer-dated based on the commodity futures' term structure. The S&P GSCI Dynamic Roll index accomplishes this with a measure called implied roll yield, as discussed in its methodology. The second method under- and over-weights commodities futures based on their term structure every month. It does this while maintaining liquidity by remaining in the most-liquid front-month contract and only selecting the most liquid commodities. The S&P GSCI Roll Weight Select is a newly launched index that uses the second technique to flexibly incorporate each commodity's term structure by modifying weights. To do that, it uses an innovative measure called the change in realized roll yield.

1. INTRODUCTION

Commodity market fundamentals are changing and are influenced by various factors, including weather patterns, political unrest, monetary policy, the health of the global economy and demand prospects. Whether a commodity is plagued by a huge inventory build-up or supported due to scarcity and high demand will be reflected in its futures curve. A global surplus of a difficult and expensive-to-store commodity will result in strong contango for the contract, meaning that the forward price of the contract is higher than the spot price. The flip side, called backwardation, occurs when the market has a shortage and there is no value to store the commodity. In this case, the price of the contract with a nearby expiration date is priced higher than the later-dated contract.

Below is a diagram representation of future curves in a scenario of backwardation versus one in contango. Note that a forward curve can vary in steepness.

Exhibit 1: **Contango and Backwardation Futures Curves Compared**



Source: Greer, Robert J., Editor. The Handbook of Inflation hedging Investments, Enhance Performance and Protect Your Portfolio from Inflation Risk. Greer, Robert J. Author, Chapter 5: Commodity Indexes for Real Return. Published by McGraw Hill, January 2006. Sample for illustrative purposes only.

Many strategies using modified rolls and/or weights, as discussed above, have been developed to reduce negative returns due to contango, though the success of these strategies has been variable. Both modified roll and modified weight strategies reduce the liquidity of the S&P GSCI, which is world-production weighted and holds the front-month contracts, but modified weight strategies preserve liquidity better than modified rolling strategies. While rolling strategies have had greater success than the weighting strategies in minimizing negative returns from contango, not every investor is willing to give up liquidity for the potential premium.

In this paper, we will discuss the recently launched S&P GSCI Roll Weight Select, which is designed to outperform the S&P GSCI Equal Weight Select, an equally weighted index of 14 commodities from the S&P GSCI, by under- and over-weighting the commodities using a unique measure called the change in realized roll yield. This alternative beta index offers flexibility in a changing environment while preserving the liquidity of the front-month contracts.

2. S&P GSCI ROLL WEIGHT SELECT: AN OVERVIEW

The starting point for the construction of the S&P GSCI Roll Weight Select was the S&P GSCI Equal Weight Select, which was chosen in order to maintain positions in the 14 most liquid commodities of the 24 in the S&P GSCI. This is an important screen for investors who value liquidity and are interested in the idea of holding the most-liquid front-month contracts while trying to capture returns by changing weights rather than rolls.

The commodities in the S&P GSCI Roll Weight Select are selected annually according to the S&P GSCI Equal Weight Select methodology. Their weights are then adjusted monthly by measuring the term structure according to the change in realized roll yield, which is based on the persistence of the realized roll yield. The change in realized roll yield will be discussed in the next section and in more detail throughout the paper, but it is simply the difference between the realized roll yield of the current month taken from the realized roll yield of the one-month forward, adjusted for any gaps between the adjacent contract schedules (of the S&P GSCI methodology) in the cases where a consistent one-month forward roll does not apply.

The rebalance has a monthly determination date on the third business day of each month, and the roll occurs on the fifth through ninth business days of each month as in the S&P GSCI. Finally, the Capped Component 35/20 methodology is applied, which is intended to follow the ESMA/UCITS guidelines.

3. THE CHANGE IN REALIZED ROLL YIELD

The possible reason for the persistence in realized roll yield may be, as discussed in Till and Eagleeye (2005), "if there are inadequate inventories for a commodity, only its price can respond to equilibrate supply and demand, given that in the short run, new supplies of physical commodities cannot be mined, grown, and/or drilled. When there is a supply/usage imbalance in a commodity market, its price trend may be persistent…."

When reviewing fluctuations of the commodity futures prices along the forward curves, we have found persistence in the realized roll yields (excess return – price return) across all markets. This suggests that if a given commodity futures market is in a state of contango (or conversely, backwardation), then there is a high chance it will remain in contango (or backwardation) for the following month, provided that all other factors remain the same. The relative steepness of the forward curves in the front end has also been persistent, possibly due to higher incremental storage costs in the short term.

Given the logic behind the persistence of term structures of commodity futures, the change in realized roll yield is a reasonable choice as an indicator to determine weight. Another indexing innovation afforded by the change in realized roll yield is that for the first time, a term structure measurement can be made on a broad basket or sector rather than only a single commodity.

The change in realized roll yield (RRY) is calculated for each commodity in the index by taking the difference between the monthly returns for the Excess Return index and the Price Return index for that commodity. The RRYs are calculated for both the S&P GSCI and the S&P GSCI 1 Month Forward, and are then interpolated to adjust for rolling schedules. The difference between the interpolated front and 1-month forward RRY is labeled as the *gradient*. (Please see section 5f Exhibit 13 for an illustration.)

The change in these two RRYs, or gradient, represents the change in the slopes at the first two nodes of the forward curve, and thus represents a measure of the curvature of the forward curve at the front end. Hence, the commodity with the greatest change in the realized roll yield is the one where the curvature is at its steepest incline and the commodity with the lowest change in the realized roll yield is the one where the curvature of the forward curve is at its steepest decline.

The gradients are the basis on which signals are assigned to rank the 14 commodities included in the S&P GSCI Equal Weight Select. The ranking is based on each gradient's position among those commodities included in the index, so it is only a relative measure of term structure. The commodity with the highest (or conversely, lowest) change in realized roll yield, indicating greater contango (or backwardation), is given the lowest rank of 1 (or highest rank of 14). For a comprehensive account of the approach, please refer to the S&P GSCI Roll Weight Select's index methodology.

In the rank ordering, commodities with a value of 1, 2, 3 or 4 are assigned a preliminary relative weight of 2. Commodities with a value of 5, 6, 7, 8, 9, 10, 11 or 12 are assigned a preliminary relative weight of 6. Commodities with a value of 13 or 14 are assigned a preliminary relative weight of 8. Thus, the proportion of the highest-ranked commodities to the lowest-ranked commodities is 4 to 1. This leaves the preliminary weight total at 72, so the final weights are normalized to equal 100% with respective weights of 2.8%, 8.3% and 11.1% for each individual commodity.

4. BACKTESTING RESULTS

Exhibit 2 depicts the annual performance of the S&P GSCI Roll Weight Select and the S&P GSCI Equal Weight Select during the period between 1995 and 2013. The market was predominantly in a state of contango during 15 of the 19 years, so the S&P GSCI Roll Weight Select outperformed the S&P GSCI Equal Weight Select 68% of the time.

Not only did the S&P GSCI Roll Weight Select outperform most of time over the entire period, but it outperformed when the market showed predominant backwardation in 1996, 2000, 2003 and 2004. This is an important point that demonstrates the ability of the S&P GSCI Roll Weight Select to perform across different environments, reflected by term structures, as the current environment may be shifting.

Exhibit 2: Environment and Index Performance

Year	No. of Months	Contango	Backwardation	Contango (%)	S&P GSCI Roll Weight Select TR (%)	S&P GSCI Equal Weight Select TR (%)
1995	11	6	5	55	16.03	16.72
1996	12	2	10	17	**14.50**	**14.09**
1997	12	8	4	67	-11.88	-6.64
1998	12	12	0	100	**-24.69**	**-26.92**
1999	12	11	1	92	**27.24**	**22.07**
2000	12	0	12	0	**24.69**	**24.34**
2001	12	8	4	67	**-26.23**	**-27.90**
2002	12	8	4	67	**24.37**	**21.97**
2003	12	3	9	25	**39.16**	**31.64**
2004	12	5	7	42	**12.45**	**4.69**
2005	12	12	0	100	**25.11**	**21.62**
2006	12	12	0	100	**28.45**	**15.38**
2007	12	12	0	100	14.55	15.13
2008	12	9	3	75	-36.25	-34.43
2009	12	12	0	100	**28.57**	**23.58**
2010	12	12	0	100	14.08	17.08
2011	12	9	3	75	**-10.18**	**-11.82**
2012	12	7	5	58	**4.02**	**3.14**
2013	6	5	1	83	-11.19	-11.00
Total	215	148	67	69		

Source: S&P Dow Jones Indices. Data from Jan.1995 to June 2013. Past performance is not an indication of future results. This chart reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

To better explain how this works, we divided the 14 commodities that are constituents in these two indices into three groups based on their rankings (see Exhibit 3). The group labeled "Bottom 4" includes the commodities ranked from 1 to 4, the group labeled "Middle 8" includes the eight commodities ranked from 5 to 12 and the group labeled "Top 2" includes the two commodities ranked 13 and 14. Note that the commodities in the top 2 ranks have the highest weightings, followed by the middle 8, with the bottom 4 being assigned the lowest weights.

Exhibit 3 shows the respective allocations within each of the subgroups.

Exhibit 3: Weight Allocation to Each Commodity in the Index

Index	Bottom 4 (%)	Commodities in Middle 8 (%)	Top 2 (%)
S&P GSCI Roll Weight Select	2.78	8.33	11.11
S&P GSCI Equal Weight Select	7.14	7.14	7.14

Source: S&P Dow Jones Indices. Data as of June 30, 2013. Table is provided for illustrative purposes only.

Next, the monthly excess returns of the two indices divided into the three subgroups were decomposed from March 2002 (as far back as the data were available) to February 2013 (the ending of the test period prior to the launch). The monthly returns of each of the three subgroups are based on the rankings of the individual commodities in any given month. Since the rankings for the commodities may change from month to month, this means that the constituents of the three subgroups may also have changed. Exhibit 4 shows the cumulative monthly excess returns over the whole period, for each of the three subgroups.

Exhibit 4: Cumulative Returns, April 2002 - June 2013

Index	Commodities in			
	Bottom 4 (%)	Middle 8 (%)	Top 2 (%)	Composite (%)
S&P GSCI Roll Weight Select	-4.02	52.98	41.44	90.40
S&P GSCI Equal Weight Select	-10.33	45.41	26.64	61.72
Outperformance	6.31	7.57	14.80	28.68

Source: S&P Dow Jones Indices. Data from April 2002 to June 2013. Past performance is not an indication of future results. This chart reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

The S&P GSCI Roll Weight Select outperformed the S&P GSCI Equal Weight Select by 28.68% over the period. A significant difference between the two indices across all three subgroups is apparent, indicating that the change in realized roll yield over-weighted the winners and under-weighted the losers on average monthly.

5. AN EMPIRICAL STUDY OF THE COMMODITIES MARKETS

We quantified the changes in the 24 commodities markets included in the S&P GSCI over an 11-year period, from March 2002 to February 2013. The focus was on analyzing the dynamics of the term structures in each market. Over this period, no meaningful relationship between the changes of the futures prices in these various markets was found. Similarly, we found no special relationship between the realized roll yields and either the price returns or the excess returns. However, the relationship between the realized roll yields along the forward curve from one month to the next was found to be very stable and persistent. The relationship between the gradients (a measure of the curvature of the term structure) and the realized roll yields was also found to be stable and persistent, but varied in intensity across markets.

5a. THE FORWARD CURVE

According to the theory of storage, the price F of the futures contract, with maturity T, is given by the expression $S(t)\exp[(r+s-c)(T-t)]$, for any time t, where S(t) is the spot price, r is the risk-free rate, s is the storage cost and c is the convenience yield. Whenever the futures price F is lower than the spot price, the market is said to be in backwardation; whenever the futures price F is higher than the spot price, the market is said to be in contango.

When we plot the futures prices (F0,F1,F2,…) at various maturities T0, T1, T2, .., Tn, we have a forward curve. On a daily basis, the effects of the changes in such prices are encoded in various commodity indices. There are three basic commodity indices: the price return (PR), the excess return (ER) and the total return (TR). In this paper, we are interested in the relationship between PR and ER exclusively, using this relationship to explore whether there is a way to predict returns. The PR reflects the changes in the prices themselves F0, F1, F2, and so on. The ER reflects the changes in the prices as well as the effect of rolling from one contract to the adjacent contract. We will present the results in terms of the different nodes of the forward curve, in correspondence to the consecutive monthly futures contracts. Thus, node 0 is the first price point on the forward curve, corresponding to the first nearby futures contract with price F0 and maturity T0. For many commodities, there are consecutive monthly contracts available so each node is roughly equivalent to the monthly intervals. This obviates the reference to the particulars of the futures contract, such as maturity dates, so we can avoid referring to any particular months. The prices at each node on the curve refer to the ensemble of prices of the various futures contracts at any given time.

However, not all commodities have consecutive monthly contracts available. For such commodities, we developed a monthly version using the method of interpolation. In this way, we can readily compare commodities on the same monthly basis. We will, however, focus our attention on the first three nodes of the forward curve, as they represent the most liquid portion of the market.

In order to discuss the individual commodity markets, we will use the S&P GSCI as our representative commodity index for each commodity, and adopt its methodology regarding the roll schedule and duration. We use the S&P GSCI as our dataset because it is the eligible universe for the S&P GSCI Equal Weight Select, and thus the S&P GSCI Roll Weight Select. The S&P GSCI single commodity indices and their corresponding suite of 1-Month Forward single commodity indices will provide us with the necessary data for analyzing the various commodities markets.

Whether the market is in backwardation or contango is of significant interest since the return available in the commodity futures is closely linked to the cost of rolling the futures contracts from one month to the next. In this paper, we will quantify the changes in each of the 24 markets based on whether the market was in contango or backwardation. We will then show the frequency of reversals in the markets, pointing out the differences between the ER and PR, and discuss the concept of RRY in further detail. This will be followed by an analytical framework that allows us to perform correlation analysis in a structured manner, and finally we will provide an illustration of the results using Brent crude oil as an example.

In the study period from March 2002 to February 2013, the only change in any of the commodity futures contract markets occurred in the gasoline contracts, when the Unleaded Reg Gas, NY contract (HU) became delisted, and was replaced by the NYMEX Reformulated Gasoline Blendstock for Oxygen Blending contract (RB). We had included the RB contract in the time series since October 2006.

During this 11-year period, the only market that was 100% in contango was gold (GC). All other markets experienced a mix of contango and backwardation, though some more than others. Exhibit 5 lists the frequency and magnitude of backwardation for each market, and Exhibit 6 lists the same information for periods of contango.

Exhibit 5: Frequency and Magnitude of Backwardation

Seq	Commodity Code	Max-Pos (%)	Avg-Pos (%)	Min-Pos (%)	Count	Percent (%)	Tot # of Months
1	BR	2.64	0.64	0.01	65	49	132
2	CL	6.96	1.37	0.02	34	26	132
3	GO	6.31	1.13	0.04	49	37	132
4	HO	10.10	1.44	0.02	29	22	132
5	HU/RB (1)	7.46	1.85	0.05	74	56	132
6	NG	5.96	1.12	0.06	13	10	132
7	IA	1.65	0.30	0.01	19	14	132
8	IC	2.23	0.64	0.01	61	46	132
9	IK	2.52	0.57	0.00	47	36	132
10	IL	1.77	0.62	0.02	55	42	132
11	IZ	0.53	0.30	0.05	17	13	132
12	GC	0.00	0.00	0.00	0	0	132
13	SI	0.00	0.00	0.00	3	2	132
14	CC	1.71	0.52	0.00	32	24	132
15	CT	3.01	1.01	0.00	32	24	132
16	KC	0.00	0.00	0.00	3	2	132
17	SB	5.35	1.32	0.00	45	34	132
18	CN	6.10	1.75	0.01	10	8	132
19	KW	1.68	0.81	0.00	12	9	132
20	SO	5.40	1.42	0.02	45	34	132
21	WH	0.00	0.00	0.00	1	1	132
22	FC	2.66	0.84	0.01	41	31	132
23	LC	3.35	1.47	0.05	40	30	132
24	LH	8.26	2.75	0.01	51	39	132

Note: HU replaced by RB in October 2006. Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only. Codes are spelled out in the Appendix.

Exhibit 6: Frequency and Magnitude of Contango

Seq	Commodity Code	Max-Neg (%)	Avg-Neg (%)	Min-Neg (%)	Count	Percent (%)	Tot # of Months
1	BR	-0.03	-1.13	-4.72	67	51	132
2	CL	-0.02	-1.53	-16.07	98	74	132
3	GO	-0.01	-0.93	-2.57	83	63	132
4	HO	-0.10	-1.09	-3.61	103	78	132
5	HU/RB (1)	-0.09	-2.37	-8.67	58	44	132
6	NG	-0.14	-3.83	-41.78	119	90	132
7	IA	-0.04	-0.49	-1.09	113	86	132
8	IC	-0.01	-0.19	-0.56	71	54	132
9	IK	0.00	-0.16	-0.57	85	64	132
10	IL	-0.02	-0.41	-1.12	77	58	132
11	IZ	-0.01	-0.47	-1.19	115	87	132
12	GC	0.00	-0.21	-0.53	132	100	132
13	SI	0.00	-0.21	-0.53	129	98	132
14	CC	-0.02	-0.49	-0.97	100	76	132
15	CT	0.00	-1.69	-4.29	100	76	132
16	KC	0.00	-1.15	-2.63	129	98	132
17	SB	0.00	-1.44	-4.70	87	66	132
18	CN	0.00	-1.31	-2.49	122	92	132
19	KW	0.00	-0.85	-1.94	120	91	132
20	SO	0.00	-0.62	-1.47	87	66	132
21	WH	0.00	-1.32	-2.23	131	99	132
22	FC	0.00	-0.90	-3.93	91	69	132
23	LC	0.00	-1.51	-3.39	92	70	132
24	LH	-0.01	-4.45	-12.47	81	61	132

Note: HU replaced by RB in October 2006. Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

5a. THE ANALYTICAL FRAMEWORK

We now can more deeply examine the concept of realized roll yield (RRY). By analyzing the PR and the ER index values of the S&P GSCI, we are able to see the degree of contango or backwardation for each market over time. The ER and PR of the S&P GSCI single commodity indices provide us with the information on the first node of the forward curve, while the ER and PR of the S&P GSCI 1-Month Forward single commodity indices provide us with the information on the second node of the forward curve. Below is the formal defining calculation of RRY at each node:

Determination of the Realized Roll Yield for Each Commodity

For each commodity A, at each monthly node i (for i=0 and i=1), for a given month m, we adopt the following notation:

A_PL(0,m) = the index level of S&P GSCI A, at the end of month m,
A_PL(1,m) = the index level of S&P GSCI A 1-Month Forward, at the end of month m,
A_EL(0,m) = the index level of S&P GSCI A ER, at the end of month m,
A_EL(1,m) = the index level of S&P GSCI A 1-Month Forward ER, at the end of month m.

From these four inputs, we define the following variables:

A_PR(i,m) = Price index return for commodity A, at node i, for month m
= (A_PL(i,m) – A_PL(i,m-1)) / A_PL(i,m-1).

A_ER(i,m) = Excess Return index return for commodity A, at node i, for month m
= (A_EL(i,m) – A_EL(i,m-1)) / A_EL(i,m-1).

We define the following relationship, for a given commodity A, at node i, for month m:
A_RRY(i,m) = Realized roll yield for commodity A, at node i, for month m
= A_ER(i,m) – A_PR(i,m).

Thus, the realized roll yield A_RRY(i,m) is a proxy for the monthly roll yield for commodity A, incorporating the effects of the daily changes in the prices, as well as the effects of the rolling of the relevant contracts during the month, as specified in the S&P GSCI methodology.

5c. THE RELATIONSHIP OF REALIZED ROLL YIELD TO IMPLIED ROLL YIELD

The RRY can be considered an extension of the Implied Roll Yield (IRY) concept, introduced in the S&P GSCI Dynamic Roll. IRY is a measure that pertains to the different nodes of the forward curve at a point in time. For each pair of nodes on the forward curve, we can compute the IRY related to the prices. It represents the change in the two prices, expressed as a yield of cost of rolling from one contract to the next. As the forward curve changes, the IRYs along the curve also change. However, once the effects of the changes of the forward curves have been encoded and recorded in the form of the returns of the commodity indices, the individual IRYs for each of the trading days in the month can be thought of as embedded in the form of the RRY for the month.

5d. INTERPOLATION OF S&P GSCI REALIZED ROLL YIELDS OF INDIVIDUAL COMMODITIES

Of the 24 S&P GSCI commodities, only the commodity futures contracts included in the energy and industrial metals sectors have monthly consecutive futures contracts available. This necessitates an interpolation of the RRYs for those commodities that do not have a consistent roll each month. Based on their roll schedules as followed by the S&P GSCI methodology, we spread evenly the effects of rolling over multiple months with the same futures contracts, over those same months.

The interpolation process can be broken into two stages:

We define the Interpolated RRY (IRRY) for each commodity A as follows:
A_IRRY(i,m) = A_ARRY(i,m) / A_IF(i,m),

Where,
A_ARRY(i,m) is the adjusted realized roll yield of A, for node i, for month m, and
A_IF(i,m) is the interpolation factor of A, for node i, for month m.

The adjusted RRY of A is the interim variable equal to the raw realized roll yield of A, or in the event that there is no rolling involved, the previously calculated realized roll yield, based on the roll schedule of A. The interpolation factor of A is the number of months during which the same futures contract will be in use in accordance with the S&P GSCI methodology. The details of the roll schedule and the interpolation matrices are provided in Appendix A. We also provide a numerical example of the interpolation process for sugar in Appendix B. Trivially, for those commodities with monthly consecutive contracts, IRRY is identical to their RRY, as their interpolation factors are equal to 1. From now on, whenever we talk about RRY, we will no longer make a distinction between IRRY and RRY.

5e. CORRELATION ANALYSIS

We now revert to the individual commodities markets over the past eleven years. Despite the significant changes in all these markets over this period, we want to go beyond the dramatic shifts in the forward curves, and look at the dynamics in these markets as expressed by the roll yields along the forward curve, and changes that occur over time. Using the analytical framework outlined above, we use the correlation method to detect the underlying relationships.

The results of the correlation analysis and of the relationships between PR, ER and RRY for each of the 24 markets will be discussed below. We first look at the auto-correlation of PR, ER and RRY.

In terms of our framework, analyzing the auto-correlation of PR, ER and RRY is tantamount to finding the correlation over time, with a lag of one month, for i=0 and 1, between:

A_PR(i,m) and A_PR(i,m+1),
A_ ER(i,m) and A_ER(i,m+1), and
A_RRY(i,m) and A_RRY(i,m+1).

The returns of the S&P GSCI single commodity indices provide us with the necessary market data to perform this correlation analysis.

Exhibit 7: Auto-correlation Results of PR, ER and RRY of S&P GSCI Single Commodity Indices

Code	Price Return	P-value	Excess Return	P-value	Interp RRY	P-value
BR	0.244	0.005	0.281	0.001	0.877	0.000
CL	0.164	0.062	0.212	0.015	0.673	0.000
GO	0.156	0.075	0.181	0.039	0.790	0.000
HO	0.128	0.147	0.141	0.109	0.738	0.000
HU/RB	0.136	0.121	0.118	0.179	0.477	0.000
NG	-0.005	0.951	0.022	0.802	0.468	0.000
IA	0.144	0.101	0.159	0.069	0.554	0.000
IC	0.234	0.007	0.244	0.005	0.940	0.000
IK	0.039	0.662	0.047	0.596	0.771	0.000
IL	0.042	0.638	0.051	0.567	0.753	0.000
IZ	-0.009	0.918	-0.009	0.915	0.785	0.000
GC	-0.220	0.012	-0.210	0.016	0.984	0.000
SI	-0.085	0.336	-0.086	0.329	0.967	0.000
CC	-0.247	0.004	-0.267	0.002	0.887	0.000
CT	-0.002	0.983	0.035	0.695	0.885	0.000
KC	-0.240	0.006	-0.214	0.014	0.869	0.000
SB	0.082	0.351	0.184	0.036	0.851	0.000
CN	-0.027	0.760	0.010	0.912	0.744	0.000
KW	0.008	0.930	-0.002	0.986	0.698	0.000
SO	0.020	0.820	-0.028	0.752	0.756	0.000
WH	-0.040	0.647	-0.045	0.611	0.816	0.000
FC	0.033	0.706	0.080	0.361	0.656	0.000
LC	0.077	0.379	0.081	0.359	0.637	0.000
LH	-0.150	0.087	-0.096	0.275	0.673	0.000

Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

For the S&P GSCI single commodity indices, the correlation results for PR were mostly random. Only five markets (BR, IC, GC, CC and KC) had results that were statistically significant. As for ER, seven markets (BR, CL, GO, IC, GC, CC and KC) had results that were statistically significant. For RRY, all 24 markets were statistically significant.

We carried out a similar analysis on the PR, ER and RRY of the single commodity indices of the S&P GSCI 1 Month Forward. Whereas the S&P GSCI encoded the changes at the first two nodes of the forward curve, the S&P GSCI 1 Month Forward encoded the changes at the second and third nodes of the forward curve.

The results for the S&P GSCI 1 Month Forward single commodity indices were similar to those for the S&P GSCI single commodity indices.

Exhibit 8: Auto-correlation Results of PR and ER of S&P GSCI 1 Month Forward Single Commodity Indices

Code	Price Return	P-value	Excess Return	P-value	Interp RRY	P-value
BR	0.243	0.005	0.279	0.001	0.907	0.000
CL	0.166	0.058	0.203	0.020	0.837	0.000
GO	0.178	0.042	0.209	0.017	0.826	0.000
HO	0.158	0.071	0.179	0.040	0.813	0.000
HU/RB	0.158	0.072	0.152	0.084	0.412	0.000
NG	0.110	0.212	0.124	0.158	0.634	0.000
IA	0.152	0.084	0.169	0.053	0.649	0.000
IC	0.230	0.008	0.244	0.005	0.932	0.000
IK	0.031	0.723	0.046	0.601	0.591	0.000
IL	0.049	0.581	0.066	0.454	0.805	0.000
IZ	-0.005	0.958	0.000	1.000	0.758	0.000
GC	-0.209	0.017	-0.211	0.015	0.981	0.000
SI	-0.091	0.301	-0.085	0.333	0.961	0.000
CC	-0.251	0.004	-0.242	0.005	0.908	0.000
CT	0.092	0.297	0.062	0.480	0.918	0.000
KC	-0.244	0.005	-0.208	0.017	0.936	0.000
SB	0.202	0.021	0.178	0.042	0.739	0.000
CN	-0.032	0.715	0.011	0.902	0.735	0.000
KW	-0.017	0.844	0.007	0.938	0.750	0.000
SO	-0.004	0.961	0.000	0.996	0.746	0.000
WH	-0.086	0.327	-0.042	0.633	0.807	0.000
FC	0.061	0.489	0.046	0.598	0.772	0.000
LC	-0.004	0.964	0.081	0.355	0.668	0.000
LH	0.007	0.938	-0.016	0.857	0.707	0.000

Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

These two sets of results regarding PR effectively show that there is no meaningful relationship between the returns from one period to the next, for the majority of the markets studied. Or, in other words, in general there is no reliable way to use a previous month's return to predict the next month's return. However, the results regarding RRY were very promising, as they point to a very stable and persistent relationship across all markets.

We now look at the relationship of PR, ER and RRY along the forward curve, specifically the first two nodes of the forward curve.

Exhibit 9: Correlation Results of PR, ER and RRY Along the Forward Curve

Code	Price Return	P-value	Excess Return	P-value	Interp RRY	P-value
BR	0.998	0.000	0.998	0.000	0.963	0.000
CL	0.993	0.000	0.993	0.000	0.905	0.000
GO	0.995	0.000	0.996	0.000	0.931	0.000
HO	0.989	0.000	0.992	0.000	0.862	0.000
HU/RB	0.960	0.000	0.988	0.000	0.493	0.000
NG	0.932	0.000	0.964	0.000	0.660	0.000
IA	0.998	0.000	0.999	0.000	0.601	0.000
IC	1.000	0.000	1.000	0.000	0.976	0.000
IK	1.000	0.000	1.000	0.000	0.897	0.000
IL	0.999	0.000	0.999	0.000	0.929	0.000
IZ	1.000	0.000	1.000	0.000	0.836	0.000
GC	0.994	0.000	1.000	0.000	0.977	0.000
SI	0.998	0.000	1.000	0.000	0.943	0.000
CC	0.991	0.000	0.998	0.000	0.767	0.000
CT	0.886	0.000	0.990	0.000	0.821	0.000
KC	0.957	0.000	1.000	0.000	0.765	0.000
SB	0.921	0.000	0.989	0.000	0.691	0.000
CN	0.947	0.000	0.994	0.000	0.735	0.000
KW	0.974	0.000	0.997	0.000	0.618	0.000
SO	0.941	0.000	0.988	0.000	0.724	0.000
WH	0.948	0.000	0.998	0.000	0.611	0.000
FC	0.926	0.000	0.986	0.000	0.733	0.000
LC	0.767	0.000	0.971	0.000	0.587	0.000
LH	0.494	0.000	0.957	0.000	0.667	0.000

Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

The results indicate that by and large, while the forward curves may change in many different ways, the changes at node 0 and node 1 tend to be in tandem.

There was a high degree of correlation along the forward curve for RRY. We now take it a step further, and see whether there is any meaningful relationship (a) between the RRY(0,m+1) and RRY(1,m), (b) between the RRY(0,m+2) and RRY(1,m), and (c) between the RRY(0,m+3) and RRY(1,m), i.e., lagged 1-month, 2-month and 3-month respectively.

Exhibit 10: Correlation Results of RRY on a Lagged Basis

Code	Lag 1	P-value	Lag 2	P-value	Lag 3	P-value
BR	0.862	0.000	0.761	0.000	0.672	0.000
CL	0.760	0.000	0.558	0.000	0.446	0.000
GO	0.839	0.000	0.669	0.000	0.547	0.000
HO	0.852	0.000	0.672	0.000	0.429	0.000
HU/RB	0.845	0.000	0.359	0.000	0.190	0.031
NG	0.829	0.000	0.447	0.000	0.097	0.273
IA	0.808	0.000	0.534	0.000	0.486	0.000
IC	0.930	0.000	0.877	0.000	0.836	0.000
IK	0.743	0.000	0.727	0.000	0.665	0.000
IL	0.778	0.000	0.693	0.000	0.658	0.000
IZ	0.761	0.000	0.657	0.000	0.593	0.000
GC	0.981	0.000	0.968	0.000	0.956	0.000
SI	0.950	0.000	0.926	0.000	0.900	0.000
CC	0.774	0.000	0.738	0.000	0.701	0.000
CT	0.881	0.000	0.816	0.000	0.751	0.000
KC	0.876	0.000	0.884	0.000	0.898	0.000
SB	0.815	0.000	0.689	0.000	0.551	0.000
CN	0.949	0.000	0.670	0.000	0.390	0.000
KW	0.768	0.000	0.529	0.000	0.283	0.001
SO	0.960	0.000	0.721	0.000	0.482	0.000
WH	0.672	0.000	0.554	0.000	0.430	0.000
FC	0.874	0.000	0.616	0.000	0.428	0.000
LC	0.868	0.000	0.591	0.000	0.294	0.001
LH	0.922	0.000	0.619	0.000	0.271	0.002

Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

The results showed a very stable and persistent relationship among the RRY at the 1-month lag, and started to weaken as the lagging increased further, for most commodities. In some cases, such as copper, gold, silver, cocoa, cotton and coffee, the correlations remained very high even with a 3-month lag, despite very weak auto-correlations of the PR and ER for these commodities.

These findings allow us to see through the surface changes in the form of shifts of the term structures in the forward curves. The true dynamics were less chaotic and more systematic, as can be seen in the stable and persistent relationships among the RRYs at node 0 and node 1, and between the RRYs from one month to the next.

We now present the findings regarding how often each commodity market changed from positive to negative returns, for both PR and ER, during the study period. In Exhibit 11, for example, out of a total of 132 months, there were 59 times when Brent crude oil had its ER switch from either positive to negative, or vice versa. However, Exhibit 12 shows that during the same period, the RRY for Brent crude oil had only changed signs 14 times, or 11% of the time [=14/(132-1)]. This indicates that the *ER and PR are much more volatile, while RRY is much more stable and persistent, despite many kinds of changes in the term structures of the forward curves.*

Exhibit 11: Frequency of Reversals of ER and PR

Seq	Code	Excess Return	Price Return
1	BR	59	59
2	CL	59	61
3	GO	65	61
4	HO	61	61
5	HU	55	56
6	NG	50	56
7	IA	66	66
8	IC	61	63
9	IK	73	75
10	IL	60	63
11	IZ	65	65
12	GC	69	69
13	SI	71	71
14	CC	81	79
15	CT	72	68
16	KC	67	69
17	SB	53	59
18	CN	68	66
19	KW	69	69
20	SO	67	67
21	WH	71	67
22	FC	54	56
23	LC	66	66
24	LH	70	77

Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

Exhibit 12: Frequency of Reversals of RRY

Seq	Code	RRY	Percent (%)
1	BR	14	11
2	CL	22	17
3	GO	17	13
4	HO	19	15
5	HU	28	21
6	NG	16	12
7	IA	20	15
8	IC	12	9
9	IK	28	21
10	IL	26	20
11	IZ	10	8
12	GC	0	0
13	SI	5	4
14	CC	13	10
15	CT	9	7
16	KC	3	2
17	SB	10	8
18	CN	9	7
19	KW	6	5
20	SO	15	11
21	WH	2	2
22	FC	18	14
23	LC	21	16
24	LH	25	19

Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

We now want to analyze the dynamics of the curvature of the forward curve signified by the first three nodes of the curve over the past 11 years. The tight relationships between the RRYs of the first and second nodes across all markets led us to believe that this would be a worthwhile attempt.

5f. GRADIENT

Let us define the following relationship, for a given commodity A, at node i, for month m:

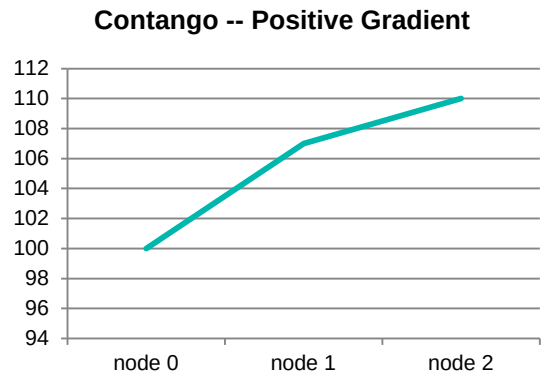
A_GD(i+1,m) = Gradient for commodity A, at node (i+1), for month m
= A_IRRY(i+1,m) – A_IRRY(i,m).

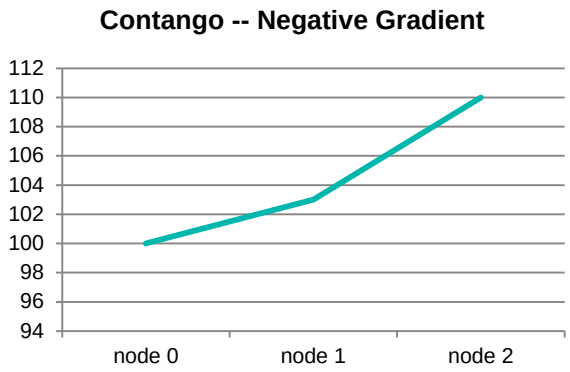
The gradient A_GD(1,m) is a measure of the change in the interpolated realized roll yields for commodity A, at node 1 and node 0, respectively, for a given month m. This is a proxy for the curvature of the forward curve along the first three nodes. When A_IRRY(1,m) and A_IRRY(0,m) are the same, A_GD(1,m)=0 so the curvature of the three nodes of the forward curve is linear. Otherwise, the curve would be concave or convex depending on whether the gradient was positive or negative.

As shown in Exhibit 13, when A is in contango:

And the gradient is positive, the forward curve appears concave.
And the gradient is negative, the forward curve appears convex.

Exhibit 13: Two Different Profiles in Contango





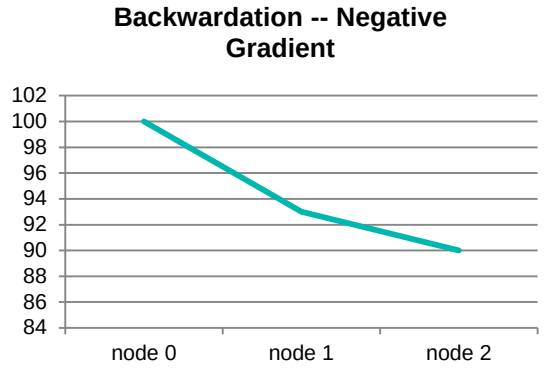
Hypothetical example, for illustrative purposes only.

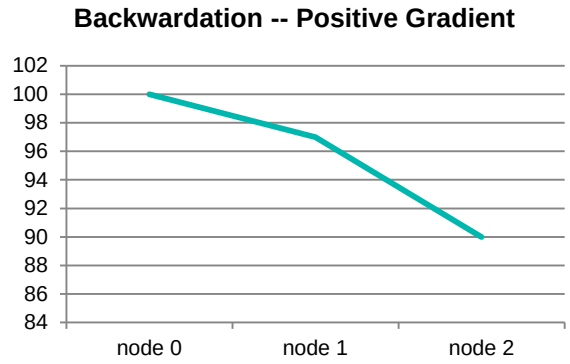
As shown in Exhibit 14, when A is in backwardation:

And the gradient is negative, the forward curve appears convex.

And the gradient is negative, the forward curve appears concave.

Exhibit 14: Two Different Profiles in Backwardation





Hypothetical example, for illustrative purposes only.

Exhibit 15: Gradient: Auto-correlation Results and Correlations with RRY

Code	Auto-correlation	P-value	Correlation with RRY	P-value	Correlation with RRY -- lag 1	P-value
BR	0.485	0.000	-0.435	0.000	-0.319	0.000
CC	0.584	0.000	-0.612	0.000	-0.429	0.000
CL	0.299	0.001	-0.815	0.000	-0.342	0.000
CN	0.002	0.977	-0.379	0.000	0.268	0.002
CT	0.452	0.000	-0.244	0.005	0.046	0.604
FC	0.099	0.262	-0.284	0.001	0.371	0.000
GC	0.200	0.022	-0.133	0.129	-0.039	0.662
GO	0.245	0.005	-0.199	0.022	0.122	0.166
HO	0.604	0.000	-0.142	0.104	0.324	0.000
HU/RB	-0.293	0.001	-0.489	0.000	0.396	0.000
IA	-0.225	0.010	-0.439	0.000	0.290	0.001
IC	0.298	0.001	0.246	0.004	0.288	0.001
IK	-0.145	0.098	0.188	0.031	0.259	0.003
IL	0.441	0.000	0.274	0.002	0.410	0.000
IZ	0.116	0.186	-0.305	0.000	-0.056	0.524
KC	0.516	0.000	-0.452	0.000	-0.100	0.255
KW	0.282	0.001	-0.389	0.000	0.123	0.160
LC	0.139	0.114	-0.448	0.000	0.259	0.003
LH	0.156	0.075	-0.450	0.000	0.264	0.002
NG	0.207	0.018	-0.619	0.000	0.254	0.003
SB	0.319	0.000	-0.420	0.000	-0.073	0.406
SI	0.386	0.000	-0.367	0.000	-0.246	0.005
SO	0.112	0.203	-0.332	0.000	0.315	0.000
WH	0.540	0.000	-0.184	0.035	0.072	0.413

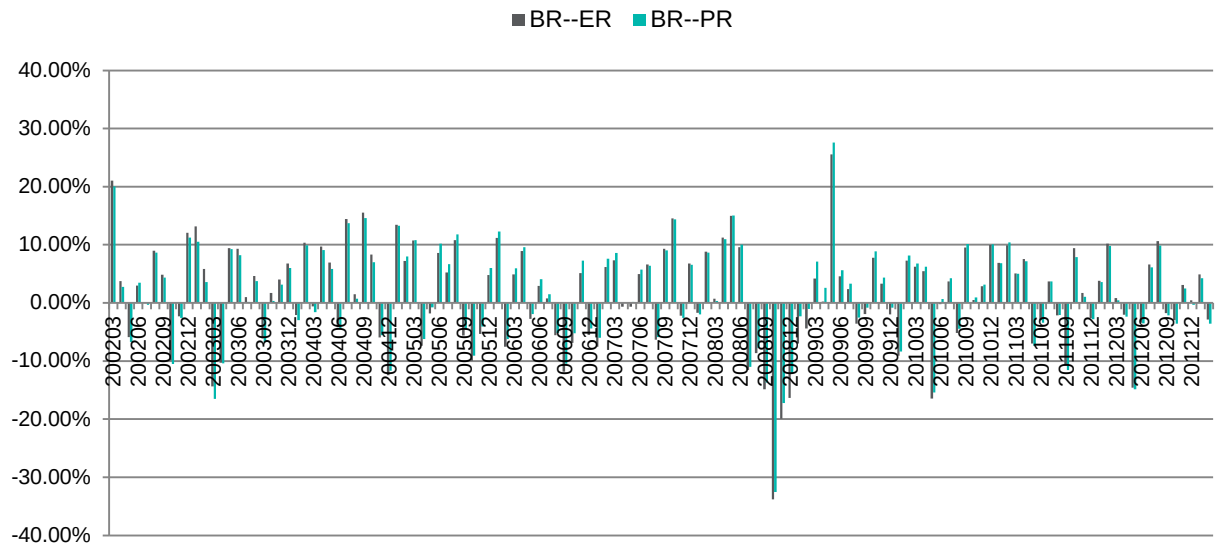
Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

For 17 out of 24 of the commodities markets, there is a significant auto-correlation among their gradient measures. This suggests that the gradients for these markets tend to persist. However, when compared with the RRY, the persistence seems to be less pronounced. Furthermore, we notice that in markets such as LH, LC, FC, IK, IZ, SO and CN, there is no meaningful auto-correlation of the gradient measure. However, even for these seven markets, we found there were significant relationships between the gradient measure and the RRY, both concurrently and on a 1-month-lag basis.

5g. BRENT CRUDE OIL EXAMPLE

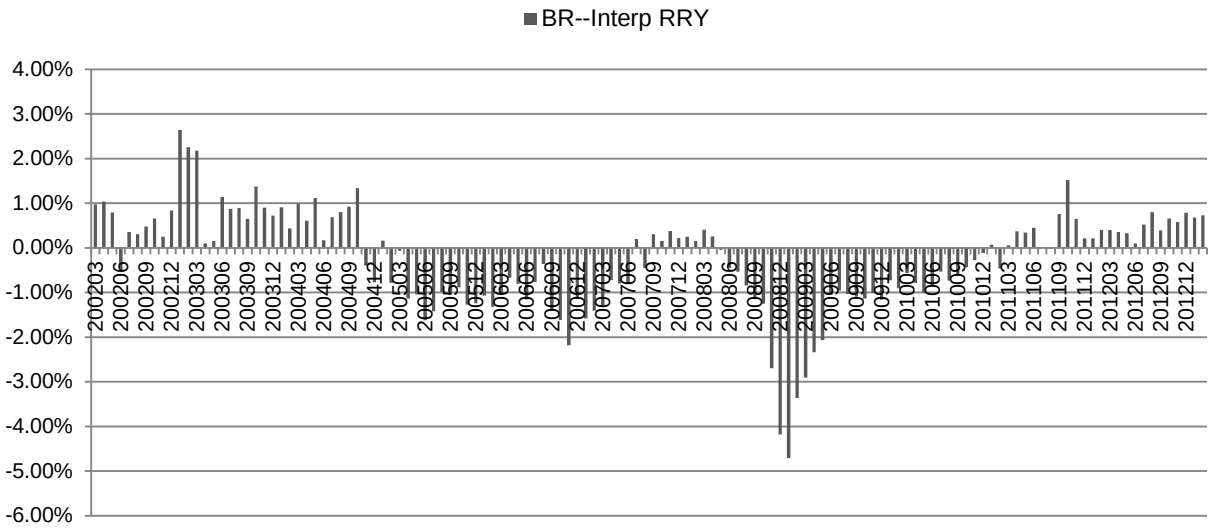
Let us now illustrate the results using Brent crude oil as an example. Exhibit 16 shows the monthly ER and PR of Brent crude oil. Notice that there are a large number of reversals of PR and ER—59 times in both cases—though not necessarily occurring in the same months. Exhibit 17 illustrates the RRY of Brent crude oil, and a very different pattern emerges, with the RRY tending to occur in clusters. Exhibit 18 shows that there is also a clustering pattern in the gradient of Brent crude oil, suggesting that the curvature of Brent crude oil may not change drastically from month to month, but rather in a gradual manner.

Exhibit 16: Comparison of Brent Crude Oil ER and PR Returns



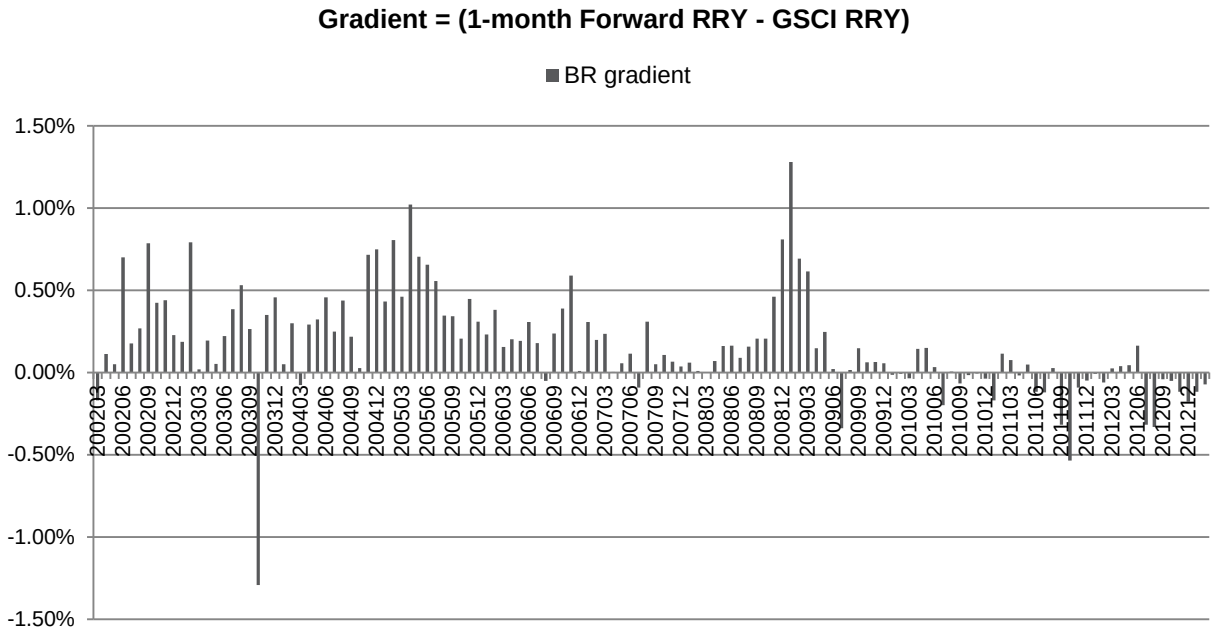
Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only. The monthly intervals are expressed as YYYYMM.

Exhibit 17: Brent Crude Oil Realized Roll Yields Over Time



Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only. The monthly intervals are expressed as YYYYMM.

Exhibit 18: Brent Crude Oil Gradient Over Time



Source: S&P Dow Jones Indices. Data from March 2002 to Feb. 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only. The monthly intervals are expressed as YYYYMM.

6. CONCLUSION

Because they represent the most liquid part of the curve and may be most interesting to commodities investors seeking to preserve liquidity, we focused our analysis on the first three nodes of the term structure of the forward curves. Although we found little relationship between the changes in futures prices over time, we discovered the persistence of a different and innovative measure of term structure called the realized roll yield. The persistence of the realized roll yield implies that the market inertia would continue if other market conditions remained the same; thus, it can be used as a signal to under- and over-weight commodities, based on how the relative term structures of various commodities are being measured. Lastly, *by decoding the information embedded in the PR and ER indices, we can bypass using the actual historical prices of the commodity futures contracts so that we can measure theoretical forward curves of not only single commodities but also sectors and broad-based indices.*

APPENDIX A

Exhibit A-1 illustrates the roll schedule of each commodity in the S&P GSCI, and Exhibit A-2 shows the interpolation matrix.

Exhibit A-1: Roll Schedule for S&P GSCI Commodities: Contract at the End of the Month Indicated.

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BR	J	K	M	N	Q	U	V	X	Z	F	G	H
CL	H	J	K	M	N	Q	U	V	X	Z	F	G
GO	H	J	K	M	N	Q	U	V	X	Z	F	G
HO	H	J	K	M	N	Q	U	V	X	Z	F	G
HU	H	J	K	M	N	Q	U	V	X	Z	F	G
NG	H	J	K	M	N	Q	U	V	X	Z	F	G
IA	H	J	K	M	N	Q	U	V	X	Z	F	G
IC	H	J	K	M	N	Q	U	V	X	Z	F	G
IK	H	J	K	M	N	Q	U	V	X	Z	F	G
IL	H	J	K	M	N	Q	U	V	X	Z	F	G
IZ	H	J	K	M	N	Q	U	V	X	Z	F	G
GC	J	J	M	M	Q	Q	Z	Z	Z	Z	G	G
SI	H	K	K	N	N	U	U	Z	Z	Z	H	H
CC	H	K	K	N	N	U	U	Z	Z	Z	H	H
CT	H	K	K	N	N	Z	Z	Z	Z	Z	H	H
KC	H	K	K	N	N	U	U	Z	Z	Z	H	H
SB	H	K	K	N	N	V	V	V	H	H	H	H
CN	H	K	K	N	N	U	U	Z	Z	Z	H	H
KW	H	K	K	N	N	U	U	Z	Z	Z	H	H
SO	H	K	K	N	N	X	X	X	X	F	F	H
WH	H	K	K	N	N	U	U	Z	Z	Z	H	H
FC	H	J	K	Q	Q	Q	U	V	X	F	F	H
LC	J	J	M	M	Q	Q	V	V	Z	Z	G	G
LH	J	J	M	M	N	Q	V	V	Z	Z	G	G

Source: S&P Dow Jones Indices. Data as of June 30, 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

Exhibit A-2: S&P GSCI Roll Yield Interpolation Matrix

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BR	1	1	1	1	1	1	1	1	1	1	1	1
CL	1	1	1	1	1	1	1	1	1	1	1	1
GO	1	1	1	1	1	1	1	1	1	1	1	1
HO	1	1	1	1	1	1	1	1	1	1	1	1
HU	1	1	1	1	1	1	1	1	1	1	1	1
NG	1	1	1	1	1	1	1	1	1	1	1	1
IA	1	1	1	1	1	1	1	1	1	1	1	1
IC	1	1	1	1	1	1	1	1	1	1	1	1
IK	1	1	1	1	1	1	1	1	1	1	1	1
IL	1	1	1	1	1	1	1	1	1	1	1	1
IZ	1	1	1	1	1	1	1	1	1	1	1	1
GC	2	2	2	2	2	2	4	4	4	4	2	2
SI	3	2	2	2	2	2	2	3	3	3	3	3
CC	3	2	2	2	2	2	2	3	3	3	3	3
CT	3	2	2	2	2	5	5	5	5	5	3	3
KC	3	2	2	2	2	2	2	3	3	3	3	3
SB	5	2	2	2	2	3	3	3	5	5	5	5
CN	3	2	2	2	2	2	2	3	3	3	3	3
KW	3	2	2	2	2	2	2	3	3	3	3	3
SO	2	2	2	2	2	4	4	4	4	2	2	2
WH	3	2	2	2	2	2	2	3	3	3	3	3
FC	2	1	1	3	3	3	1	1	1	2	2	2
LC	2	2	2	2	2	2	2	2	2	2	2	2
LH	2	2	2	2	1	1	2	2	2	2	2	2

Source: S&P Dow Jones Indices. Data as of June 30, 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

For the S&P GSCI 1 Month Forward RRYs, the process is similar, but with a different roll schedule. Exhibit A-3 shows the roll schedule for the S&P GSCI 1 Month Forward indices, and Exhibit A-4 shows the corresponding interpolation matrix.

Exhibit A-3: Roll Schedule for S&P GSCI 1 Month Forward Commodities: Contract at the End of the Month Indicated

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BR	K	M	N	Q	U	V	X	Z	F	G	H	J
CL	J	K	M	N	Q	U	V	X	Z	F	G	H
GO	J	K	M	N	Q	U	V	X	Z	F	G	H
HO	J	K	M	N	Q	U	V	X	Z	F	G	H
HU	J	K	M	N	Q	U	V	X	Z	F	G	H
NG	J	K	M	N	Q	U	V	X	Z	F	G	H
IA	J	K	M	N	Q	U	V	X	Z	F	G	H
IC	J	K	M	N	Q	U	V	X	Z	F	G	H
IK	J	K	M	N	Q	U	V	X	Z	F	G	H
IL	J	K	M	N	Q	U	V	X	Z	F	G	H
IZ	J	K	M	N	Q	U	V	X	Z	F	G	H
GC	J	M	M	Q	Q	Z	Z	Z	Z	G	G	J
SI	K	K	N	N	U	U	Z	Z	Z	H	H	H
CC	K	K	N	N	U	U	Z	Z	Z	H	H	H
CT	K	K	N	N	Z	Z	Z	Z	Z	H	H	H
KC	K	K	N	N	U	U	Z	Z	Z	H	H	H
SB	K	K	N	N	V	V	V	H	H	H	H	H
CN	K	K	N	N	U	U	Z	Z	Z	H	H	H
KW	K	K	N	N	U	U	Z	Z	Z	H	H	H
SO	K	K	N	N	X	X	X	X	F	F	H	H
WH	K	K	N	N	U	U	Z	Z	Z	H	H	H
FC	J	K	Q	Q	Q	U	V	X	F	F	H	H
LC	J	M	M	Q	Q	V	V	Z	Z	G	G	J
LH	J	M	M	N	Q	V	V	Z	Z	G	G	J

Source: S&P Dow Jones Indices. Data as of June 30, 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

Exhibit A-4: S&P GSCI 1 Month Forward Roll Yield Interpolation Matrix

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BR	1	1	1	1	1	1	1	1	1	1	1	1
CL	1	1	1	1	1	1	1	1	1	1	1	1
GO	1	1	1	1	1	1	1	1	1	1	1	1
HO	1	1	1	1	1	1	1	1	1	1	1	1
HU	1	1	1	1	1	1	1	1	1	1	1	1
NG	1	1	1	1	1	1	1	1	1	1	1	1
IA	1	1	1	1	1	1	1	1	1	1	1	1
IC	1	1	1	1	1	1	1	1	1	1	1	1
IK	1	1	1	1	1	1	1	1	1	1	1	1
IL	1	1	1	1	1	1	1	1	1	1	1	1
IZ	1	1	1	1	1	1	1	1	1	1	1	1
GC	2	2	2	2	2	4	4	4	4	2	2	2
SI	2	2	2	2	2	2	3	3	3	3	3	3
CC	2	2	2	2	2	2	3	3	3	3	3	3
CT	2	2	2	2	5	5	5	5	5	3	3	3
KC	2	2	2	2	2	2	3	3	3	3	3	3
SB	2	2	2	2	3	3	3	5	5	5	5	5
CN	2	2	2	2	2	2	3	3	3	3	3	3
KW	2	2	2	2	2	2	3	3	3	3	3	3
SO	2	2	2	2	4	4	4	4	2	2	2	2
WH	2	2	2	2	2	2	3	3	3	3	3	3
FC	1	1	3	3	3	1	1	1	2	2	2	2
LC	2	2	2	2	2	2	2	2	2	2	2	2
LH	2	2	2	1	1	2	2	2	2	2	2	2

Source: S&P Dow Jones Indices. Data as of June 30, 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

Legend					
Contract Month	Contract Month Code	Code	Commodity	Code	Commodity
JAN	F	BR	Brent Crude	SI	Silver
FEB	G	CL	WTI Crude	CC	Cocoa
MAR	H	GO	Gasoil	CT	Cotton
APR	J	HO	Heating Oil	KC	Coffee
MAY	K	HU	RBOB	SB	Sugar
JUN	M	NG	Natural Gas	CN	Corn
JUL	N	IA	Aluminum	KW	Kansas Wheat
AUG	Q	IC	Copper	SO	Soybeans
SEP	U	IK	Nickel	WH	Wheat
OCT	V	IL	Lead	FC	Feeder Cattle
NOV	X	IZ	Zinc	LC	Live Cattle
DEC	Z	GC	Gold	LH	Lean Hogs

APPENDIX B

Exhibit B-1 provides a numerical illustration of the interpolation process, using sugar as an example, as tracked by the S&P GSCI Sugar 1 Month Forward.

For January 2012, we showed the RRY for sugar in column 4 (RRY=0.0187). Based on sugar's roll schedule, we know that sugar will be long the same contract in the following month (the May contract, K), and thus the raw or unadjusted realized roll yield for February will be equal to 0, as there would be no rolling of contracts. The unadjusted RRY for February will be filled in with the realized roll yield for January. For January and February, the interpolated RRY is obtained by dividing the adjusted RRY by the interpolation factor for the given month. Thus, we apply an interpolation factor of 2 for January and February, essentially spreading the unadjusted RRY over a 2-month period. The interpolation factor is a function of how many months the same futures contract would be in force. Thus, for March and April, the interpolation factor is again 2 because the July contract (N) is in use. Likewise, the unadjusted realized roll yield for April will be filled in with the RRY for March. However, for May through July, the October contract (V) would be in use for 3 months; thus beginning in May, when we calculate the RRY for sugar, we will spread the May RRY over the 3 months (May to July). Similarly, from August through December, we would be long the upcoming March (H) contract for 5 months, and so we set the interpolation factor at 5.

Exhibit B-1: Example of Sugar (SB): S&P GSCI Sugar 1 Month Forward

Month	Interpolation Factor	Contract Month	RRY	Adj	Interpolated RRY
201201	2	K	0.0187	0.0187	0.0093
201202	2	K	0.0000	0.0187	0.0093
201203	2	N	0.0375	0.0375	0.0187
201204	2	N	0.0000	0.0375	0.0187
201205	3	V	-0.0176	-0.0176	-0.0059
201206	3	V	0.0000	-0.0176	-0.0059
201207	3	V	0.0000	-0.0176	-0.0059
201208	5	H	-0.0210	-0.0210	-0.0042
201209	5	H	0.0000	-0.0210	-0.0042
201210	5	H	0.0000	-0.0210	-0.0042
201211	5	H	0.0000	-0.0210	-0.0042
201212	5	H	0.0000	-0.0210	-0.0042
201301	2	K	-0.0122	-0.0122	-0.0061
201302	2	K	0.0000	-0.0122	-0.0061

Source: S&P Dow Jones Indices. Data as of Feb. 28, 2013. Past performance is not an indication of future results. Table is provided for illustrative purposes only.

REFERENCES

Till, Hilary and Joseph Eagleeye (2005). "Commodities – Active Strategies for Enhanced Return," a chapter in The Handbook of Inflation Hedging Investments (Edited by Robert Greer). New York: McGraw Hill.

ABOUT S&P DOW JONES INDICES

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PERFORMANCE DISCLOSURE

The S&P GSCI Roll Weight Select TR was launched on July 10, 2013. All information presented prior to the launch date is back-tested. Back-tested performance is not actual performance, but is hypothetical. The back-test calculations are based on the same methodology that was in effect on the launch date. Complete index methodology details are available at www.spdji.com.

The S&P GSCI Equal Weight Select was launched on September 9, 2010. All information presented prior to the launch date is back-tested. Back-tested performance is not actual performance, but is hypothetical. The back-test calculations are based on the same methodology that was in effect on the launch date. Complete index methodology details are available at www.spdji.com.

S&P Dow Jones Indices defines various dates to assist our clients in providing transparency on their products. The First Value Date is the first day for which there is a calculated value (either live or back-tested) for a given index. The Base Date is the date at which the Index is set at a fixed value for calculation purposes. The Launch Date designates the date upon which the values of an index are first considered live; index values provided for any date or time period prior to the index's Launch Date are considered back-tested. S&P Dow Jones Indices defines the Launch Date as the date by which the values of an index are known to have been released to the public, for example via the company's public Web site or its datafeed to external parties. For Dow Jones-branded indices introduced prior to May 31, 2013, the Launch Date (which prior to May 31, 2013, was termed "Date of Introduction") is set at a date upon which no further changes were permitted to be made to the index methodology, but that may have been prior to the Index's public release date.

Past performance of the Index is not an indication of future results. Prospective application of the methodology used to construct the Index may not result in performance commensurate with the back-test returns shown. The back-test period does not necessarily correspond to the entire available history of the Index. Please refer to the methodology paper for the Index, available at www.spdji.com for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations.

Another limitation of using back-tested information is that the back-tested calculation is generally prepared with the benefit of hindsight. Back-tested information reflects the application of the index methodology and selection of index constituents in hindsight. No hypothetical record can completely account for the impact of financial risk in actual trading. For example, there are numerous factors related to the equities (or fixed income, or commodities) markets in general which cannot be, and have not been accounted for in the preparation of the index information set forth, all of which can affect actual performance.

Additionally, it is not possible to invest directly in an Index. The Index returns shown do not represent the results of actual trading of investable assets/securities. S&P Dow Jones Indices maintains the Index and calculates the Index levels and performance shown or discussed, but does not manage actual assets. Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the Index or investment funds that are intended to track the performance of the Index. The imposition of these fees and charges would cause actual and back-tested performance of the securities/fund to be lower than the Index performance shown. For example, if an index returned 10% on a US $100,000 investment for a 12-month period (or US$ 10,000) and an actual asset-based fee of 1.5% was imposed at the end of the period on the investment plus accrued interest (or US$ 1,650), the net return would be 8.35% (or US$ 8,350) for the year. Over a three-year period, an annual 1.5% fee taken at year end with an assumed 10% return per year would result in a cumulative gross return of 33.10%, a total fee of US$ 5,375, and a cumulative net return of 27.2% (or US$ 27,200).

DISCLAIMER

S&P acquired the GSCI from Goldman Sachs on February 2, 2007 and it was subsequently renamed the S&P GSCI. Goldman Sachs began first publishing the GSCI related indices in 1991 but has calculated the historical value of the GSCI beginning January 2, 1970 based on actual prices from that date forward and the selection criteria, methodology and procedures in effect during the applicable periods of calculation (or, in the case of all calculation periods prior to 1991, based on the selection criteria, methodology and procedures adopted in 1991). The GSCI has been normalized to a value of 100 on January 2, 1970, in order to permit comparisons of the value of the GSCI to be made over time.