A COMPARATIVE STUDY OF THE VOLATILITY AND EFFICIENCY OF COMMODITY FUTURES INDEX ROLL METHODS

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Abstract

Given the size of the commodity index market, rollovers require large numbers of contracts to be purchased and sold on rollover dates. Index providers are careful in choosing their roll methods in order to minimize volatility and maximize the market efficiency of their indexes. This study investigates the efficiency of various roll methodologies compared to their respective continuous futures series. We compare roll methodologies to see whether they have similar volatility and efficiency characteristics as naïve rolling. Daily settlement prices for 15 commodities (precious metals, metals, agriculture, and energy) from each of five index providers (Credit Suisse (CS), Merrill Lynch (ML), Dow Jones – UBS (DJUBS), Diapson (DCI) and Standard and Poor's – Goldman Sachs (GS)) were collected and analyzed. Daily prices for a continuous series of futures contracts (Continuous Futures Series) representing each of the aforementioned commodities is used as a benchmark. Results show that any differences that indexes have with their continuous futures series are dependent on the type of commodity and not on a particular roll methodology. Thus, an investor/ETP investing in commodities should not worry about the roll methodology used by an index provider.

Keywords: futures, contracts, rollover, diversification

JEL Classification: G11, G13, G19

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1. Introduction

Investors who hold portfolios with long positions in stocks and bonds seek alternative investments that will provide diversification opportunities. Commodity returns exhibit negative or weak correlations with stock and bond market returns and hence, diversification potential. A long buy and hold strategy could be very expensive for retail investors attempting to purchase physical commodities. An alternative to investing in physical commodities is commodity futures. However, futures contract trading presents challenges to retail investors. Contracts expire periodically. A futures-based buy and hold strategy involves selling the current contract when it expires and buying the next available contract. Also, many retail investors lack the knowledge or the financial capability to invest directly via the commodity futures market.

Financialization of commodities via exchange traded products (ETPs) and index investing have enabled retail investors to access previously inaccessible commodities markets. The number of ETPs has increased over time. Currently, over 100 ETPs that track or invest in commodities (ETFdb.com, n.d.) are traded. Thus, retail investors have opportunities for exposure to commodity returns. Most of these indexes are created using futures contracts. Returns on commodity indexes are based upon futures prices of their underlying commodities. Indexes are priced continuously, while futures contracts have finite maturities. Thus, indexes must continuously rollover futures contracts. A naïve rollover strategy is to continuously hold a current month's futures contract until it expires and then purchase the next active contract (hence, the continuous futures series or CFS). This strategy can be difficult or expensive to implement. Expiring month contracts can be thinly traded and experience high price volatility.

Additionally, the US Commodity Futures Trading Commission (2015) estimates the volume of commodity index trading to be $138 billion. Given the size of the commodity index market, rollovers require that large numbers of contracts be purchased and sold on rollover dates. Index providers are careful in choosing their roll methods in order to minimize volatility and maximize the market efficiency of their indexes.

To avoid the pitfalls of rolling on expiration dates, many commodity index providers roll their contracts much earlier. Some

also avoid the expiration month entirely and roll contracts in the preceding month. Others use contracts from multiple months and roll over a longer period (multiple days) rather than a single day to reduce volatility.

Exchange Traded Products (ETPs) provide investors exposure to commodity returns. Investors who purchase ETPs assume that they are getting the same performance as a CFS. However, it is possible that a roll methodology could introduce inefficiency in the index. This study compares the performance of various roll methodologies to that of the continuous futures series.

2. Discussion and Literature Review

Commodity returns are negatively correlated with those of stocks and bonds (Gorton and Rouwenhorst, 2006). Büyükşahin, Haigh, and Robe (2010) find weaker correlations between stocks and commodities even in the long-term. Thus, adding commodities to traditional stock and bond portfolios provides portfolio diversification in the short-term (Garcia-Feijoo, Jensen, and Johnson, 2012) and in the long-term (Bansal, Kumar, and Verma 2014). Just as stock index-based products provide investors exposure to stock market returns, commodity index-based products provide exposure to commodity returns.

Index providers use different roll methodologies while creating their indexes. For fifteen individual commodities, we analyze the extent to which indexes introduce additional inefficiencies when compared to the respective continuous futures series (CFS). As indicators of market inefficiencies, we examine the difference in means and volatilities between indexes and their respective CFSs and test serial correlations and day-of-the week effects. Most energy and agricultural indexes have lower standard deviations than their CFS counterparts. For metals and energy indexes, serial correlations are consistent with the respective CFS, but results are inconsistent in agricultural commodities. Thus, no additional inefficiencies are introduced by the index providers for metals and energy. However, agricultural commodities across index providers exhibit inefficiencies. This suggests that differences between commodity indexes and their respective continuous futures series are dependent upon the type of commodity rather than the roll methodology.

3. Data

Data for this study ranges from 15 January 2002 through 28 August 2011. Daily settlement prices for 15 commodities: (gold, silver, aluminum, copper, lead, nickel, corn, cotton, soybeans, sugar, wheat, live cattle, lean hogs, natural gas, oil) from each of five index providers (Credit Suisse (CS), Merrill Lynch (ML), Dow Jones – UBS (DJUBS), Diapson (DCI) and Standard and Poor's – Goldman Sachs (GS)) are collected and analyzed. Daily prices for a continuous series of futures contracts (Continuous Futures Series) representing each of the aforementioned commodities is used as a benchmark.

Rollover methodologies differ among the index providers with respect to the roll dates used, the number of days used to roll the contracts and the choice of the futures contracts. Table 1 summarizes the roll methodologies that are included in the study.

Table 1

Roll methodologies

Commodity Index Provider	Contracts	Rollover Period
Credit Suisse (CS)	Equal weights in the first, second, and third nearby contract	5th to last business day of the previous month and runs to the 9th business day
Diapson (DCI)	From first to second nearby contract	Last 3 business days of the previous month
Dow Jones UBS (DJUBS)	From the first to the second nearby contract	Begins on the fifth and ends on the ninth business day of each month
Merrill Lynch (ML)	From the second to the third nearby contract	1st – 15th business days of each month
S&P Goldman Sachs (GS)	From the first to the second nearby contract, but rolling every other month	Begins on the fifth and ends on the ninth business day of each month
Continuous Futures Series (CFS)	From the first to the second nearby contract	On expiration of the first nearby contract

Credit Suisse indexes invest equally in contracts that fall within the first three months. They roll contracts over a 15-day period, which starts on the 5th to last business of the previous month and runs to the 9th business day of the current month at a roll rate of 1/15 each business day. Merrill Lynch rolls contracts from the 2nd month to the 3rd month, at the rate of 1/15 each business day, over a 15-day period from the 1st to the 15th business day of the month. Diapson

rolls contracts from the current month to the next month. The rollover period is the last 3 business days of the previous month. Dow Jones UBS rolls contracts from the current month to the next month between the 5th through the 9th business days of the current month. S&P Goldman Sachs rolls contracts forward from the current to the next month from the 5th through the 9th business day of the month and rolls every other month.

4. Methodology

An efficient rollover methodology will not create serial correlations between successive daily price changes or exhibit a day-of-the-week effect (Ma, Mercer, and Walker, 1992). Day-of the-week effect is identified from their model:

$$r_{it} = a + B_{TU}D_{TU} + B_W D_W + B_{TH}D_{TH} + B_F D_F + e_i \quad (1)$$

where r_{it} is the *i*th time series of the daily return for the daily price change series. D_i represents the daily dummy and its coefficient measures the difference between the Monday return (measured as "*a*") and returns from the other days of the week.

4. Results

Results indicate that most metals indexes are similar to their continuous futures series. They follow similar distribution characteristics. Additionally, for metals, indexes maintain the directional significance serial correlation found (or lack thereof) in the continuous futures series. Most metal indexes also maintain the day-of-the-week effect (or lack thereof) as found in the respective CFS.

Energy indexes maintain the serial correlation found in their respective CFSs. Except for one oil index, they don't demonstrate a day-of-the-week effect if such is not found in the CFS. While there are no distinguishing differences in means of both commodities with their respective CFS, they have significantly lower standard deviations (SD) than their corresponding CFSs.

Agricultural commodity indexes have similar means and, except for live cattle and corn, similar day-of-the-week effects as their respective CFS. However, most have lower standard deviations than their respective CFSs and demonstrate inconsistent serial correlation compared to the respective CFS.

5.1 The Payoff Distribution

Comparative results of the payoff distribution for each of the six series are presented in Table 2. The series means and standard deviations are calculated for all 15 commodities across the five providers and the continuous futures series. For all series and all providers, the difference in means between each index and its respective continuous futures series is not statistically significant. In the remainder of this section, the focus will be on the standard deviations.

Table 2

Index average returns and standard deviations

Gold	**AVG**	**SD**	**Nickel**	**AVG**	**SD**	**Wheat**	**AVG**	**SD**
CSCBGCE	0.0001	0.0156*	CSCBNIE	0.0006	0.0258	CSCBKWE	0.0002	0.0185*
DCIGCER	0.0007	0.0121	DCINIER	0.0005	0.0257	DCIWHER	-0.0002	0.0214*
DJUBSCE	0.0002	0.0119	DJUBSNI	0.0005	0.0260	DJUBSWH	-0.0003	0.0210*
MLCXGCE	0.0007	0.0119	MLCXLNE	0.0006	0.0259	MLCXW.E	-0.0001	0.0206*
GSGCEXR	0.0007	0.0119	GSIKEXR	0.0005	0.0261	GSWHEXR	-0.0003	0.0210*
CFS	0.0008	0.0119	CFS	0.0005	0.0262	CFS	0.0004	0.0219
Silver	**AVG**	**SD**	**Corn**	**AVG**	**SD**	**Live Cattle**	**AVG**	**SD**
CSCBSIE	0.0008	0.0212	CSCBCNE	-0.0005	0.0433*	CSCBLCE	0.0001	0.0086*
DCISIER	0.0008	0.0217	DCICNER	0.0000	0.0203*	DCILCER	0.0000	0.0097*
DJUBSSI	0.0008	0.0212	DJUBCNE	-0.0001	0.0186*	DJUBSLC	-0.0001	0.0096*
MLCXSIE	0.0008	0.0212	MLCXC.E	0.0000	0.0183*	MLCXLCE	0.0001	0.0090*
GSSIEXR	0.0008	0.0212	GSCNEXR	-0.0001	0.0186*	GSLCEXR	-0.0001	0.0095*
CFS	0.0009	0.0213	CFS	0.0005	0.0195	CFS	0.0002	0.0108
Aluminum	**AVG**	**SD**	**Cotton**	**AVG**	**SD**	**Lean Hog**	**AVG**	**SD**
CSCBALE	0.0001	0.0145	CSCBCTE	0.0002	0.0175*	CSCBLHE	-0.0002	0.0137*
DCIAHER	0.0001	0.0151	DCICTER	-0.0001	0.0187*	DCILHER	Insufficient data	
DJUBALE	0.0001	0.0146	DJUBCTE	-0.0001	0.0186*	DJUBSLH	-0.0006	0.0154*
MLCXLAE	0.0001	0.0146	MLCXALE	X	X	MLCXLHE	-0.0002	0.0144*
GSIAEXR	0.0000	0.0147	GSCTEXR	-0.0001	0.0186*	GSLHEXR	-0.0006	0.0154*
CFS	0.0002	0.0148	CFS	0.0004	0.0213	CFS	0.0002	0.0210
Copper	**AVG**	**SD**	**Soybean**	**AVG**	**SD**	**Natural Gas**	**AVG**	**SD**
CSCBHGE	0.0008	0.0197	CSCBSYE	0.0005	0.0162*	CSCBNGE	-0.0008	0.0273*
DCICAER	0.0007	0.0192*	DCBSOER	0.0006	0.0160*	DCINGER	-0.0010	0.0306*
DJUBSHG	0.0007	0.0199	DJUBSSY	0.0005	0.0165*	DJUBNGT	-0.0010	0.0295*
MLCXLPE	0.0008	0.0192*	MLCXS.E	0.0006	0.0163*	MLCXNGE	-0.0009	0.0282*
GSICEXR	0.0008	0.0193	GSSOEXR	0.0005	0.0165*	GSNGEXR	-0.0013	0.0311*
CFS	0.0007	0.0199	CFS	0.0005	0.0172	CFS	0.0002	0.0351

Lead	AVG	SD	Sugar	AVG	SD	Oil	AVG	SD
CSCBHGE	0.0008	0.0236	CSCBSBE	0.0005	0.0207*	CSCBOLE	0.0005	0.0209*
DCICAER	0.0006	0.0235	DCISBER	0.0004	0.0219*	DCICOER	0.0005	0.0217*
DJUBSHG	0.0007	0.0239	DJUBSSB	0.0003	0.0219*	DJUBCLE	0.0002	0.0222*
MLCXLPE	X	X	MLCXSBE	0.0005	0.0212*	MLCXCLE	0.0004	0.0218*
GSICEXR	0.0007	0.0240	GSSBEXR	0.0003	0.0220*	GSCLEXR	0.0002	0.0228*
CFS	0.0007	0.0241	CFS	0.0005	0.0371	CFS	0.0006	0.0246

*Notes: *Significant at p = 5%; X indicates insufficient data.*
The first letters of the indexes listed in this exhibit indicate their correspondence to the indexes discussed in the paper as follows: CS – Credit Suisse, DCI – Diapson, DJUBS – Dow Jones UBS, ML – Merrill Lynch, GS – S&P Goldman Sachs, and CFS – Continuous Futures Series.

Precious metals. For gold and silver, only the CS gold index has a significantly higher standard deviation than the continuous futures series. For all other gold and silver indexes, there is no statistical difference in the SD with the CFS.

Metals. The DCI and ML copper indexes have significantly lower standard deviations than the continuous futures series. For all other metals, the differences between the indexes and the continuous futures series are not significant.

Energy. The oil and natural gas standard deviations for all index providers are significantly lower than their respective continuous futures series.

Agriculture. All agriculture commodities have significantly lower standard deviations than their respective continuous futures series.

Summary of payoff distributions. Most metal indexes (except for DCI and ML for copper and CS gold) do not have significantly different standard deviations than from those of their respective continuous futures series. Natural gas, oil, and all agriculture commodities have significantly different standard deviations than their respective continuous futures series. Of the total of 75 series (5 providers, 15 commodities), only three indexes (CS gold and corn and DCI corn) have significantly higher standard deviations than the continuous futures series. Overall, 46 indexes representing 10 of the 15 commodities had significantly lower standard deviations when compared to the continuous futures series. In the following sections, index efficiency is compared to the continuous futures series.

5.2 Index Efficiency: Serial Correlations

The results of the serial correlations tests are presented in Table 3. Here we break them down by commodity category.

Precious metals. For precious metals (gold and silver), none of the indexes exhibit statistically significant serial correlations. The continuous futures series also does not exhibit a significant serial correlation.

Metals. Among the metals indexes, aluminum exhibits a statistically significant negative serial correlation for all providers, as does the aluminum continuous futures series. Lead has a positive serial correlation for all providers, as does the lead continuous futures series. The copper and nickel indexes across all providers do not have significant serial correlations. Their respective continuous futures series also do not.

Energy. Both oil and natural gas indexes across all providers have significant, negative serial correlations. Their respective continuous futures series also have significant negative serial correlations.

Agriculture. For corn, the continuous futures series and indexes that are provided by DJUBS, ML and GS have significant positive serial correlation while DCI's index has a negative serial correlation. For live cattle, significant, positive correlation is observed in the case of the DJUBS and GS and the CFS.

For cotton, the DJUBS and GS indexes exhibit a significant positive serial correlation. The positive serial correlation found in the continuous futures series for cotton is not significant.

For wheat and sugar, only DCI indexes have significant negative serial correlations. The respective continuous futures series for these commodities do not have significant serial correlations.

Table 3

One-period lag serial correlations for indexes and futures continuous series

	Index					
Commodity	**CSCBGCE**	**DCIGCER**	**DJUBSCE**	**MLCXGCE**	**GSGCEXR**	**CFS**
Gold	-0.032	-0.009	0.014	0.013	0.012	0.010
Silver	0.015	-0.006	0.017	0.016	0.015	0.014
Aluminum	-0.046*	-0.066*	-0.040*	-0.043*	-0.046*	-0.042*
Copper	-0.085	-0.083	-0.081	-0.074	-0.074	-0.085
Lead	0.045*	0.048*	0.046*	X	0.046*	0.050*
Nickel	0.001	0.006	0.001	-0.004	0.002	0.000

	Index					
Commodity	**CSCBGCE**	**DCIGCER**	**DJUBSCE**	**MLCXGCE**	**GSGCEXR**	**CFS**
Corn	-0.014	-0.045*	0.045*	0.043*	0.045*	0.037*
Cotton	0.009	0.022	0.037*	X	0.037*	0.016
Soy-beans	-0.021	-0.002	-0.021	-0.018	-0.021	0.004
Sugar	-0.025	-0.039*	-0.026	-0.028	-0.027	-0.007
Wheat	0.017	-0.035*	-0.008	-0.007	-0.009	-0.013
Live Cattle	0.011	-0.030	0.036*	0.002	0.037*	0.053*
Lean Hogs	0.007	X	-0.006	-0.003	0.002	0.006
Natural Gas	-0.039*	-0.062*	-0.048*	-0.036*	-0.051*	-0.045*
Oil	-0.052*	-0.059*	-0.046*	-0.045*	-0.045*	-0.039*

*Notes: *Significant at p = 5%; X indicates insufficient data.*
The first letters of the indexes listed in this exhibit indicate their correspondence to the indexes discussed in the paper as follows: CS – Credit Suisse, DCI – Diapson, DJUBS – Dow Jones UBS, ML – Merrill Lynch, GS – S&P Goldman Sachs, and CFS – Continuous Futures Series.

Summary Serial Correlations. The direction of effects of serial correlation from series to series is consistent and significant for aluminum, copper, oil, natural gas, and lead.

Thus, for all metals and energy if the CFS had a significant serial correlation, the indexes also maintained the significance and direction of the serial correlation. If the CFS did not have a significant serial correlation, the indexes did not have a significant serial correlation.

For the two agricultural commodities which had significant serial correlation in the CFS, the serial correlation was not maintained in all the respective indexes. Of the five agricultural commodities which had no significant serial correlation in the CFS, three demonstrated significant serial correlation in at least one of the indexes, and two maintained no significant serial correlation.

5.3 Index Efficiency: Day-of-the-Week

The results of the day-of-the-week tests are presented in Table 4. Here we break them down by commodity category.

Precious metals. The continuous futures series does not have a significant coefficient for any day of the week. This is maintained for all indexes for silver and all indexes for gold (except for the Tuesday effect for CS gold).

Metals. For aluminum, the GS index has a significant negative coefficient for Monday while the coefficient for the corresponding continuous futures series is not significant. All other metals indexes

do not have significant Monday coefficients. S&P Goldman Sachs, CS and the continuous futures series for aluminum have significant positive coefficients for Wednesday. All aluminum indexes have significant coefficients for Thursday, including the continuous futures series. The CFS and all indexes for aluminum do not have a significant Friday effect.

All indexes for lead and copper, including the CFS, do not exhibit a day-of-the-week effect. For nickel, the CFS and all indexes except ML have significant positive coefficients for Friday. None of the nickel indexes, including the CFS, demonstrates any significant effect for rest of the days.

Agriculture. The GS index for corn has a significant positive coefficient for Wednesday while the corresponding continuous futures series coefficient is not significant. All indexes for cotton, soybeans, sugar, and wheat do not have significant day-of-the-week coefficients.

The CS index for live cattle has a significant coefficient for Monday, while the corresponding continuous futures series does not. Credit Suisse, DCI and ML indexes have significant negative coefficients for Thursday. The corresponding live cattle index for the continuous futures series does not have a significant coefficient.

All lean hog indexes and their corresponding CFS have significant positive coefficients for Wednesday, Thursday, and Friday.

Energy. For natural gas, all indexes have significant negative coefficients for Thursday, including the corresponding futures series. For oil, DCI's index has a significant coefficient for Thursday while the corresponding continuous futures series does not.

Summary of day-of-the-week effect. The significance of the Monday effect is almost nonexistent across indexes and commodities. Only the GS aluminum and CS live cattle indexes have significant Monday effect. For other days of the week, the results are different across indexes and commodities. Credit Suisse gold has a significant Tuesday effect; the CS, ML and GS aluminum, ML corn and all lean hog indexes except DCI, have a significant Wednesday effect. All indexes for aluminum, the DCI oil index, all natural gas indexes, the CS, DCI, and ML live cattle indexes and all lean hog indexes except DCI have a Thursday effect. All nickel indexes except ML, and all lean hog indexes except DCI have a significant Friday effect.

Results of other days are mixed. For eight commodities, there are no effects in the CFS that are maintained in the indexes. In two of

the three series that have a significant day of the week, T, W, or TR, in the CFS the effect is maintained in all indexes. For four commodities, there are no effects in the CFS, but effects are found in at least one of the indexes for one of the days. Inefficiency is found in only 4 of 15 commodities when such inefficiency is not found in the CFS.

Table 4

Day-of-the-week regression coefficients

Commodity	Index	Day of the Week				
		M	TU	W	TH	F
Gold	CSCBGCE	-0.0010	0.0016*	0.0016	0.0012	0.0009
	DCIGCER	0.0009	-0.0010	0.0000	-0.0006	0.0004
	DJUBSCE	0.0008	-0.0009	0.0001	-0.0006	0.0005
	MLCXGCE	0.0009	-0.0010	0.0001	-0.0006	0.0004
	GSGCEXR	0.0009	-0.0010	0.0001	-0.0006	0.0004
	CFS	0.0011	-0.0011	0.0000	-0.0007	0.0004
Silver	CSCBGCE	0.0009	-0.0005	0.0007	-0.0013	0.0005
	DCIGCER	0.0005	-0.0002	0.0012	-0.0010	0.0013
	DJUBSCE	0.0007	-0.0003	0.0009	-0.0011	0.0009
	MLCXGCE	0.0008	-0.0004	0.0009	-0.0011	0.0008
	GSGCEXR	0.0008	-0.0004	0.0008	-0.0011	0.0007
	CFS	0.0009	-0.0003	0.0007	-0.0011	0.0006
Aluminum	CSCBGCE	-0.0010	0.0013	0.0016*	0.0018*	0.0009
	DCIGCER	-0.0008	0.0008	0.0014	0.0016*	0.0007
	DJUBSCE	-0.0010	0.0012	0.0014	0.0018*	0.0006
	MLCXGCE	-0.0008	0.0011	0.0014	0.0017*	0.0004
	GSGCEXR	-0.0012*	0.0014	0.0017*	0.0020*	0.0010
	CFS	-0.0010	0.0014	0.0017*	0.0019*	0.0008
Copper	CSCBGCE	0.0014	-0.0012	-0.0011	-0.0017	0.0009
	DCIGCER	0.0007	-0.0003	-0.0003	-0.0006	0.0010
	DJUBSCE	0.0011	-0.0010	-0.0009	-0.0014	0.0012
	MLCXGCE	0.0014	-0.0006	-0.0008	-0.0011	-0.0001
	GSGCEXR	0.0010	-0.0004	-0.0004	-0.0007	0.0006
	CFS	0.0009	-0.0009	-0.0006	-0.0011	0.0014
Lead	CSCBGCE	0.0009	0.0001	0.0001	-0.0010	0.0004
	DCIGCER	0.0008	0.0000	0.0000	-0.0010	0.0003
	DJUBSCE	0.0005	0.0001	0.0006	-0.0007	0.0009
	MLCXGCE	0.0008	0.0002	0.0002	-0.0008	0.0003
	GSGCEXR	0.0006	0.0001	0.0004	-0.0005	0.0007
	CSCBGCS	0.0005	0.0001	0.0005	-0.0006	0.0011
Nickel	CSCBGCE	-0.0013	0.0016	0.0029	0.0017	0.0032*
	DCIGCER	-0.0018	0.0020	0.0032	0.0021	0.0038*
	DJUBSCE	-0.0014	0.0015	0.0028	0.0019	0.0033*
	MLCXGCE	-0.0011	0.0012	0.0026	0.0017	0.0026
	GSGCEXR	-0.0015	0.0016	0.0030	0.0020	0.0033*
	CFS	-0.0015	0.0017	0.0029	0.0019	0.0034*

Table 4 continued

Commodity	Index	Day of the Week				
		M	Tu	W	TH	F
Corn	CSCBGCE	-0.0010	0.0009	0.0021	-0.0017	0.0010
	DCIGCER	0.0005	-0.0018	0.0011	-0.0005	-0.0014
	DJUBSCE	-0.0006	-0.0001	0.0021	0.0007	0.0000
	MLCXGCE	-0.0004	-0.0005	0.0018	0.0007	-0.0002
	GSGCEXR	-0.0008	0.0000	0.0022*	0.0008	0.0002
	CFS	0.0001	-0.0003	0.0020	0.0004	-0.0001
Cotton	CSCBGCE	-0.0005	0.0012	0.0009	0.0011	0.0005
	DCIGCER	-0.0007	0.0000	0.0019	-0.0002	0.0013
	DJUBSCE	-0.0005	-0.0001	0.0014	-0.0001	0.0008
	MLCXGCE	X	X	X	X	X
	GSGCEXR	-0.0005	-0.0001	0.0015	-0.0001	0.0007
	CFS	0.0007	-0.0009	0.0009	-0.0007	-0.0009
Soybeans	CSCBGCE	0.0003	-0.0002	0.0012	0.0001	0.0001
	DCIGCER	0.0006	-0.0004	0.0006	-0.0001	-0.0002
	DJUBSCE	0.0004	-0.0003	0.0011	0.0001	-0.0002
	MLCXGCE	0.0005	-0.0003	0.0010	0.0001	-0.0003
	GSGCEXR	0.0002	-0.0002	0.0013	0.0002	0.0001
	CFS	0.0000	0.0000	0.0015	0.0003	0.0005
Sugar	CSCBGCE	-0.0002	0.0020	0.0011	-0.0004	0.0009
	DCIGCER	-0.0008	0.0022	0.0020	0.0002	0.0018
	DJUBSCE	-0.0007	0.0023	0.0016	0.0001	0.0010
	MLCXGCE	-0.0002	0.0020	0.0012	0.0000	0.0007
	GSGCEXR	-0.0006	0.0022	0.0015	0.0000	0.0009
	CFS	-0.0010	0.0013	0.0021	0.003	0.0011
Wheat	CSCBGCE	0.0004	-0.0016	0.0009	0.0000	-0.0005
	DCIGCER	-0.0004	-0.0006	0.0016	-0.0007	0.0003
	DJUBSCE	0.0001	-0.0012	0.0010	-0.0010	-0.0007
	MLCXGCE	0.0002	-0.0011	0.0009	-0.0009	-0.0007
	GSGCEXR	-0.0001	-0.0009	0.0013	-0.0008	-0.0003
	CFS	0.0008	-0.0013	0.0010	-0.0012	-0.0007
Live Cattle	CSCBGCE	0.0008*	-0.0008	-0.0008	-0.001*	-0.0007
	DCIGCER	0.0006	-0.0010	-0.0009	-0.001*	-0.0004
	DJUBSCE	0.0004	-0.0003	-0.0006	-0.0008	-0.0005
	MLCXGCE	0.0007	-0.0006	-0.0007	-0.001*	-0.0006
	GSGCEXR	0.0004	-0.0004	-0.0006	-0.0009	-0.0006
	CFS	0.0001	0.0004	0.0001	-0.0002	0.0001

Table 4 continued

Commodity	Index	Day of the Week				
		M	Tu	W	TH	F
Lean Hogs	CSCBGCE	-0.0018	-0.0002	0.0023*	0.0025*	0.0033*
	DCIGBER	X	X	X	X	X
	DJUBSCE	-0.0024	0.0002	0.0029*	0.0028*	0.0029*
	MLCXGCE	-0.0017	-0.0004	0.0024*	0.0024*	0.0031*
	GSGCEXR	-0.0027	0.0005	0.0032*	0.0031*	0.0036*
	CFS	-0.0014	0.0001	0.0025*	0.0018*	0.0035*
Natural Gas	CSCBGCE	0.0005	-0.0018	0.0003	-0.0047*	-0.0003
	DCIGCER	0.0004	-0.0017	0.0005	-0.0054*	-0.0008
	DJUBSCE	0.0005	-0.0019	0.0005	-0.0054*	-0.0006
	MLCXGCE	0.0004	-0.0021	0.0003	-0.0047*	-0.0002
	GSGCEXR	-0.0002	-0.0012	0.0010	-0.0054*	0.0002
	CFS	0.0014	-0.0006	0.0001	-0.0048*	-0.0008
Oil	CSCBGCE	-0.0004	-0.0010	0.0017	0.0021	0.0015
	DCIGCER	-0.0004	-0.0011	0.0020	0.0023*	0.0015
	DJUBSCE	-0.0009	-0.0010	0.0021	0.0022	0.0024
	MLCXGCE	-0.0006	-0.0011	0.0020	0.0022	0.0023
	GSGCEXR	-0.0012	-0.0008	0.0024	0.0024	0.0026
	CFS	-0.0001	-0.0013	0.0015	0.0014	0.0017

*Notes: * Significant at p = 5%; X indicates insufficient data.*
The first letters of the indexes listed in this exhibit indicate their correspondence to the indexes discussed in the paper as follows: CS – Credit Suisse, DCI – Diapson, DJUBS – Dow Jones UBS, ML – Merrill Lynch, GS – S&P Goldman Sachs, and CFS – Continuous Futures Series.
Day-of the-week effect is identified from the following model suggested by Ma et. al. (1992): $r_{it} = a + B_{TU}D_{TU} + B_W D_W + B_{TH}D_{TH} + B_F D_F + e_i$, where r_{it} is the i_{th} time series of the daily return for the daily price change series. D_i represents the daily dummy and its coefficient measures the difference between the Monday return (measured as "a") and returns from the other days of the week.

6. Conclusions

Various index providers use different methods to roll their futures contracts. Indexes roll their contracts on different days, for a different number of days, and use different months for the futures contracts. The objective of a roll methodology is to mimic the change in the commodity price without introducing additional volatility or inefficiency.

This study demonstrates that all indexes have no distinction in means with their respective CFS. Metals have volatility similar to that

of their respective CFS. However, energy and agricultural indexes demonstrate lower volatility than their respective CFS.

In most cases, indexes are efficient if such efficiency as measured by the day-of-the-week effect is demonstrated in the CFS. Results are similar for metals and energy using serial correlation but inconsistent for agricultural commodity indexes.

This study indicates that different returns volatility and inefficiency as compared to the CFS is mostly not dependent on the roll methodology but on the type of commodity investigated. Thus, investors or ETP providers should choose between index providers based on the roll methodology.

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