S&P Dow Jones Indices

S&P Global

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# A Liquidity Analysis of Crude Oil

## ANNOUNCEMENT

Effective at the open on May 28, 2015, for implementation during the June roll period starting on June 1, 2015, the S&P GSCI Enhanced Commodity will follow a new contract determination for WTI crude oil.

The old methodology is as follows: on the third-to-last business day of every month, the contract determination is done through a calculation using the S&P GSCI contract calendar roll-out and roll-in contracts. If the return between the roll-in and roll-out contracts is greater than 0.5%, the contracts roll in to the sixth contract month out.

The new methodology is as follows: during the roll-in contract determination months of January through June, if the prior mentioned rule applies, the contracts will roll to the current year's December contracts. During the roll-in contract determination months of July through December, if the rule applies, the contracts will roll to the next year's December contracts.

We modified the enhanced roll strategy for the S&P GSCI Crude Oil because we observed a fundamental shift in the liquidity profile of the crude oil market. The following analysis presents the case for such a change.

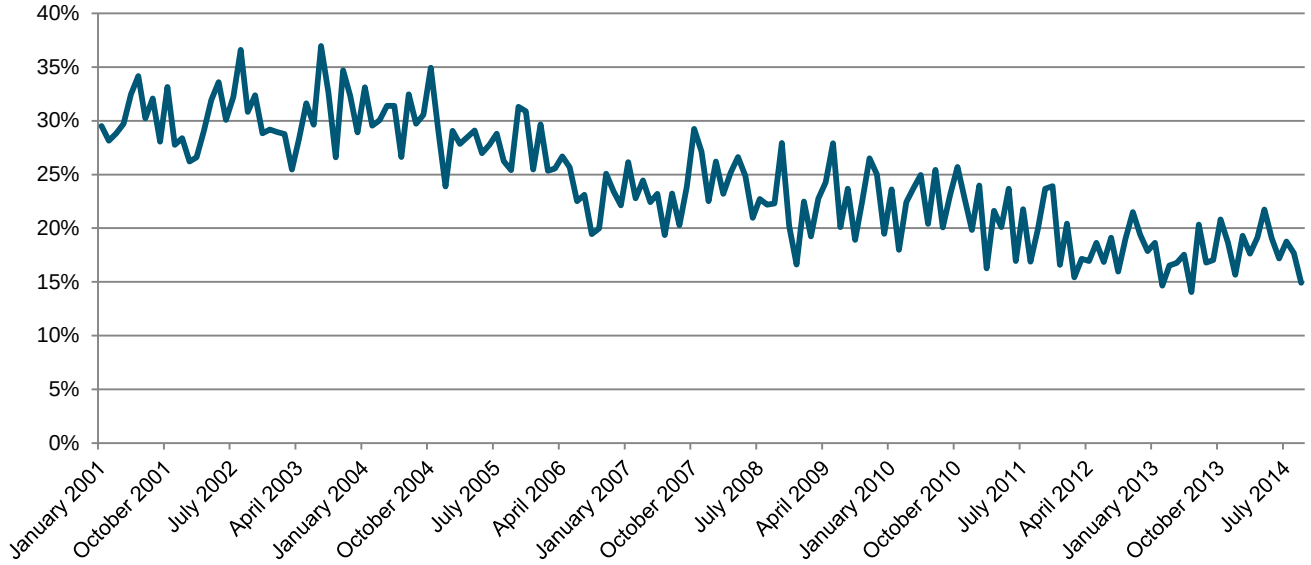
## A LIQUIDITY ANALYSIS OF CRUDE OIL

The liquidity of the front-month crude oil contracts has been decreasing steadily since 2001, while the next six forward month contracts have maintained their levels. There have been notable spikes in the liquidity profiles of the front-month contracts and the next six forward contracts, which is primarily due to the greater acceptance of the December and June contracts since 2001.

To investigate the liquidity levels, we calculated the value of open interests for each of the contracts for each month in U.S. dollars, from January 2001 to September 2014. We then normalized the values into percentages, and then we ranked them in descending order. The liquidity percentages of the contracts highlight the shifts in liquidity over time. By definition, the front-month contract changes each month, and thus when we comment on the liquidity of the front-month contract, we are implicitly talking about different contracts over time.

However, regardless of which contract is in the front-month position, we have seen a steady decline in its liquidity (see Exhibit 1).

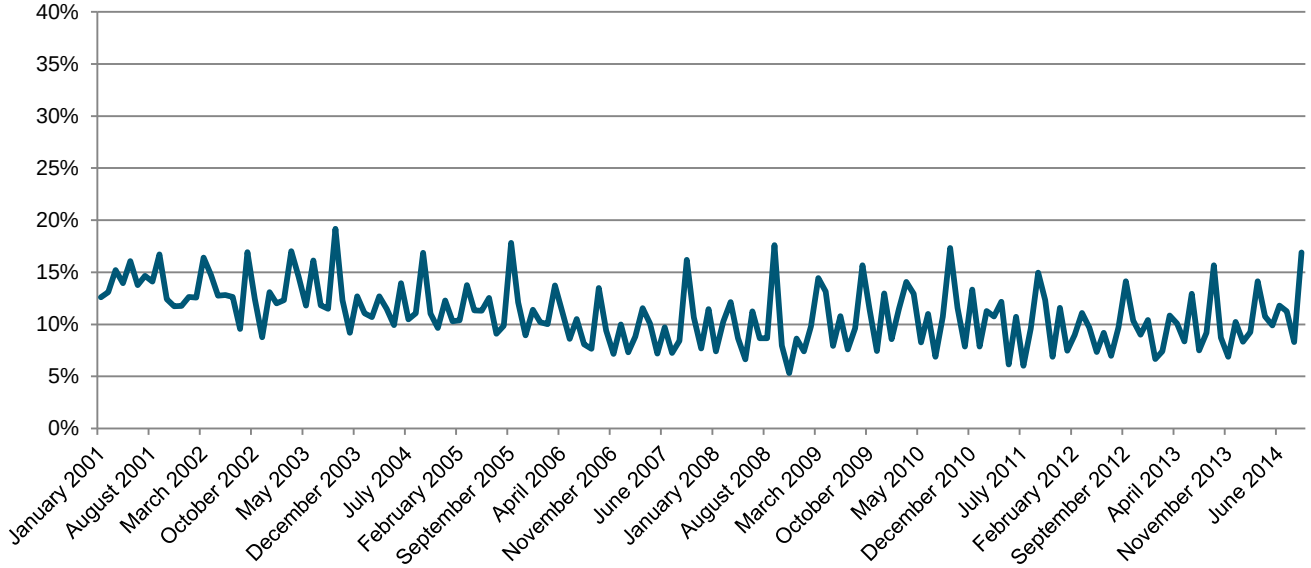
**Exhibit 1: Front-Month Contract**




Source: CRB (Commodity Research Bureau). Data from 2001 to 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

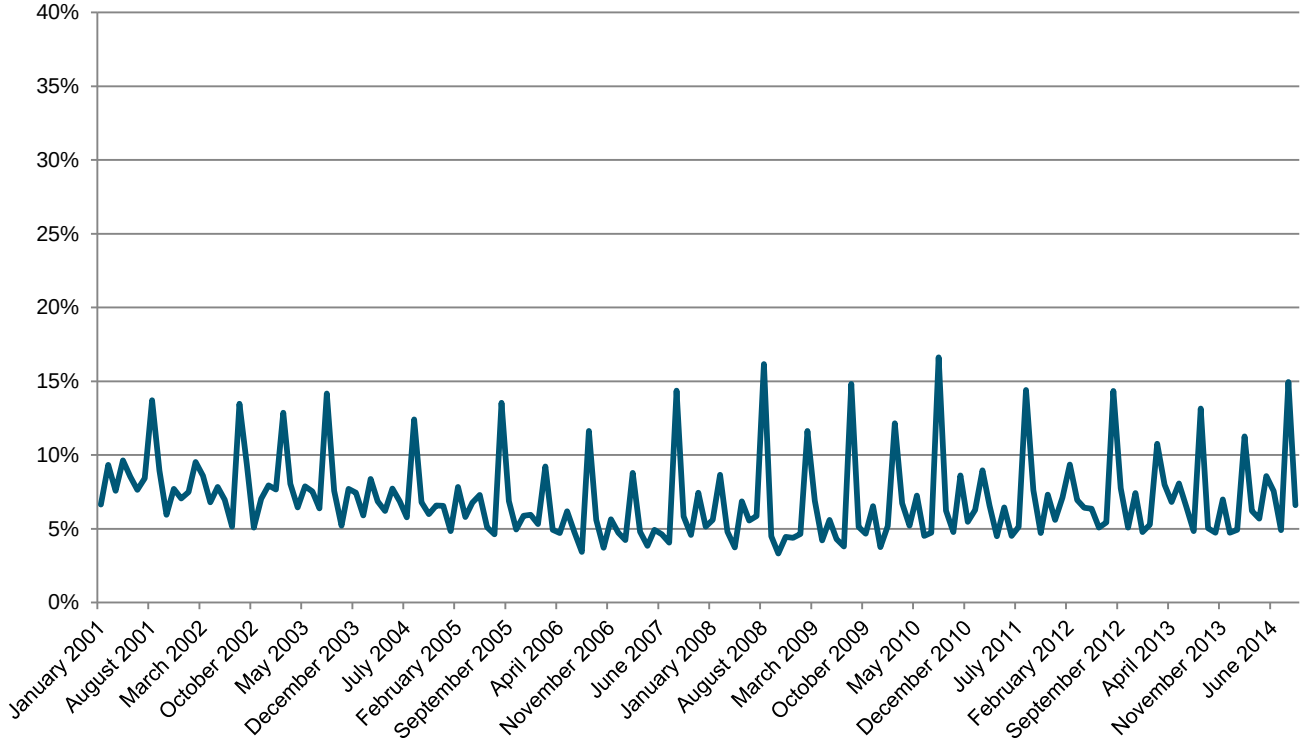
Exhibits 2 through 7 show the relative liquidity of the next six contracts over time. To be comparable with Exhibit 1, the same scales are used.

**Exhibit 2: Contract 1**



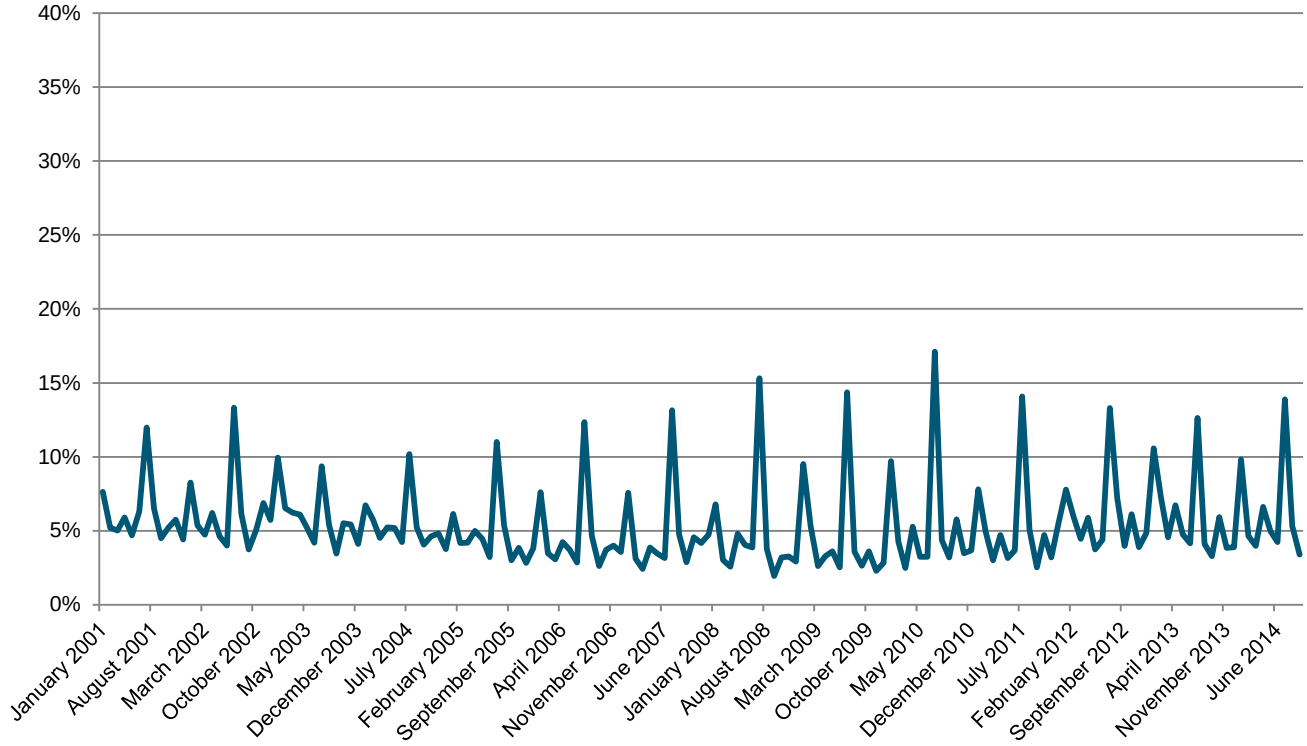

Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

**Exhibit 3: Contract 2**



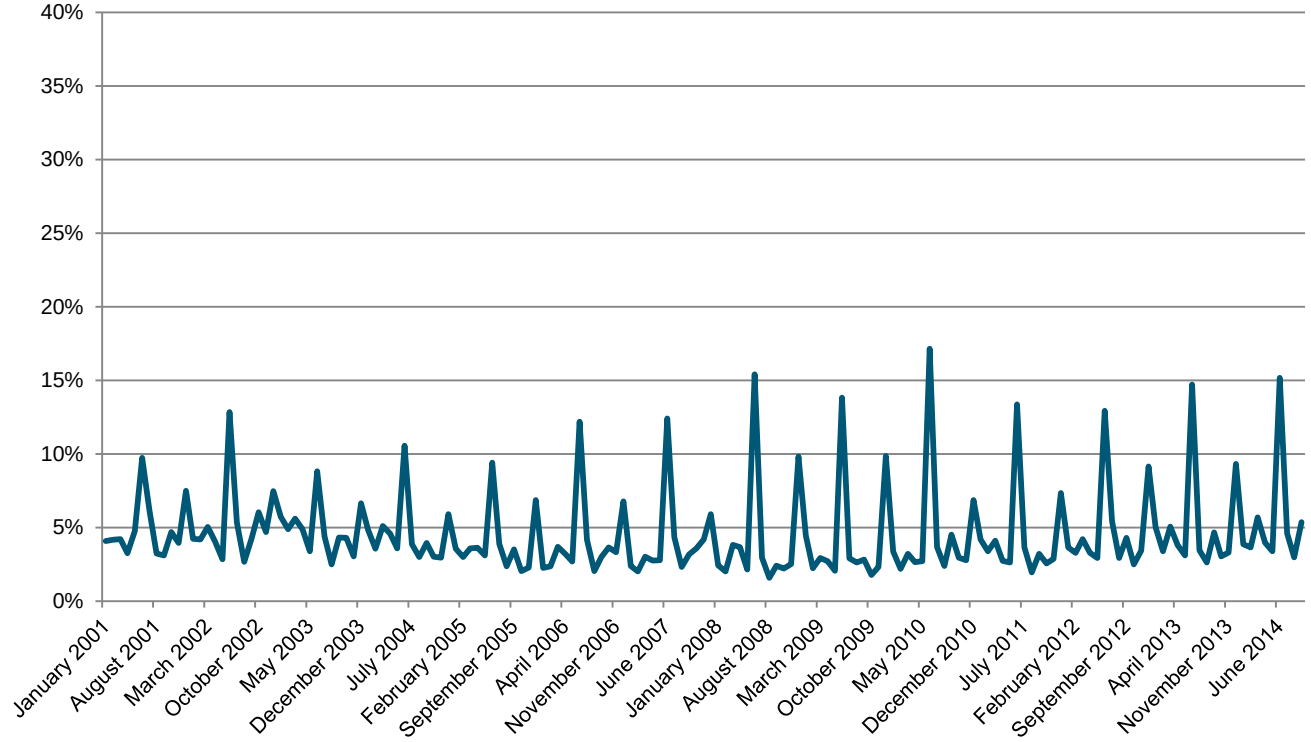

Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

**Exhibit 4: Contract 3**



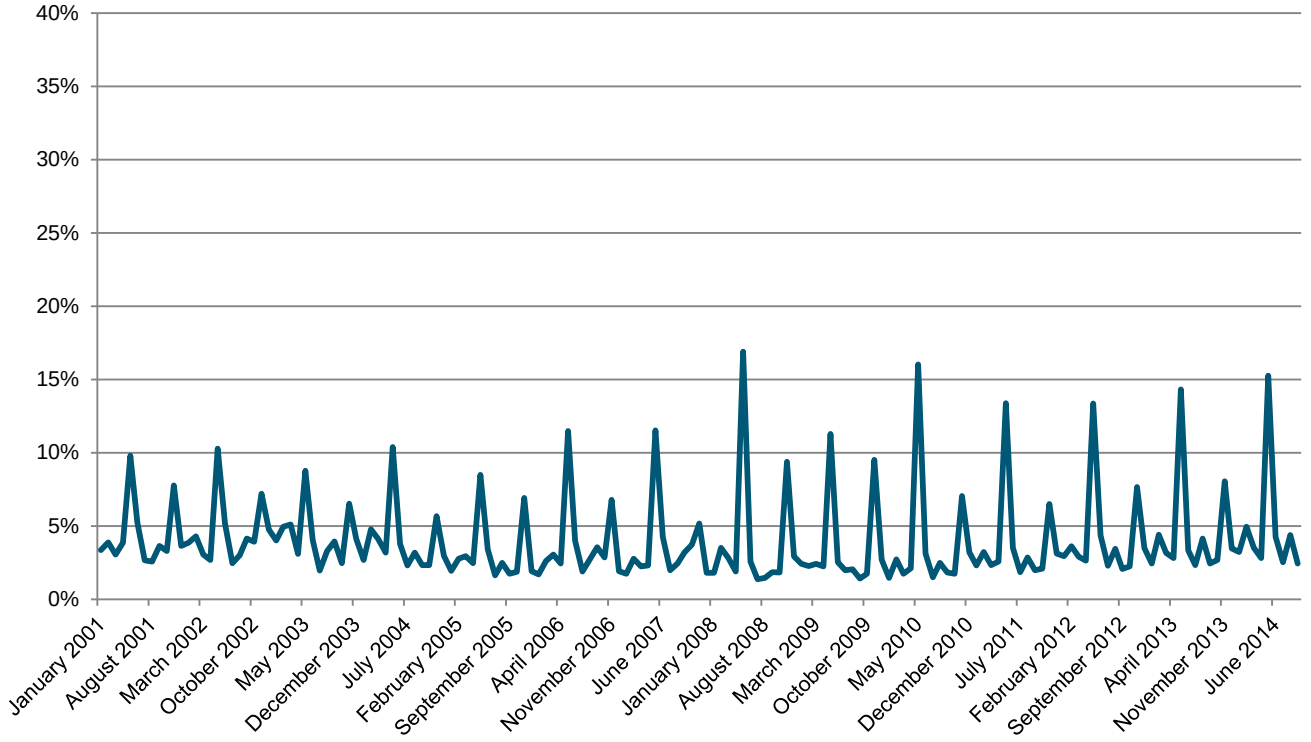

Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

**Exhibit 5: Contract 4**



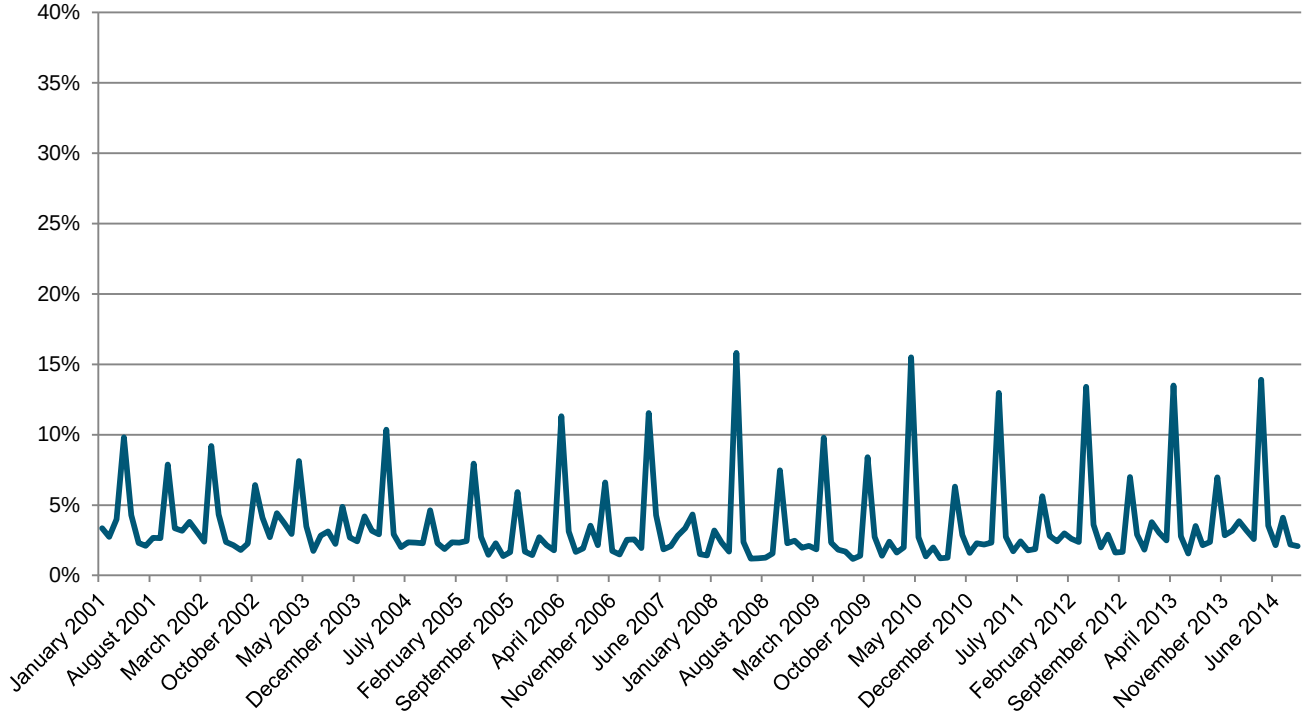

Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

**Exhibit 6: Contract 5**




Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

**Exhibit 7: Contract 6**




Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

The liquidity levels of the six contracts following the front-month contract seem to be relatively stable, except for the periodic spikes. Upon further investigation, these spikes were found to be due to the December and June contracts moving into the corresponding months. To illustrate this phenomenon more clearly, we ranked the liquidity percentage of each of the contracts in descending order. We then computed the average ranking of each contract month over five different time horizons prior to their expiration month: three months, six months, nine months, twelve months, and twenty-four months.

**Exhibit 8: Average Ranking Analysis**

| Contract Month | 3-Month Average | 6-Month Average | 9-Month Average | 12-Month Average | 24-Month Average |
|---|---|---|---|---|---|
| F | 2.6 | 4.8 | 6.6 | 8.3 | 14.7 |
| G | 3.4 | 6.9 | 9.3 | 11.4 | 18.5 |
| H | 2.7 | 5.3 | 7.7 | 9.7 | 17.0 |
| J | 3.2 | 6.1 | 8.7 | 11.2 | 18.8 |
| K | 3.2 | 6.2 | 8.9 | 11.4 | 19.2 |
| M | 2.3 | 3.1 | 3.8 | 4.6 | 8.1 |
| N | 2.8 | 5.4 | 7.6 | 9.3 | 17.5 |
| Q | 3.3 | 6.4 | 9.4 | 11.7 | 19.6 |
| U | 2.8 | 4.9 | 6.7 | 8.3 | 14.6 |
| V | 3.2 | 5.8 | 8.2 | 10.5 | 18.3 |
| X | 3.5 | 6.5 | 8.5 | 10.5 | 17.6 |
| Z | 1.7 | 2.0 | 2.2 | 2.3 | 3.4 |

Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Table is provided for illustrative purposes. Shaded rows represent the most-liquid months with the lowest average rankings. Monthly contracts from January through December are represented by letters F, G, H, J, K, M, N, Q, U, V, X, and Z, respectively.

The shaded rows in Exhibit 8 indicate the months that were the most liquid, with the lowest average rankings. For example, the December contract (Z) consistently ranked the highest, followed by the June (M) contract. The remaining four contracts in the top half were those from January (F), March (H), July (N), and September (U).

Exhibits 9 through 13 show the rankings by individual contracts, rather than by contract month. This allows us to see the trend over time for the individual contract months as well.

In Exhibit 9, the CLZ2001 (December 2001 contract) had an average ranking of 2.00 (under the column labeled "Z," which stands for the December contract month). From 2002 to 2013, the value of the December contract for each year stayed at 1.67, except for a brief uptick in 2006. There was no data for the CLZ2014, as the cutoff date for the dataset was September 2014. The trend is quite clear: the December (Z) contract has been the most liquid contract since 2001.

**Exhibit 9: 3-Month Average Ranking**

| Year | Contract Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | G | H | J | K | M | N | Q | U | V | X | Z |
| 2001 | - | - | - | - | 2.67 | 2.00 | 2.33 | 2.33 | 2.33 | 2.33 | 2.33 | 2.00 |
| 2002 | 2.00 | 2.67 | 2.33 | 2.33 | 2.33 | 2.00 | 2.33 | 2.33 | 2.67 | 2.67 | 3.33 | 1.67 |
| 2003 | 2.00 | 3.00 | 2.67 | 2.00 | 3.00 | 1.67 | 2.33 | 2.33 | 2.33 | 2.33 | 2.67 | 1.67 |
| 2004 | 2.00 | 2.33 | 2.00 | 2.00 | 2.67 | 2.33 | 2.33 | 2.67 | 2.33 | 2.33 | 3.00 | 1.67 |
| 2005 | 2.00 | 2.33 | 2.33 | 2.33 | 3.00 | 2.33 | 2.67 | 2.33 | 2.33 | 3.00 | 3.33 | 1.67 |
| 2006 | 2.00 | 3.00 | 3.00 | 3.00 | 3.00 | 2.33 | 3.00 | 3.33 | 3.00 | 3.33 | 4.67 | 2.00 |
| 2007 | 3.00 | 3.33 | 3.33 | 3.67 | 3.33 | 2.67 | 3.00 | 5.00 | 3.33 | 3.33 | 3.67 | 1.67 |
| 2008 | 2.67 | 2.67 | 2.67 | 3.33 | 3.33 | 2.67 | 3.00 | 4.33 | 2.67 | 3.33 | 3.33 | 1.67 |
| 2009 | 3.33 | 4.67 | 3.67 | 3.67 | 3.33 | 1.67 | 2.67 | 3.67 | 3.00 | 4.00 | 4.00 | 1.67 |
| 2010 | 3.00 | 3.67 | 3.00 | 4.00 | 3.67 | 2.33 | 2.67 | 3.33 | 3.00 | 3.67 | 3.33 | 1.67 |
| 2011 | 2.67 | 4.33 | 2.33 | 3.67 | 3.33 | 3.00 | 3.00 | 4.33 | 3.00 | 4.00 | 4.00 | 1.67 |
| 2012 | 2.67 | 3.67 | 2.33 | 3.67 | 3.33 | 2.33 | 3.00 | 3.33 | 3.00 | 3.67 | 3.67 | 1.67 |
| 2013 | 2.67 | 3.67 | 3.00 | 4.33 | 4.00 | 2.33 | 3.33 | 3.67 | 3.00 | 3.33 | 4.00 | 1.67 |
| 2014 | 3.33 | 4.67 | 3.00 | 3.67 | 3.67 | 2.00 | 3.00 | 3.33 | 2.67 | 3.00 | 4.00 | - |

Source: CRB. Data from 2001-2014. Past performance is no guarantee of future results. Table is provided for illustrative purposes. Monthly contracts from January through December are represented by letters F, G, H, J, K, M, N, Q, U, V, X, and Z, respectively.

We see a similar pattern in Exhibit 10 for the December (Z) contract, over a six-month horizon.

**Exhibit 10: 6-Month Average Ranking**

| Year | Contract Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | G | H | J | K | M | N | Q | U | V | X | Z |
| 2001 | - | - | - | - | - | - | - | 5.17 | 5.00 | 5.83 | 4.33 | 2.50 |
| 2002 | 3.50 | 4.83 | 5.00 | 4.50 | 5.00 | 2.50 | 4.50 | 4.83 | 4.17 | 4.67 | 6.00 | 2.00 |
| 2003 | 3.17 | 5.83 | 4.83 | 4.00 | 5.00 | 2.67 | 4.17 | 4.50 | 4.00 | 4.17 | 5.33 | 2.33 |
| 2004 | 3.67 | 5.83 | 3.67 | 4.33 | 5.67 | 3.33 | 4.00 | 5.50 | 3.83 | 4.67 | 5.50 | 2.17 |
| 2005 | 4.33 | 5.17 | 4.50 | 5.17 | 5.67 | 3.67 | 5.17 | 6.33 | 5.17 | 5.67 | 6.83 | 2.17 |
| 2006 | 5.00 | 7.33 | 5.83 | 7.00 | 7.00 | 3.33 | 7.17 | 7.83 | 5.50 | 6.67 | 7.83 | 2.00 |
| 2007 | 5.33 | 8.17 | 6.33 | 5.67 | 6.33 | 3.17 | 6.83 | 8.67 | 6.17 | 7.17 | 7.33 | 1.83 |
| 2008 | 4.17 | 7.67 | 5.83 | 6.33 | 5.67 | 3.50 | 6.50 | 7.67 | 4.67 | 5.50 | 7.00 | 1.83 |
| 2009 | 5.67 | 8.67 | 7.33 | 7.33 | 7.33 | 2.17 | 5.17 | 6.67 | 5.67 | 6.33 | 7.50 | 1.83 |
| 2010 | 6.33 | 7.00 | 6.00 | 8.67 | 7.17 | 2.83 | 5.33 | 7.33 | 4.83 | 6.83 | 6.67 | 1.83 |
| 2011 | 5.33 | 7.50 | 4.83 | 6.50 | 6.67 | 4.17 | 5.33 | 6.83 | 5.17 | 7.00 | 6.83 | 1.83 |
| 2012 | 5.33 | 8.00 | 5.00 | 6.83 | 6.50 | 3.17 | 5.17 | 6.17 | 5.17 | 6.33 | 6.67 | 1.83 |
| 2013 | 4.83 | 6.67 | 5.00 | 7.33 | 6.50 | 3.00 | 5.17 | 6.83 | 4.67 | 6.00 | 6.50 | 1.67 |
| 2014 | 6.00 | 6.83 | 4.83 | 6.00 | 6.00 | 2.67 | 5.17 | 5.67 | 4.17 | 5.00 | 6.67 | - |

Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Table is provided for illustrative purposes. Monthly contracts from January through December are represented by letters F, G, H, J, K, M, N, Q, U, V, X, and Z, respectively.

In Exhibit 11, we calculated the average ranking over a nine-month period.

**Exhibit 11: 9-Month Average Ranking**

| Year | Contract Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | G | H | J | K | M | N | Q | U | V | X | Z |
| 2001 | - | - | - | - | - | - | - | - | - | - | 5.78 | 2.78 |
| 2002 | 5.44 | 6.67 | 7.22 | 6.44 | 7.33 | 3.22 | 6.89 | 6.56 | 6.00 | 7.11 | 8.00 | 2.44 |
| 2003 | 4.89 | 7.67 | 6.78 | 6.33 | 8.33 | 3.44 | 6.11 | 6.67 | 5.44 | 6.11 | 6.89 | 2.67 |
| 2004 | 5.67 | 8.11 | 5.78 | 6.00 | 8.56 | 4.11 | 6.78 | 7.78 | 5.11 | 6.22 | 7.44 | 2.44 |
| 2005 | 6.44 | 7.56 | 6.89 | 7.56 | 8.11 | 4.67 | 7.67 | 9.78 | 7.89 | 9.56 | 8.67 | 2.44 |
| 2006 | 7.33 | 10.22 | 8.22 | 9.67 | 9.67 | 4.22 | 9.56 | 11.11 | 7.44 | 10.11 | 10.00 | 2.22 |
| 2007 | 7.33 | 10.44 | 9.00 | 7.78 | 8.56 | 3.56 | 9.67 | 11.56 | 7.67 | 9.11 | 9.78 | 1.89 |
| 2008 | 5.56 | 10.44 | 8.78 | 7.78 | 7.44 | 4.56 | 9.22 | 11.00 | 6.11 | 7.00 | 9.44 | 1.89 |
| 2009 | 7.22 | 11.44 | 10.33 | 11.44 | 9.89 | 3.11 | 8.00 | 9.33 | 8.44 | 9.00 | 10.00 | 2.33 |
| 2010 | 7.89 | 9.78 | 9.11 | 11.89 | 10.67 | 3.33 | 6.44 | 11.22 | 6.33 | 9.56 | 8.33 | 1.89 |
| 2011 | 6.78 | 10.11 | 7.22 | 9.67 | 10.22 | 4.67 | 6.78 | 10.11 | 7.44 | 9.56 | 8.89 | 1.89 |
| 2012 | 6.78 | 10.56 | 7.22 | 9.78 | 9.56 | 3.89 | 6.89 | 9.67 | 7.22 | 8.44 | 8.67 | 1.89 |
| 2013 | 6.56 | 9.22 | 6.89 | 10.44 | 9.44 | 3.67 | 7.22 | 9.67 | 6.33 | 7.89 | 8.56 | 1.78 |
| 2014 | 7.56 | 9.11 | 6.44 | 8.67 | 7.89 | 3.22 | 7.11 | 7.44 | 5.67 | 6.89 | 8.78 | - |

Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Table is provided for illustrative purposes. Monthly contracts from January through December are represented by letters F, G, H, J, K, M, N, Q, U, V, X, and Z, respectively.

In Exhibit 12, we calculated the average ranking over a 12-month period.

**Exhibit 12: 12-Month Average Ranking**

| Year | Contract Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | G | H | J | K | M | N | Q | U | V | X | Z |
| 2001 | - | - | - | - | - | - | - | - | - | - | - | - |
| 2002 | - | 8.33 | 9.00 | 9.08 | 9.25 | 4.00 | 8.50 | 8.33 | 6.83 | 8.83 | 9.75 | 3.08 |
| 2003 | 6.33 | 9.25 | 8.58 | 9.17 | 11.58 | 4.50 | 8.33 | 8.67 | 6.92 | 8.67 | 8.75 | 3.00 |
| 2004 | 7.67 | 10.08 | 8.25 | 8.33 | 11.08 | 4.50 | 9.17 | 10.25 | 6.25 | 8.50 | 9.67 | 2.83 |
| 2005 | 7.67 | 9.92 | 9.17 | 10.17 | 11.42 | 5.67 | 10.50 | 12.08 | 9.83 | 12.25 | 10.42 | 2.58 |
| 2006 | 9.67 | 12.42 | 10.25 | 11.75 | 12.25 | 5.25 | 11.92 | 13.33 | 9.92 | 12.83 | 11.58 | 2.58 |
| 2007 | 8.92 | 12.83 | 11.08 | 10.17 | 11.42 | 4.25 | 11.50 | 13.83 | 9.42 | 11.75 | 12.00 | 1.92 |
| 2008 | 7.25 | 13.33 | 11.08 | 10.25 | 8.83 | 5.67 | 11.75 | 13.75 | 7.17 | 8.33 | 11.08 | 1.92 |
| 2009 | 8.50 | 13.08 | 12.50 | 14.00 | 11.17 | 4.33 | 9.08 | 12.42 | 10.50 | 12.00 | 12.67 | 2.33 |
| 2010 | 9.58 | 12.33 | 11.17 | 14.67 | 13.67 | 4.50 | 7.08 | 13.50 | 7.75 | 11.92 | 10.17 | 1.92 |
| 2011 | 8.42 | 11.67 | 9.50 | 11.58 | 13.25 | 5.25 | 7.75 | 12.75 | 9.75 | 11.83 | 10.25 | 2.00 |
| 2012 | 8.25 | 12.42 | 9.08 | 12.33 | 11.92 | 4.33 | 8.00 | 12.00 | 9.75 | 10.50 | 9.75 | 1.92 |
| 2013 | 8.08 | 10.92 | 8.50 | 12.50 | 12.08 | 4.08 | 8.67 | 11.75 | 7.58 | 10.08 | 9.67 | 1.83 |
| 2014 | 8.83 | 11.08 | 8.25 | 11.08 | 9.83 | 3.83 | 8.33 | 9.42 | 6.58 | 8.50 | 10.58 | - |

Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Table is provided for illustrative purposes. Monthly contracts from January through December are represented by letters F, G, H, J, K, M, N, Q, U, V, X, and Z, respectively.

In Exhibit 13, we showed the average ranking over a 24-month period. An average ranking of 2.92 for CLZ2013 meant that commodity investors had been using this contract 24 months out and had endowed it with the highest liquidity levels, compared with 6.50 for the June contract from the same year (CLM2013), which had the second highest liquidity levels. These two contracts had greater liquidity than the remaining contracts in 2013.

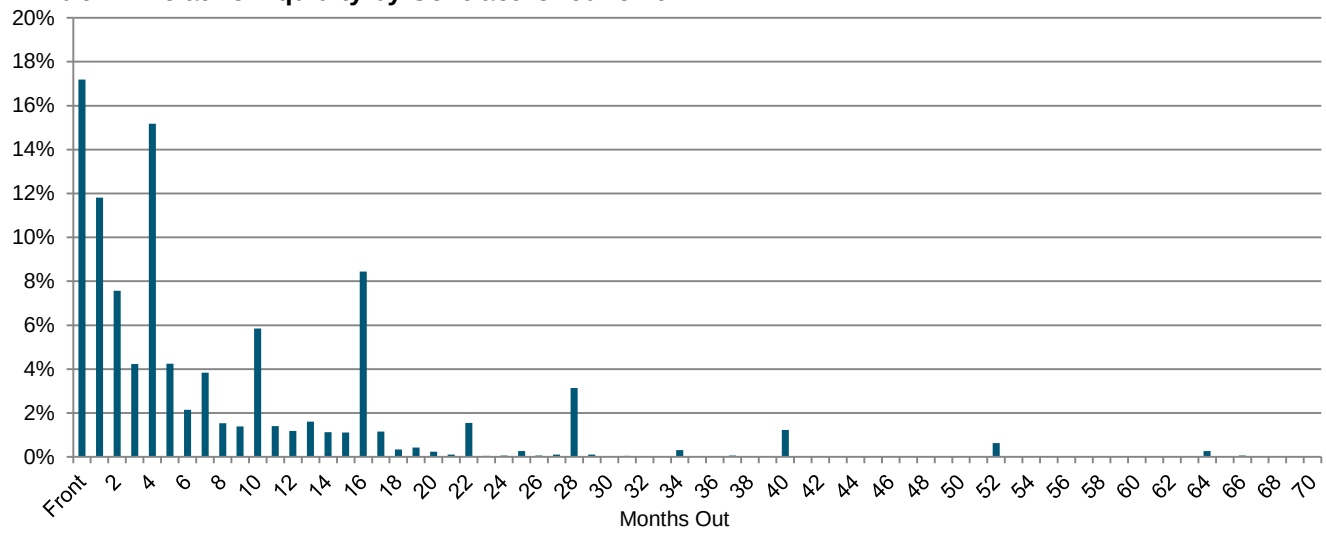
**Exhibit 13: 24-Month Average Ranking**

| Year | Contract Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | G | H | J | K | M | N | Q | U | V | X | Z |
| 2001 | - | - | - | - | - | - | - | - | - | - | - | - |
| 2002 | - | - | - | - | - | - | - | - | - | - | - | - |
| 2003 | - | 16.25 | 15.25 | 17.54 | 18.38 | 9.04 | 16.54 | 14.54 | 13.25 | 17.08 | 16.67 | 4.38 |
| 2004 | 14.54 | 17.67 | 16.08 | 17.42 | 18.42 | 8.08 | 17.50 | 18.42 | 12.46 | 17.00 | 16.83 | 5.17 |
| 2005 | 14.46 | 17.58 | 17.13 | 18.50 | 19.75 | 9.46 | 16.83 | 19.00 | 16.96 | 19.33 | 18.17 | 4.13 |
| 2006 | 15.83 | 19.29 | 17.58 | 18.58 | 18.92 | 9.04 | 18.79 | 20.08 | 16.08 | 19.88 | 18.71 | 3.54 |
| 2007 | 15.17 | 19.67 | 17.92 | 17.42 | 19.79 | 7.75 | 19.21 | 20.38 | 15.75 | 18.25 | 18.58 | 2.71 |
| 2008 | 15.33 | 19.50 | 17.17 | 18.33 | 18.83 | 8.25 | 19.54 | 21.54 | 11.92 | 15.46 | 18.46 | 2.83 |
| 2009 | 13.21 | 16.54 | 19.08 | 19.42 | 17.63 | 9.38 | 17.46 | 20.71 | 16.75 | 19.67 | 20.96 | 3.13 |
| 2010 | 16.67 | 20.13 | 17.38 | 22.88 | 21.38 | 7.17 | 17.00 | 23.46 | 15.25 | 20.00 | 18.25 | 2.92 |
| 2011 | 16.25 | 19.13 | 18.29 | 16.50 | 21.00 | 8.92 | 17.42 | 19.83 | 16.63 | 20.54 | 17.21 | 3.33 |
| 2012 | 14.00 | 19.08 | 16.50 | 20.42 | 19.00 | 7.38 | 15.63 | 19.33 | 16.67 | 18.58 | 16.21 | 2.58 |
| 2013 | 13.21 | 18.38 | 16.21 | 20.08 | 20.33 | 6.50 | 17.33 | 20.08 | 12.50 | 17.92 | 14.83 | 2.92 |
| 2014 | 13.42 | 18.67 | 15.50 | 18.71 | 17.25 | 6.50 | 16.71 | 17.88 | 10.88 | 16.38 | 16.13 | - |

Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Table is provided for illustrative purposes. Monthly contracts from January through December are represented by letters F, G, H, J, K, M, N, Q, U, V, X, and Z, respectively.

We now show the relative liquidity profile observed in two separate months, June 2014 and September 2014, in order to highlight the trend of diminishing liquidity in the front-month contracts and the prevalence of the December contracts. In Exhibit 14, the liquidity profile of crude oil looked like "business as usual" through June 2014. The front-month contract in this case was from August 2014, and it was the most liquid. We then saw the spikes represented by the subsequent December and June contracts. Generally, the liquidity is concentrated in the front end of the curve, and for June 2014, it was no exception.

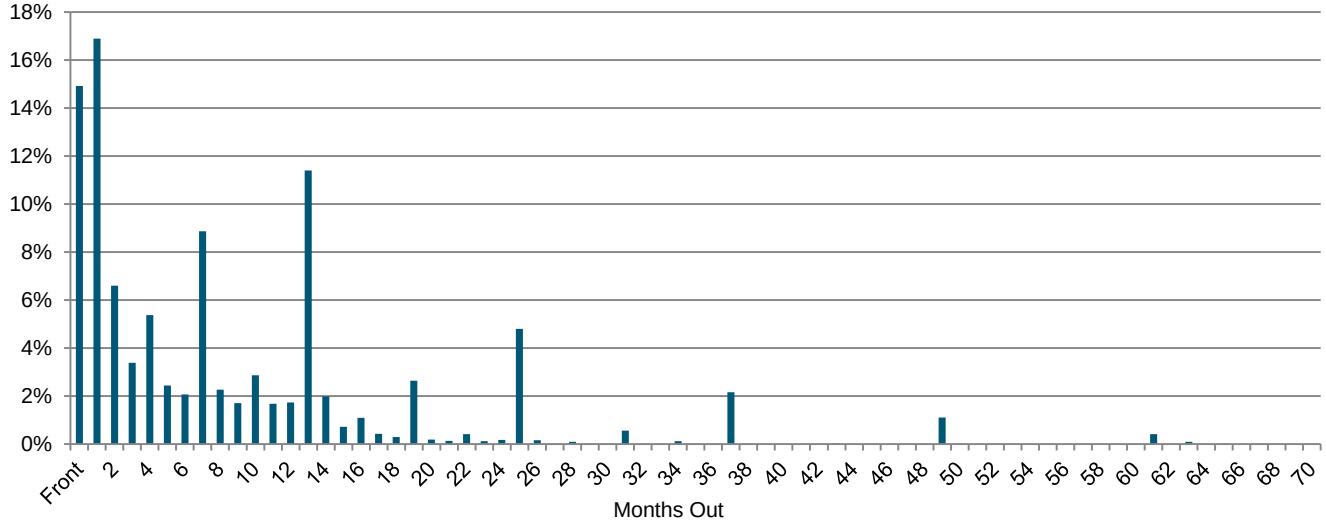
**Exhibit 14: Relative Liquidity by Contract for June 2014**




Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

In Exhibit 15, we see something that is quite unusual; the highest level of liquidity was not in the front-month contract but in the following contract. In this case, in September 2014, the front-month contract was the November 2014 contract. The first contract after that was the December 2014 contract. The December 2014 contract was 2% higher than the front-month contract as a result of the general diminishing of the front-month contract liquidity and the preference for the December contract.

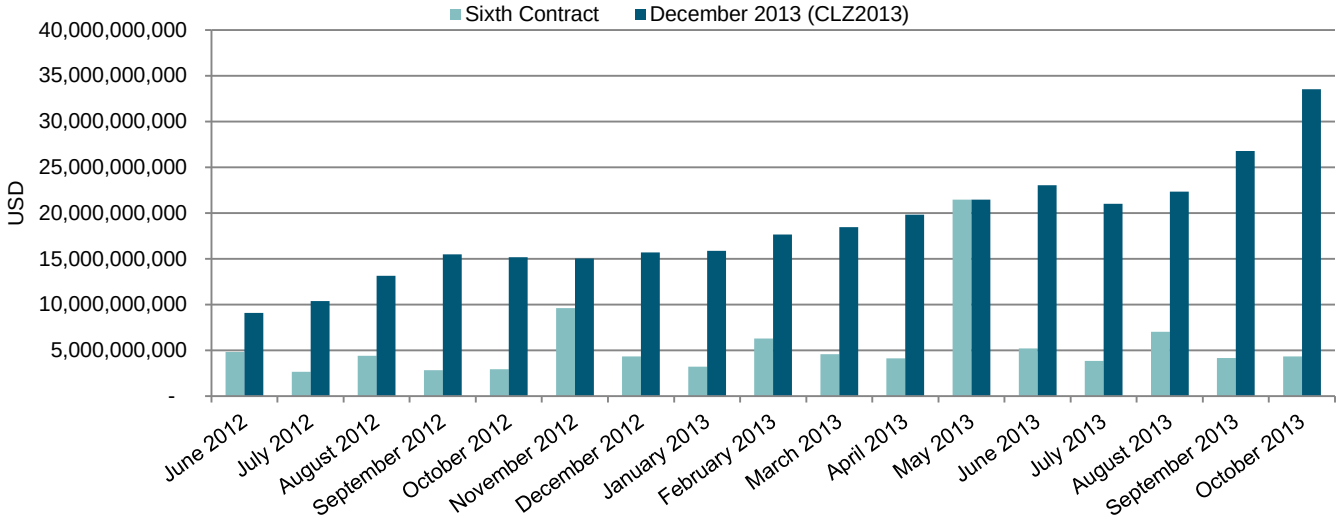
**Exhibit 15: Relative Liquidity by Contract for September 2014**




Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Finally, we compared the U.S. dollar values of the sixth-month forward contract of a given month with the December contract. In order to have a meaningful comparison, this would have to be done on an individual contract basis. For this purpose, we compared the December 2013 contract of WTI crude from June 2012 to October 2013. The sixth contract outstanding for WTI crude changes each month. For instance, the sixth-month forward contract, as of June 2012, was the January 2013 contract. Thus, we track the dollar values of the sixth-month forward contract from June 2012 until the rolling out of the WTI December 2013 contract in October 2013, for a total of 17 months. During this period, as shown in Exhibit 16, we see that the U.S. dollar values of the December 2013 contract were always greater than or equal to the U.S. dollar values of the sixth nearby contract, with the levels being the same when the December 2013 contract happened to be the sixth nearby contract in May 2013.

**Exhibit 16: U.S. Dollar Value of WTI Crude for Sixth Contract Versus December 2013 Contract (CLZ2013)**




Source: CRB. Data from 2001 to 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

## PERFORMANCE COMPARISON

We then compared the roll yields of five S&P GSCI commodity roll strategies for crude oil using back-tested index data.

1. S&P GSCI Crude Oil
2. S&P GSCI Crude Oil 3 Month Forward
3. S&P GSCI Crude Oil Dynamic Roll
4. S&P GSCI Crude Oil Enhanced
5. S&P GSCI Crude Oil Enhanced Roll (back-tested)

For number 4, we did not change any of the historical values of the new S&P GSCI Crude Oil Enhanced Roll prior to the change; for number 5, we simulated the effect of applying the new algorithm from the beginning of January 1995.

The comparison was done over the historical period of January 1995 to December 2015. We segmented this 21-year period in terms of the contango/backwardation (C/B) metric. We calculated the gradient between the following specified contracts.

a) From contract 1 to contract 2 (denoted as cb 1-2)

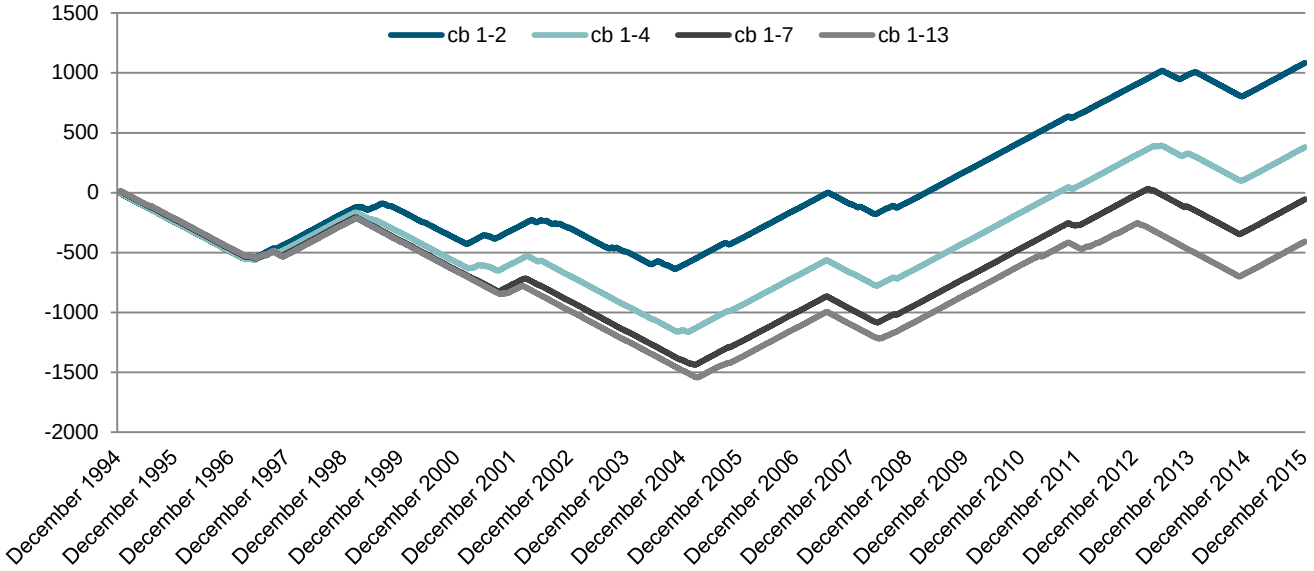
b) From contract 1 to contract 4 (denoted as cb 1-4)

c) From contract 1 to contract 7 (denoted as cb 1-7)

d) From contract 1 to contract 13 (denoted as cb 1-13)

In Exhibit 17, we can discern a persistent phenomenon of contango and backwardation. When the gradient is negative, the market is in backwardation; likewise, when the gradient is positive, the market is in contango. We assigned an index number of 1 to contango, and an index number of -1 to backwardation. When the index values of the market representing contango and backwardation are cumulatively added, we get a pathway, as seen in Exhibit 17, with one for each of the four different metrics.

**Exhibit 17: Cumulative C/BMetrics**




Source: Thomson Reuters DataScope Select. Data from 1994 to 2015. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Based on the C/B metrics, we can divide the past 21 years into eight segments.

a) From Jan. 17, 1995, to Feb. 25, 1997

b) From Feb. 25, 1997, to Feb. 24, 1999

c) From Feb. 24, 1999, to Feb. 11, 2005

d) From Feb. 11, 2005, to April 30, 2007

e) From April 30, 2007, to April 10, 2008

f) From April 10, 2008, to Dec. 12, 2012

g) From Dec. 12, 2012, to Sept. 22, 2014

h) From Sept. 22, 2014, to Dec. 31, 2015

The eight segments have a different number of days in each segment, ranging from a low of 239 days to a high of 1,488 days. The total over this historical period is 5,257 trading days. We presented the cumulative roll yields, the ranking, and the annualized roll yield in the exhibits below.

**Exhibit 18: Cumulative Roll Yields**

| Period | | Number of Days | C/B | S&P GSCI Crude Oil (%) | S&P GSCI Crude Oil 3-Month Forward (%) | S&P GSCI Crude Oil Dynamic Roll (%) | S&P GSCI Crude Oil Enhanced Roll (%) | S&P GSCI Crude Oil Enhanced Roll (Back-Tested) (%) |
|---|---|---|---|---|---|---|---|---|
| From | To | | | | | | | |
| Jan. 17, 1995 | Feb. 25, 1997 | 528 | B | 176 | 133 | 176 | 183 | 183 |
| Feb. 25, 1997 | Feb. 24, 1999 | 501 | C | 67 | 81 | 84 | 83 | 94 |
| Feb. 24, 1999 | Feb. 11, 2005 | 1,488 | B | 168 | 252 | 220 | 200 | 185 |
| Feb. 11, 2005 | April 30, 2007 | 553 | C | 61 | 85 | 114 | 89 | 105 |
| April 30, 2007 | April 10, 2008 | 239 | B | 101 | 103 | 102 | 104 | 106 |
| April 10, 2008 | Dec. 12, 2012 | 1,180 | C | 42 | 68 | 100 | 66 | 72 |
| Dec. 12, 2012 | Sept. 22, 2014 | 446 | B | 104 | 112 | 99 | 106 | 106 |
| Sept. 22, 2014 | Dec. 31, 2015 | 322 | C | 79 | 85 | 71 | 84 | 84 |
| Entire Period | | 5,257 | - | 42 | 153 | 267 | 167 | 227 |

Source: Thomson Reuters DataScope Select. Data as of Dec. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and 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.

**Exhibit 19: Ranking (1=lowest, 5=highest)**

| Period | | Number of Days | C/B | S&P GSCI Crude Oil | S&P GSCI Crude Oil 3-Month Forward | S&P GSCI Crude Oil Dynamic Roll | S&P GSCI Crude Oil Enhanced Roll | S&P GSCI Crude Oil Enhanced Roll (Back-Tested) |
|---|---|---|---|---|---|---|---|---|
| From | To | | | | | | | |
| Jan. 17, 1995 | Feb. 25, 1997 | 528 | B | 3 | 1 | 2 | 4 | 5 |
| Feb. 25, 1997 | Feb. 24, 1999 | 501 | C | 1 | 2 | 4 | 3 | 5 |
| Feb. 24, 1999 | Feb. 11, 2005 | 1,488 | B | 1 | 5 | 4 | 3 | 2 |
| Feb. 11, 2005 | April 30, 2007 | 553 | C | 1 | 2 | 5 | 3 | 4 |
| April 30, 2007 | April 10, 2008 | 239 | B | 1 | 3 | 2 | 4 | 5 |
| April 10, 2008 | Dec. 12, 2012 | 1,180 | C | 1 | 3 | 5 | 2 | 4 |
| Dec. 12, 2012 | Sept. 22, 2014 | 446 | B | 2 | 5 | 1 | 4 | 3 |
| Sept. 22, 2014 | Dec. 31, 2015 | 322 | C | 2 | 5 | 1 | 4 | 3 |
| Entire Period | | 5,257 | - | 1 | 2 | 5 | 3 | 4 |

Source: Thomson Reuters DataScope Select. Data as of Dec. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and 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.

**Exhibit 20: Annualized Roll Yield**

| Period | | Number of Days | C/B | S&P GSCI Crude Oil (%) | S&P GSCI Crude Oil 3-Month Forward (%) | S&P GSCI Crude Oil Dynamic Roll (%) | S&P GSCI Crude Oil Enhanced Roll (%) | S&P GSCI Crude Oil Enhanced Roll (Back-Tested) (%) |
|---|---|---|---|---|---|---|---|---|
| From | To | | | | | | | |
| Jan. 17, 1995 | Feb. 25, 1997 | 528 | B | 31 | 15 | 31 | 33 | 33 |
| Feb. 25, 1997 | Feb. 24, 1999 | 501 | C | -18 | -10 | -8 | -9 | -3 |
| Feb. 24, 1999 | Feb. 11, 2005 | 1,488 | B | 9 | 17 | 14 | 12 | 11 |
| Feb. 11, 2005 | April 30, 2007 | 553 | C | -20 | -7 | 6 | -5 | 2 |
| April 30, 2007 | April 10, 2008 | 239 | B | 1 | 3 | 2 | 5 | 6 |
| April 10, 2008 | Dec. 12, 2012 | 1,180 | C | -17 | -8 | 0 | -8 | -7 |
| Dec. 12, 2012 | Sept. 22, 2014 | 446 | B | 2 | 7 | -1 | 4 | 3 |
| Sept. 22, 2014 | Dec. 31, 2015 | 322 | C | -17 | -12 | -23 | -13 | -13 |
| Entire Period | | 5,257 | - | -4.1 | 2.0 | 4.8 | 2.5 | 4.0 |

Source: Thomson Reuters DataScope Select. Data as of Dec. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and 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.

We go on to look at the turnover statistic for each of the five roll strategies. Turnover is defined as the quotient of different futures contracts deployed to the number of calendar months involved. There are a total of 251 months during the period of January 1995 to December 2015. A second statistic that we are going to present is the average gap between the contract month and the calendar month. For example, for the S&P GSCI, the gap between the contract month and the calendar month for crude oil is equal to 2; this means that when the calendar month is January, the nearby futures contract is the March contract.

**Exhibit 21: How Many Different Contracts are in Each Segment Period?**

| Period | | Number of Months in Period | C/B | S&P GSCI Crude Oil | S&P GSCI Crude Oil 3-Month Forward | S&P GSCI Crude Oil Dynamic Roll | S&P GSCI Crude Oil Enhanced Roll | S&P GSCI Crude Oil Enhanced Roll (Back-Tested) |
|---|---|---|---|---|---|---|---|---|
| From | To | | | | | | | |
| February 1995 | February 1997 | 25 | B | 25 | 25 | 21 | 25 | 25 |
| March 1997 | February 1999 | 24 | C | 24 | 24 | 8 | 24 | 11 |
| March 1999 | February 2005 | 72 | B | 72 | 72 | 39 | 72 | 64 |
| March 2005 | April 2007 | 26 | C | 26 | 26 | 3 | 26 | 5 |
| May 2007 | April 2008 | 12 | B | 12 | 12 | 4 | 12 | 10 |
| May 2008 | December 2012 | 56 | C | 56 | 56 | 8 | 56 | 30 |
| January 2013 | September 2014 | 21 | B | 21 | 21 | 6 | 21 | 20 |
| October 2014 | December 2015 | 15 | C | 15 | 15 | 4 | 10 | 5 |
| Grand Total | | 251 | - | 251 | 251 | 93 | 246 | 170 |
| Turnover Rate (%) | | - | - | 100.0 | 100.0 | 37.1 | 98.0 | 67.7 |

Source: Thomson Reuters DataScope Select. Data as of Dec. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and 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 turnover statistic for the S&P GSCI and the S&P GSCI Crude Oil 3 Month Forward was 100%. This means that a new contract was deployed for each passing calendar month. The S&P GSCI Crude Oil Dynamic Roll strategy had the lowest turnover of 37.1%. The new S&P GSCI Crude Oil Enhanced (back-tested) had the second-lowest turnover of 67.7%.

In Exhibit 22, we converted the contract months into numerical values and calculated the gap between the contract month and the calendar month, and summed up all the individual gaps. As mentioned earlier, the minimum value of the gap is equal to 2 in the case of the S&P GSCI. For the S&P GSCI 3 Month Forward, the gap is equal to 5 (2+3). For the S&P GSCI Dynamic Roll, on average, the gap is almost 17 months, while the gap for the new S&P GSCI Crude Oil Enhanced (back-tested) strategy is about 6.

**Exhibit 22: How Much Is the Gap Between the Contract Month and the Calendar Month?**

| Period | | Number of Months in Period | C/B | S&P GSCI Crude Oil | S&P GSCI Crude Oil 3-Month Forward | S&P GSCI Crude Oil Dynamic Roll | S&P GSCI Crude oil Enhanced Roll | S&P GSCI Crude Oil Enhanced Roll (Back-Tested) |
|---|---|---|---|---|---|---|---|---|
| From | To | | | | | | | |
| February 1995 | February 1997 | 25 | B | 50 | 125 | 62 | 54 | 50 |
| March 1997 | February 1999 | 24 | C | 48 | 120 | 490 | 116 | 224 |
| March 1999 | February 2005 | 72 | B | 144 | 360 | 506 | 196 | 232 |
| March 2005 | April 2007 | 26 | C | 52 | 130 | 659 | 152 | 281 |
| May 2007 | April 2008 | 12 | B | 24 | 60 | 160 | 56 | 33 |
| May 2008 | December 2012 | 56 | C | 112 | 280 | 1571 | 252 | 418 |
| January 2013 | September 2014 | 21 | B | 42 | 105 | 193 | 46 | 51 |
| October 2014 | December 2015 | 15 | C | 30 | 75 | 504 | 129 | 144 |
| Grand Total | | 251 | - | 502 | 1,255 | 4,145 | 1,001 | 1,433 |
| Average | | - | - | 2 | 5.0 | 16.5 | 4.0 | 5.7 |

Source: Thomson Reuters DataScope Select B. Data as of Dec. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and 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.

## PROS AND CONS

In terms of the comparison between the old and the new S&P GSCI Crude Oil Enhanced Roll strategy using back-tested data, Exhibits 23-26 tell an interesting story. The new roll strategy theoretically would have added approximately 1.5% in annual yield and reduced the turnover from 98% to 68%. The average gap between the contract month and the calendar month increased from 4.0 to 5.7, meaning that on average, the contracts deployed theoretically would be extended by two more months out on the curve.

**Exhibit 23: Cumulative Roll Yields**

| Period | | Number of Days | C/B | S&P GSCI Crude Oil Enhanced Roll (%) | S&P GSCI Crude Oil Enhanced Roll (Back-Tested) (%) |
|---|---|---|---|---|---|
| From | To | | | | |
| Jan. 17, 1995 | Feb. 25, 1997 | 528 | B | 183 | 183 |
| Feb. 25, 1997 | Feb. 24, 1999 | 501 | C | 83 | 94 |
| Feb. 24, 1999 | Feb. 11, 2005 | 1,488 | B | 200 | 185 |
| Feb. 11, 2005 | April 30, 2007 | 553 | C | 89 | 105 |
| April 30, 2007 | April 10, 2008 | 239 | B | 104 | 106 |
| April 10, 2008 | Dec. 12, 2012 | 1,180 | C | 66 | 72 |
| Dec. 12, 2012 | Sept. 22, 2014 | 446 | B | 106 | 106 |
| Sept. 22, 2014 | Dec. 31, 2015 | 322 | C | 84 | 84 |
| Entire Period | | 5,257 | - | 167 | 227 |

Source: Thomson Reuters DataScope Select. Data as of Dec. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and 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.

**Exhibit 24: Annualized Roll Yields**

| Period | | Number of Days | C/B | S&P GSCI Crude Oil Enhanced Roll (%) | S&P GSCI Crude Oil Enhanced (Back-Tested) (%) |
|---|---|---|---|---|---|
| From | To | | | | |
| Jan. 17, 1995 | Feb. 25, 1997 | 528 | B | 33 | 33 |
| Feb. 25, 1997 | Feb. 24, 1999 | 501 | C | -9 | -3 |
| Feb. 24, 1999 | Feb. 11, 2005 | 1,488 | B | 12 | 11 |
| Feb. 11, 2005 | April 30, 2007 | 553 | C | -5 | 2 |
| April 30, 2007 | April 10, 2008 | 239 | B | 5 | 6 |
| April 10, 2008 | Dec. 12, 2012 | 1,180 | C | -8 | -7 |
| Dec. 12, 2012 | Sept. 22, 2014 | 446 | B | 4 | 3 |
| Sept. 22, 2014 | Dec. 31, 2015 | 322 | C | -13 | -13 |
| Entire Period | | 5,257 | - | 2.5 | 4.0 |

Source: Thomson Reuters DataScope Select. Data as of Dec. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and 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 performances.

**Exhibit 25: How Many Different Contracts are in Each Segment Period?**

| Period | | Number of Months in Each Period | C/B | S&P GSCI Crude Oil Enhanced Roll | S&P GSCI Crude Oil Enhanced Roll (Back-Tested) |
|---|---|---|---|---|---|
| From | To | | | | |
| February 1995 | February 1997 | 25 | B | 25 | 25 |
| March 1997 | February 1999 | 24 | C | 24 | 11 |
| March 1999 | February 2005 | 72 | B | 72 | 64 |
| March 2005 | April 2007 | 26 | C | 26 | 5 |
| May 2007 | April 2008 | 12 | B | 12 | 10 |
| May 2008 | December 2012 | 56 | C | 56 | 30 |
| January 2013 | September 2014 | 21 | B | 21 | 20 |
| October 2014 | December 2015 | 15 | C | 10 | 5 |
| Grand Total | | 251 | - | 246 | 170 |
| Turnover Rate | | - | - | 98.0% | 67.7% |

Source: Thomson Reuters DataScope Select. Data as of Dec. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and 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.

**Exhibit 26: How Much is the Gap Between the Contract Month and the Calendar Month?**

| Period | | Number of Months in Each Period | C/B | S&P GSCI Crude Oil Enhanced Roll | S&P GSCI Crude Oil Enhanced Roll (Back-Tested) |
|---|---|---|---|---|---|
| From | To | | | | |
| February 1995 | February 1997 | 25 | B | 54 | 50 |
| March 1997 | February 1999 | 24 | C | 116 | 224 |
| March 1999 | February 2005 | 72 | B | 196 | 232 |
| March 2005 | April 2007 | 26 | C | 152 | 281 |
| May 2007 | April 2008 | 12 | B | 56 | 33 |
| May 2008 | December 2012 | 56 | C | 252 | 418 |
| January 2013 | September 2014 | 21 | B | 46 | 51 |
| October 2014 | December 2015 | 15 | C | 129 | 144 |
| Grand Total | | 251 | - | 1,001 | 1,433 |
| Average | | - | - | 4.0 | 5.7 |

Source: Thomson Reuters DataScope Select. Data as of Dec. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and 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.

## SUMMARY

The popularity of the December and June contracts for crude oil cannot be simply explained by the term structure. When investors take a long position in those months, they create pockets of liquidity that may override the temporary exigencies of contango or backwardation. Given the sustained liquidity demonstrated by back-tested data with respect to approximately the past decade of such contracts, there may be extra room for capitalizing on such liquidity from a rolling strategy perspective.

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The S&P GSCI Crude Oil Dynamic Roll was launched on January 26, 2011. The S&P Crude Oil Enhanced was launched on September 22, 2009. The S&P GSCI Crude Oil was launched on May 1, 1991. The S&P GSCI Crude Oil 3 Month Forward was launched on December 6, 2007. All information presented prior to an index's Launch Date is hypothetical (back-tested), not actual performance. The back-test calculations are based on the same methodology that was in effect on the index Launch Date. Complete index methodology details are available at www.spdji.com.

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