Construction Rules for Morningstar Commodity Indexes

Morningstar Methodology Paper

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Index Characteristics

Morningstar Commodity Index Family Structure
The Morningstar Commodity Index family consists of five indexes that employ different combinations of long futures, short futures, and cash (referred to as flat) and four sector indexes employing long futures (see Appendix C). The index family is based on a transparent, rules-based methodology that is designed to serve investors seeking an appropriate benchmark for commodities and support investment product creation.

For each commodity, we calculate a "linked" price series that incorporates both price changes and roll yield. At each monthly rebalancing, if the linked price exceeds its 12-month moving average, we take the long side in the subsequent month. Conversely, if the linked price is below its 12-month moving average, we take the short side. An exception is made for commodities in the energy sector. If the signal for a commodity in the energy sector is short, the weight of that commodity is moved into cash; that is, we take a flat position. Energy is unique in that its price is extremely sensitive to geopolitical events and not necessarily driven purely by demand-supply imbalances.

Morningstar® Long/Short Commodity(SM) Index
The Long/Short Commodity Index is a fully collateralized commodity futures index that uses the momentum rule to determine each commodity is held long, short, or flat.

Morningstar® Long/Flat Commodity(SM) Index
The Long/Flat Commodity Index is a fully collateralized commodity futures index that is derived from the positions of the Long/Short index. It takes the same long and flat positions as the Long/Short index and replaces the short positions with flat positions.

Morningstar® Short/Flat Commodity(SM) Index
The Short/Flat Commodity Index is a fully collateralized commodity futures index that is derived from the positions of the Long/Short index. It takes the same short positions as the Long/Short index and replaces long positions with flat positions.

Morningstar® Long-Only Commodity(SM) Index
The Long-Only Commodity Index is a fully collateralized commodity futures index that is long all in eligible commodities. This index provides investors with a means of understanding the performance of the commodity futures markets and serves as a benchmark for investment performance of commodities as an asset class.

Morningstar® Short-Only Commodity(SM) Index
The Short-Only Commodity Index is a fully collateralized commodity futures index that is short in all eligible commodities.

Morningstar® Agriculture Commodity(SM) Index
The Agriculture Commodity Index is a fully collateralized commodity futures index that is long all eligible commodities in the agriculture sector.

Morningstar® Energy Commodity(SM) Index
The Energy Commodity Index is a fully collateralized commodity futures index that is long all eligible commodities in the energy sector.

Morningstar® Livestock Commodity(SM) Index
The Livestock Commodity Index is a fully collateralized commodity futures index that is long all eligible commodities in the livestock sector.

Morningstar® Metals Commodity(SM) Index
The Metals Commodity Index is a fully collateralized commodity futures index that is long all eligible commodities in the metals sector.

Inception Dates
The inception dates of the Morningstar Commodity Indexes are December 21st, 1979. Daily total return series are available from this date forward.

Calculation and Dissemination of Index Values
Index values for the Morningstar Commodity Index Family are currently calculated end-of-day and distributed through major data vendors.

Scheduled Reconstitution/Rebalance Date
The Morningstar Commodity Indexes are reconstituted and rebalanced—i.e., the index membership and the constituent weights are reset —once annually, on the third Friday of December after the day's closing index values have been determined. The reconstitution is effective at the open of trading on first trading day after third Friday of December. Note the effective date of individual commodities is specific to the exchange on which the commodity trades.

Position Determination Dates

The direction of the position—i.e. Long or Short-- in the individual commodity indexes are adjusted monthly. Adjustments are made on the third Friday of the month and are effective on the first trading day after the third Friday. Again, the effective data is specific to the exchange on which the commodity trades.

Commodity Selection

Overview
At each reconstitution date index eligibility is defined based on the criteria described in this section. Commodities not meeting the specific rules set forth in this section are not eligible for inclusion in the Morningstar Commodity Index Family.

Eligibility Requirements
To qualify for inclusion in the index family, a commodity future must list on a U.S. exchange and be denominated in U.S. dollars.
The following are excluded:

1) Financial futures (e.g. securities, currencies, interest rates, etc.) are not eligible for inclusion.
2) Commodity contracts not denominated in U.S. dollars are excluded.
3) Commodities with less than 12 months of pricing are excluded.

Commodity Selection
We sort all commodities that meet the above eligibility requirements in descending order by the total U.S. dollar value of open interest. All commodities that make up the top 95% of the total open interest pool of all eligible commodities, starting with the one with the largest open interest value, will be included in the Morningstar Commodity Index Family.

Index Construction - Individual Commodity Futures

Rolling Futures Contracts

To avoid taking physical delivery of a commodity, futures contracts due to expire are replaced with a contract with a longer term. This is called "rolling" the contract. Contracts are rolled on the third Friday of each month to coincide with portfolio reconstitution, rebalancing and the rolling of the Treasury bills used for collateral.[1] To ensure that contracts are rolled before becoming committed to receive physical delivery, contracts are selected so that the delivery month is at least two months away from the upcoming month. On each potential roll date, the delivery month of the current contract is compared to the delivery month of the nearest contract whose delivery month is at least two months away from the upcoming month. If the latter is further into the future than the former, the contract is rolled.

For example, the third Friday of December 2005 was December 16, 2005. On this day, the nearest corn contract was March 2006. Since this was two months away from the upcoming month, January 2006, the contract was held until the third Friday of January, January 20, 2006. Since in the upcoming month, February 2006, the contract would no longer be two months away, on January 20, the position was rolled to the nearest contract that was at least two months away from February. This was May 2006. In March, this contract was still at least two months away so the contract was held. In April, it was no longer two months away; so on the third Friday of March, the position was rolled to the nearest contract that was at least two months away from the upcoming month. This was July 2006.

1 If the third Friday of the month is a trading holiday, we roll and rebalance or reconstitute on the trading day prior to the third Friday. For ease of exposition, we refer to this date as the "third Friday" throughout this document.

Linking Factor Calculation

A "linking" factor is defined for each commodity that converts the price of the contract in effect at each point in time to a value that accounts for contract rolls which we call a "linked price." Each time a contract is rolled, the 'linking' factor is adjusted by the ratio of the closing price of the current contract to the closing price of the new contract.

Formally, Let:

$P_i(t,D)$ = the closing price of the contract on commodity i with delivery month D on day t
$t\uparrow$ = the trading day before day t
$t\downarrow$ = the next trading day after day t
$D_i[t]$ = the delivery month for commodity i on day t
$L_i(t)$ = the linking factor of the index on commodity i on day t

To calculate the linking factor on day t of commodity i use the following formula:

Hence,

$$L_i(t) = \frac{P_i(t, D_i[t])}{P_i(t, D_i[t\downarrow])} L_i(t\uparrow)$$

Hence, the linking factor changes value on the third Friday of each month when there is a roll and remains constant on days between roll implementations.

To illustrate the calculation of the linking factor, we consider the rolling of the corn contract that would have been implemented on the third Friday of January 2006. On that day, we have

t = January 20, 2006
$t\uparrow$ = January 19, 2006
$t\downarrow$ = January 23, 2006

Through January 20, the contract was March 2006 and starting January 23, the contract was May 2006. Hence,

$D_1[t]$ = March 2006
$D_1[t\downarrow]$ = May 2006

The prices of these contracts on January 20 were

$P_1(t, D_1[t])$ = 205 cents/bushel
$P_1(t, D_1[t\downarrow])$ = 215 cents/bushel

The linking factor just prior to implementing the roll was

$L_1(t\uparrow) = 0.1015$

Hence,

$$L_1(t) = \frac{205}{215}0.1015 = 0.096779$$

Linked Prices

The linked price index for each commodity is calculated by multiplying the closing price of the contract in effect by the linking factor from the previous day. In this way, the linking factor calculated from the closing prices at the end of a month is applied starting with the first trading day of the new month. Formally, let

$PL_i(t)$ = the closing value of the linked price for commodity i on day t

We calculate $PL_i(t)$ as follows:

$$PL_i(t) = P_i(t, D_i[t])L_i(t\uparrow)$$

Cash Index Calculation and Collateralization Adjustment

To collateralize the futures positions, on the third Friday of each month, we buy a T-bill that matures no earlier than the third Friday of the upcoming month.[2] We buy enough T-bills so that their value on the third Friday of the upcoming month would be equal to the face value of the contracts if the yield to maturity were to remain the same. We form the cash index by rolling the T-bills from month-to-month just as we roll the contracts and rebalance the composite portfolios.

To formalize the calculation of cash index, let

$B(t,M)$ = the price of T-bills per dollar of face value that matures on day M on day t
$M[t]$ = the maturity date of T-bill that we use on day t (tE for $\Uparrow tE < t \leq tE$)
$IB(t)$ = the value of the cash index on day t

[2] Our calculation agent for the cash index, Credit Suisse, selects the T-bill. It matures 6, 7, or 8 weeks from the date of purchase.

The daily return on the cash index is

$$BR\left(t\uparrow,t\right)=\frac{B\left(t,M\left[t\right]\right)}{B\left(t\uparrow,M\left[t\right]\right)}-1$$

So that cash index value is updated each day as follows:

$$IB\left(t\right)=IB\left(t\uparrow\right)\left[1+BR\left(t\uparrow,t\right)\right]$$

Because of the way that we collateralize futures contracts, we need to make an adjustment to the daily rate of change in the futures prices when calculating excess returns. Let

t_E, = the upcoming third Friday of the month
$\Uparrow t_E$ = the previous third Friday of the month
t = a given date, $\Uparrow t_E < t \le t_E$,
A(t) = the adjustment factor for t

We calculate

$$A\left(t\right)=\frac{B\left(\Uparrow t_E,M\left[t\right]\right)^{\frac{t_E-M[t]}{\Uparrow t_E-M[t]}}}{B\left(t,M\left[t\right]\right)}$$

Note $A(t_E)=1$ if the T-bill's yield to maturity on t_E is the same as on $\Uparrow t_E$ so that

$$B\left(\Uparrow t_E,M\left[t_E\right]\right)^{-\frac{1}{M[t_E]-\Uparrow t_E}}=B\left(t_E,M\left[t_E\right]\right)^{-\frac{1}{M[t_E]-t_E}}$$

We start the cash index on 12/21/1979 at 1. For the period 12/21/1979 – 12/18/1998, we use the Federal Reserve's history of yield on a discount basis (YDB) of 3-month T-bills traded on the secondary market, annualized on a 360-day year, to form a proxy for T-bill prices.[3] We assume that YDB is constant across maturities at the short end of the yield so that our proxy for price is

$$B\left[t,M\right]=1-\frac{YDB\left(t\right)}{100}\frac{M-t}{360}$$

On the third Friday of each month, we purchase a bill with 7 weeks to maturity. Using the formulas given above, we calculate values for the index and the adjustment factor using this proxy data for the period 12/21/1979 – 12/18/1998.

Our calculation agent for the cash index starts their calculation of the index by purchasing a T-bill on 12/18/1998 with a term of 42 days. They have provided prices on this bill from 12/18/1998 through 12/31/1998. We use this data to extend our index and values of the adjustment factor through 12/31/1998.

Starting on 12/31/1998, the calculation agent provides us daily values for the cash index scaled to be 100 on 12/31/1998. We use this data to extend our cash index by rescaling their index values to match our value on 12/31/1998. Let

$IB_{CS}(t)$ = the value of index as calculated by the calculation agent on day t
IB_0 = the value of the index that we calculate for 12/31/1998

For $t > 12/31/1998$, we calculate

$$IB(t) = \frac{IB_0}{100} IB_{CS}(t)$$

Starting on 12/31/1998, the calculation agent provides the following data:

$$Price(t) = 100 \cdot B(t, M[t_E]), \text{ for } \Uparrow t_E \le t < t_E$$

$$Term(t) = (M[t_E] - t_E)/365, \text{ for } \Uparrow t_E \le t < t_E$$

From these data and the values of the index, for $\Uparrow t_E < t \le t_E$, we calculate

$$B(t, M[t]) = \frac{IB(t)}{IB(t\uparrow)} \frac{Price(t\uparrow)}{100}$$

$$B(\Uparrow t_E, M[t]) = \frac{Price(\Uparrow t_E)}{100}$$

$$M[t] = \Uparrow t_E + \lceil 365 \cdot term(\Uparrow t_E) \rceil$$

where $\lceil x \rceil$ denotes rounding up to the nearest integer. (For example, $\lceil 41.999 \rceil = 42$.)

We use these data to calculate values from the adjustment factor starting from 12/31/1998.

Index Construction – Composite Indexes

Overview

The composite indexes are constructed from the individual commodity linked prices and the cash index described above.

Calculation of Weights

The weight on each commodity futures index in each of the composite indexes is the product of two factors: (1) the magnitude of the weight and (2), the direction (+1 for long, 0 for flat, or –1 for short). On the annual reconstitution date, the magnitude is the open-interest weight of the commodity, calculated on the second Friday of December, using data through the last trading day of November.

Let

t_R = the reconstitution date (the third Friday of December)
s_{12} = the last trading day of November prior to t_R
s_{11} = the last trading day of October prior to t_R
•
•
•
s_1 = the last trading of December prior to t_R

Let

$TOI_i(t)$ = the total U.S. dollar value of open interest of all contracts on commodity i on day t
$ATOI_i(t_R)$ = average of TOI_i over the year prior to t_R
$n(t_R)$ = the number of commodities in the Morningstar Commodity Indexes as of t_R

We calculate $TOI_i(t)$ as follows:

$$TOI_i(t) = \frac{PN_i(t)NOI_i(t)CS_i}{Div_i}$$

where

$PN_i(t)$ = nearest contract price for commodity i on day t in its basic unit; e.g. cents/bushel
$NOI_i(t)$ = total number of open interest contracts, summed across all maturities, for commodity i on day t
CS_i = contract size for commodity i; e.g. 5000 bushels
Div_i = price divisor of commodity i so that all prices are in dollars (1 if PN is in dollars; 100 if PN is in cents)

For each commodity i= 1,2, …, $n(t_R)$, , we calculate

$$ATOI_i(t_R) = \frac{\sum_{k=1}^{12} TOI_i(s_k)}{12}$$

We have five composite index types:

Abbreviation	Type
LO	Long-Only
LF	Long/Flat
LS	Long/Short
SF	Short/Flat
SO	Short-Only

The preliminary weights on the reconstitution date for all index types, IT, are given by:

$$w_{Pi}(t_R;IT) = \frac{ATOI_i(t_R)}{\sum_{j=1}^{n(t_R)} ATOI_j(t_R)}$$

To ensure adequate diversification, individual contract weights are capped at 10%. See Appendix A for weight capping algorithm. Weights are not capped for the Commodity Sector indexes. Let

$w_i(t_R;IT)$ = the final weight on commodity i, calculated on reconstitution date t_R from the preliminary weights using the weight capping algorithm.

Between reconstitution dates, the weights vary based on the performance of the individual commodity positions. Let

$ER_i(t_1,t_2;IT)$ = the excess return on commodity i from day t_1 to day t_2 for index type IT

We explain how to calculate $ER_i(t_1,t_2;IT)$ below.

Each day $t>t_R$, until the next reconstitution date, we update the weights as follows:

$$w_i\left(t;IT\right)=\frac{w_i\left(t\uparrow;IT\right)\left[1+ER_i\left(t\uparrow,t;IT\right)\right]}{\sum_{j=1}^{n(t_R)}w_j\left(t\uparrow;IT\right)\left[1+ER_j\left(t\uparrow,t;IT\right)\right]}$$

The direction of the weight depends in part on the type of the composite index. Let

$\beta_i(t_E,IT)$ = the direction for commodity i for index type IT, for rebalancing day t_E

We calculate the directions on the second Friday of each month, that is, one week prior to the rebalancing day. Let

t_β = the Friday prior to t_E

We derive the direction for each index type from what we call the base direction. The base direction is set by a simple moving average rule: the base direction of the constituent weighting will be long (short) if $PL_i(t_\beta)$ is greater (less) than the moving average of the daily values of PL_i for year-long ending on t_β. To state this formally, let

$Y(t_\beta)$ = the set of trading days for the year-long period ending in t_β
$APL_i(t_\beta)$ = the average of PL_i over $Y(t_\beta)$
$B_i(t_\beta)$ = the base direction for commodity i set on t_β

So that

$$APL_i\left(t_\beta\right)=\frac{\sum_{t\in Y\left(t_\beta\right)}PL_i\left(t\right)}{\left|Y\left(t_\beta\right)\right|}$$

We set the base direction as follows:

$$B_i\left(t_\beta\right)=\begin{cases}1, & \text{if } PL_i\left(t_\beta\right)\geq APL_i\left(t_\beta\right)\\ -1, & \text{if } PL_i\left(t_\beta\right)<APL_i\left(t_\beta\right)\end{cases}$$

How we use the base direction to set the direction for a commodity in the Long/Short Index depends on whether or not the commodity in question is in the energy sector. Let

Γ = the set of energy commodities

We set the directions for the Long/Short Index as follows:

$$\beta_i\left(t_E,LS\right)=\begin{cases}\max\left[B_i\left(t_\beta\right),0\right], & \text{if } i\in\Gamma\\ B_i\left(t_\beta\right), & \text{if } i\notin\Gamma\end{cases}$$

The directions for the remaining index types are set as follows:

$$\beta_i\left(t_E,LO\right)=+1$$
$$\beta_i\left(t_E,LF\right)=\max\left[B_i\left(t_\beta\right),0\right]$$
$$\beta_i\left(t_E,SF\right)=\min\left[B_i\left(t_\beta\right),0\right]$$
$$\beta_i\left(t_E,SO\right)=-1$$

Excess Returns for Individual Commodities

Given t, $\Uparrow t_E < t \leq t_E$, we calculate an adjusted excess return for each commodity i over the period $\Uparrow t_E$ to t which we denote $ERA_i(t)$. Recall term $A(t)$ is the collateralization adjustment factor, while term PL_i is the individual commodity linked price. We calculate $ERA_i(t)$ as follows:

$$ERA_i(t) = A(t)\left[\frac{PL_i(t)}{PL_i(\Uparrow t_E)} - 1\right]$$

From $ERA_i(t)$ we calculate a return relative to each index type IT which we denote $V_i(t;IT)$ and calculate as follows:

$$V_i(t) = 1 + \beta_i(\Uparrow t_E; IT)ERA_i(t)$$

Given t_1 and t_2, $\Uparrow t_E \leq t_1 < t_2 \leq t_E$, we calculate $ER_i(t_1,t_2;IT)$ as defined earlier as follows:

$$ER_i(t_1,t_2;IT) = \begin{cases} V_i(t_2;IT) - 1, & \text{if } t_1 = \Uparrow t_E \\ \dfrac{V_i(t_2;IT)}{V_i(t_1;IT)} - 1, & \text{if } t_1 > \Uparrow t_E \end{cases}$$

Composite Index Values – Excess and Total Returns
Each day t, we calculate the daily returns on the indexes. Let

$ER(t\uparrow,t;IT)$ = the excess return for index type IT for $t\uparrow$ through t
$TR(\uparrow\uparrow t_E,t,IT)$ = the total return for index type IT for t $t\uparrow$ through t

We have:

$$ER\left(t\uparrow,t;IT\right)=\sum_{i=1}^{n(t_R)}w_i\left(t\uparrow;IT\right)ER_i\left(t\uparrow,t;IT\right)$$

With our collateralization methodology, the value a total return index for a commodity is the product of the value of its excess return index and the cash index. Hence,

$$TR\left(t\uparrow,t;IT\right)=\left[1+ER\left(t\uparrow,t;IT\right)\right]\left[1+BR\left(t\uparrow,t\right)\right]-1$$

Let

$IE(t;IT)$ = the value of the excess return index of type IT at the close of day t
$IT(t;IT)$ = the value of the total return index of type IT at the close of day t

So that

$$IE\left(t;IT\right)=IE\left(t\uparrow;IT\right)\left[1+ER\left(t\uparrow,t;IT\right)\right]$$

and

$$IT\left(t;IT\right)=IT\left(t\uparrow;IT\right)\left[1+TR\left(t\uparrow,t;IT\right)\right]$$

Data Correction and Precision

Intraday Index Data Corrections
Commercially reasonable efforts are made to ensure the correctness of data used in index calculations. If incorrect price data affects index daily high or lows, it is corrected retroactively as soon as feasible.

Index-Related Data and Divisor Corrections
Incorrect pricing data for individual issues in the database will be corrected upon detection. In addition, an incorrect divisor of an index, if discovered within five days of its occurrence, will always be fixed retroactively on the day it is discovered to prevent an error from being carried forward. Commercially reasonable efforts are made to correct an older error subject to its significance and feasibility.

Computational and Reporting Precision
All calculated and adjusted data are stored in real numbers. For reporting purposes, index values are rounded to two decimal places and divisors are rounded to appropriate decimal places.

Undocumented Events
Any matter arising from undocumented events will be resolved at the discretion of the Morningstar Index Committee.

Appendix A: Weight Capping

Let:

N = number of contracts in the portfolio

cap = maximum weight that we allow for any contract, currently 10%

x_i = original weight of the ith largest contract in the portfolio, $x_1 > x_2 \ldots > x_N$

$$\sum_{i=1}^{n} x_i = 1$$

We re-weight using a two-part linear function as follows:

$$w_i = \begin{cases} w_K + \gamma_1 (x_i - x_K), & \text{if } i \le K \\ \gamma_2 x_K, & \text{if } i \ge K \end{cases}$$

where K is the index of the contract at which the function is kinked. Note that this re-weighting preserves the relative weights of all contracts beginning from the K^{th} contract.

Given K, we need to set γ_1 and γ_2. From the above equation, it follows that

$$\gamma_1 = \frac{w_1 - w_K}{x_1 - x_K}$$

and

We set w_1 = cap.

We need to set w_K so that $\sum_{i=1}^{N} w_i = 1$. Some algebra shows that this occurs when

$$w_K = \frac{1 - \delta w_1}{(K-1) - \delta + \frac{1-z}{x_K}}$$

where

$$z = \sum_{i=1}^{K-1} x_i$$

and

$$\delta == \frac{z - (K-1)x_K}{x_1 - x_K}$$

We chose K to maximize the number of contracts for which relative weights are preserved. This occurs at the lowest value of K for which $y_K \leq y_1$. Hence, our re-weighting algorithm is as follows:

1. If $x_1 \leq$ cap, no reweighting is necessary. For $i = 1,\ldots, N$, set $w_i = x_i$. Stop.
2. Set $z=0$, $w_1 =$ cap, and $K=2$.
3. Set $z = z + x_{K-1}$.
4. Set δ and w_K using the equations presented earlier.
5. If $w_K > w_1$, go back to step 3.
6. Set γ_1 and γ_2 using the equations presented earlier.
7. For $i = 1,\ldots, N$, set w_i using our first equation. Stop.

Appendix B: Calculating the Arithmetic Total Return Index without the Collateralization Adjustment

In our methodology, we collateralize our futures positions on the third Friday of each month based on what we expect our cash collateral to be worth on the third Friday of the upcoming month. A more standard approach is to ignore the fact that the cash collateralize pays interest and collateralize based on the current value of the portfolio.

Another difference between our methodology and the more standard approach is in the way we define excess return. In our approach, excess return is the geometric difference between total return and the return on cash. In the more standard approach, it is the arithmetic difference.

If we were to take the more standard approaches to collateralization and excess return, the collateralization adjustment that we make in the calculation of excess return, A(t), drops out the formula for excess return. Given t, $\hat{1}\hat{1}t_E < t \leq t_E$, we calculate the unadjusted excess return for each commodity i over the period $\hat{1}\hat{1}t_E$ to t which we denote $ERU_i(t)$. Recall the term PL_i is the individual commodity linked price. We calculate $ERU_i(t)$ as follows:

$$ERU_i(t) = \frac{PL_i(t)}{PL_i(\hat{1}\hat{1}\, t_E)} - 1$$

The remainder of the excess return calculation is unchanged

From $ERU_i(t)$ we calculate a return relative to each index type IT which we denote $VU_i(t;IT)$ and calculate as follows:

$$VU_i(t) = 1 + \beta_i(\hat{1}\hat{1}\, t_E; IT) ERU_i(t)$$

Given t_1 and t_2, $\hat{1}\hat{1}t_E \leq t_1 < t_2 \leq t_E$, we calculate the unadjusted excess return fro commodity I from day t_1 to day t_2 for index type IT which we denote $ERM_i(t_1,t_2;IT)$ as defined earlier as follows:

$$ERM_i(t_1, t_2; IT) = \begin{cases} VU_i(t_2; IT) - 1, & \text{if } t_1 = \Uparrow t_E \\ \dfrac{VU_i(t_2; IT)}{VU_i(t_1; IT)} - 1, & \text{if } t_1 > \Uparrow t_E \end{cases}$$

In addition the calculation of excess return for each index type remains unchanged. Each day t, we calculate the daily returns on the indexes.

Let

ERM(t↑,t;IT) = the unadjusted excess return for index type IT for t↑ through t

We have:

$$ERM(t\uparrow, t; IT) = \sum_{i=1}^{n(t_R)} w_i(t\uparrow; IT) ERM_i(t\uparrow, t; IT)$$

Finally let us define the resulting excess return index as the unadjusted excess return index.

Let

IEU(t,IT) = the value of the unadjusted excess return index of type IT on day t
ITU(t,IT) = the value of the corresponding total return index

So that

$$IEU(t; IT) = IEU(t\uparrow; IT)\left[1 + ERM(t\uparrow, t; IT)\right]$$

Because excess return is defined as an arithmetic difference rather that a geometric difference, deriving the value of ITU from IEU is more involved that it is in our previous methodology.

Recall from our methodology document the following definitions:

t_E, = the upcoming third Friday of the month
$\Uparrow t_E$ = the previous third Friday of the month
t = a given date, $\Uparrow t_E < t \leq t_E$,
IB(t) = the value of the cash index on day t

We have

$$ITU(t,IT) = ITU(\Uparrow t_E, IT)\left(\frac{IB(t)}{IB(\Uparrow t_E)} + \frac{IEU(t,IT)}{IEU(\Uparrow t_E, IT)} - 1\right)$$

Appendix C: Commodity Sector Assignments

The following reflects sector assignments for eligible commodities:

Sector	Commodity	Description
Agriculture	Butter	Butter Cash Settled
Agriculture	Butter	Butter, AA
Agriculture	Cocoa	Cocoa / Ivory Coast
Agriculture	Coffee	Coffee 'C' / Mini
Agriculture	Coffee	Coffee 'C' /Colombian
Agriculture	Corn	Corn / No. 2 Yellow
Agriculture	Corn	Corn Mini-sized
Agriculture	Cotton	Cotton / 1-1/16"
Agriculture	Diamonium Phosphate	Diammonium Phosphate
Agriculture	Lumber	Lumber / Spruce-Pine Fir 2x4
Agriculture	Milk	Milk
Agriculture	Milk	Milk, Class IV
Agriculture	Milk	Milk, Nonfat Dry
Agriculture	Oats	Oats / No. 2 Milling
Agriculture	Oats	Oats / No. 2 White Heavy
Agriculture	Orange Juice	Orange Juice, Differential
Agriculture	Orange Juice	Orange Juice, Frozen Concentrate
Agriculture	Pulp	Pulp
Agriculture	Rice	Rough Rice #2
Agriculture	Soybean Meal	Soybean Meal / 48% Protein
Agriculture	Soybean Oil	Soybean Oil / Crude
Agriculture	Soybeans	Soybean, South American
Agriculture	Soybeans	Soybeans / No. 1 Yellow
Agriculture	Soybeans	Soybeans Mini-Sized
Agriculture	Sugar	Sugar #11/World Raw
Agriculture	Sugar	Sugar #14/Domestic Raw
Agriculture	Urea	Urea

Sector	Commodity	Description
Agriculture	Urea Ammonium Nitrate	Ammonium Nitrate
Agriculture	Wheat	Wheat / No. 2 Hard Winter
Agriculture	Wheat	Wheat / No. 2 Soft Red
Agriculture	Wheat	Wheat / Spring 14% Protein
Agriculture	Wheat	Wheat Mini-Sized
Agriculture	Wheat	Wheat, Hard Red Winter
Energy	Coal	Coal, Central Appalachian
Energy	Coal	Coal, Richards Bay
Energy	Coal	Coal, Rotterdam
Energy	Crude Oil	Crude Oil (E)
Energy	Crude Oil	Crude Oil E-mini
Energy	Crude Oil	Crude Oil, Brent
Energy	Crude Oil	Crude Oil, Brent / Global Spot
Energy	Crude Oil	Crude Oil, Brent emiNY
Energy	Crude Oil	Crude Oil, Sour / Midland, TX
Energy	Crude Oil	Crude Oil, WTI / Global Spot
Energy	Crude Oil	Crude Oil, WTI Light Sweet
Energy	Ethanol	Ethanol
Energy	Ethanol	Ethanol
Energy	Gas Oil	Gas Oil
Energy	Gas Oil	Gas-Oil-Petroleum
Energy	Gasoline	Gasoline Unleaded, E-MinNY
Energy	Gasoline	Gasoline, Blendstock
Energy	Gasoline	Gasoline, Blendstock RBOB (E)
Energy	Gasoline	Gasoline, Unleaded / Regular Non-Ox
Energy	Gasoline	Gasoline, Unleaded Blendstock (RBOB
Energy	Heating Oil	Heating Oil
Energy	Heating Oil	Heating Oil #2 / Fuel Oil
Energy	Heating Oil	Heating Oil (ED)
Energy	Heating Oil	Heating Oil / E-MinNY
Energy	Natural Gas	Natrual Gas E-mini
Energy	Natural Gas	Natural Gas (E) Last Day
Energy	Natural Gas	Natural Gas (E) Penultimate
Energy	Natural Gas	Natural Gas, Henry Hub
Energy	Propane	Propane
Livestock	Broilers	Broilers / Dressed 'A', 1-3/4 to 3-
Livestock	Feeder Cattle	Cattle, Feeder / Average

Sector	Commodity	Description
Livestock	Hogs	Hogs, Lean / Average Iowa/S Minn
Livestock	Hogs	Hogs, Live, Old
Livestock	Live Cattle	Cattle, Live / Choice Average
Livestock	Pork Bellies	Pork Bellies, Frozen, 12-14 lbs.
Metals	Alumninum	Aluminum / Pig Ingots
Metals	Copper	Copper / Electrolytic Cathodes
Metals	Copper	Copper High Grade / Scrap No. 2 Wir
Metals	Gold	Gold
Metals	Gold	Gold, 100 oz
Metals	Gold	Gold, N.Y. Mini-sized
Metals	Palladium	Palladium
Metals	Platinum	Platinum
Metals	SIlver	Silver
Metals	Silver	Silver, 5000 oz
Metals	Silver	Silver, N.Y. Mini-sized