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# Overreaction and Underreaction in the Commodity Futures Market

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**Abstract:** Using an event-study methodology, this study examines the overreaction and underreaction in the commodity futures markets, including softs, grains, livestocks, metals and energies. An underreaction phenomenon in agricultural commodities (softs, grains and livestocks) and an overreaction phenomenon in non-agricultural commodities (metals and energies) are found. Even after controlling for potentially confounding factors, the cross-sectional analysis confirms that the non-agricultural commodities, especially for the winners, experience stronger degrees of overreaction than the agricultural commodities.

JEL Code: G13; G14
Key Words**:** Overreaction, Underreaction, Geopolitical Risk

## 1. Introduction

The possibility of market irrationality has generated significant discussion among financial economics journals over last three decades. One particular area of interest is the adjustment process of asset prices in reaction to the release of information. Some scholars have asserted that most investors tend to overreact to bad news and underreact to good news. The overreaction and underreaction hypotheses of asset prices have been investigated in several studies. DeBondt and Thaler (1985) are the first to document the evidence of stock price overreaction. They divide the sample stocks into ten portfolios based on three years of performance and document that the lowest portfolio dominates the highest portfolio by 24.6% during the subsequent 3-year period. DeBondt and Thaler (1987) reinvestigate investor overreaction while controlling for firm size and differences in systematic risk. The results still support the overreaction hypothesis.

Some previous studies (Howe, 1986; Brown *et al*., 1988; Atkins and Dyl, 1990; Bremer and Sweeney, 1991; Cox and Peterson, 1994; Peterson, 1995; Akhigbe *et al*., 1998) have also explored post-event abnormal returns pursuant to extreme, one-day stock price changes (daily return) for U.S. stock markets. Some of their findings support the overreaction or underreaction hypothesis and the remaining results support efficient markets hypothesis. Thus, the findings of these studies are obviously inconclusive. In addition, Brown *et al*. (1988) and Ajayi and Mehdian (1994) examine overreaction and underreaction relating to stock market indices for U.S. and non-U.S. markets. Their findings show that the impact of macroeconomic events is not immediately reflected in stock prices.

Some studies extend the above research for other financial markets. For example, Ma *et al.* (1990) have found that the futures prices of agricultural commodities tend to overreact to significant events. In addition, Allen *et al.* (1994) have documented that spot prices of agricultural commodities tend to reverse after significant events, which evidence also supports the overreaction hypothesis. Recently, Larson and Madura (2001) have found that an overreaction phenomenon for currencies in emerging markets and an underreaction phenomenon for currencies in industrial markets.

The previous studies of market rationality focus, as noted above, mainly on stock markets, with little attention given to commodity futures markets in literature. According to the annual volume survey of Futures Industry Association (FIA), the growth rate of the trading volumes for agriculture, energy and non-precious metals futures and options were 27.5%, 11.2% and 27.4% in 2012, respectively.[20] Bodie and Rosansky (1980), Gorton and Rouwenhorst (2006), Erb and Harvey (2006), Miffre and Rallis (2007) and Fuertes *et al*. (2010) have also found that the portfolios of commodity futures have had average returns similar to the S&P 500 Index. These report and research indicate that it is important for investors and academicians to realize the price behaviors of various commodity futures. Therefore, the first marginal contribution of this study is to investigate whether extreme one-day commodity futures price adjustments fully reflect new information or to check whether they exist in systematical bias. Twenty-eight futures contracts, including 8 metal futures, 6 soft futures, 7 grain futures, 4 livestock futures and 3 energy futures, are examined in this study.[21]

This study develops six hypotheses to examine the price behaviors of various commodity futures around the period of significant events. The three traditional hypotheses, including the efficient markets hypothesis (Hypothesis 1), the overreaction hypothesis (Hypothesis 2) and the underreaction hypothesis (Hypothesis 3)**,** are first examined by estimating commodity futures price changes following extreme one-day changes in prices.[22]

Larson and Madura (2001) have documented that the political events have a higher degree of overreaction than economic events in the foreign exchange markets, as the political events should be more difficult for market participants to assess than economic events. Belgrave (1985), an early study, discusses how geopolitical forces affect energy supplies between states. Recently, Billon (2001), Varisco (2009) and Wolfe and Tessman (2012) or some websites also examine or report how the geopolitical risks influence energy and metal prices.[23] It is reasonably conjectured that the non-agricultural

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[20]. Please refer to the report of Acworth (2012) "Volume climbs 11.4% to 25 billion contracts worldwide", p. 24-33, www.futuresindustry.com.

[21]. As noted above, Ma *et al.* (1990) only examines the price behavior around the period of significant events for some agricultural commodities futures. However, this study includes all kinds of commodity futures, which are taken from *DataStream*.

[22]. In some papers, "price changes" means "return", so two terms are interchangeably used in this study.

[23]. For example, a conflict exists between Iran and the West about nuclear program during the second season of 2012, so one of the headlines in *New York Times* in 11 May, 2012 is "Geopolitical Risks Keep Oil Expense, but Plentiful". Carr (2012) also asserts that "A much-noted characteristic of energy markets last year was that prices were influenced more by geopolitics and macroeconomics than pure supply and demand fundamentals." in *Energy Risk* (7 Feb, 2012). These reports obviously explain why geopolitical risks influence the energy prices. In addition, the

commodities (including metals and energies) are more easily affected by the geopolitical risks than other commodities, that is, the price behavior of non-agricultural commodities is high fluctuation around the period of the geopolitical events.[24] Therefore, the second marginal contribution of this study is that a new hypothesis, geopolitical risks (Hypothesis 4), is examined to check whether the degree of overreaction is stronger when the commodities are related to non-agricultural commodities.

Regression analysis is used to test whether the degree of overreaction of non-agricultural commodities is stronger than agricultural commodities and to examine whether larger initial futures price changes is associated with stronger degrees of overreaction (Hypothesis 5). Post-event futures price changes are also regressed against the pre-event period cumulative price changes to find possible support for the information leakage hypothesis (Hypothesis 6)**.**

The results of this study suggest that the losers (winners) of the agricultural commodities (softs, grains and livestocks) subsequently earn negative (positive) mean-adjusted returns to support the underreaction hypothesis. On the other hand, the evidence suggests that the winners of the non-agricultural commodities (metals and energies) subsequently earn negative mean-adjusted returns to support the overreaction hypothesis. Next, the cross-sectional analysis shows that non-agricultural commodities are associated with stronger degrees of overreaction than the agricultural commodities. Finally, the results show that the magnitude of overreaction varies according to the degree of the initial commodity change and information leakage.

The remainder of this paper is organized as follows. Section 2 explains the research hypotheses, Section 3 introduces the data and event definition, Section 4 describes the methodology and Section 5 presents the empirical results. Finally, Section 6 provides the conclusion that we draw from the study.

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relationship between geopolitical risks and metal production is often reported in some websites, such as Bloomberg (http://www.bloomberg.com) or BabyBullTwits (www.theaureport.com).

[24]. For example, the mean and standard deviation of daily returns for crude oil futures during the 1983/3-2012/12 are 0.06% and 2.31%, respectively, however, those during the Gulf War (1991/1/17-2/28) are -0.87% and 7.48%, respectively, and those during the Iraq War (2003/3/21-5/1) are 0.02%% and 3.40%, respectively. So the prices are obviously high fluctuation during the geopolitical events.

## 2. Research Hypotheses

As mentioned above, six hypotheses are examined in this study. Their assertions or discussion are respectively stated as follows.[25]

Three traditional hypotheses are first applied to extreme, one-day futures price changes (return): the efficient markets, overreaction and underreaction hypotheses. The efficient markets hypothesis (Hypothesis 1) asserts that investors can appropriately estimate the futures price when new information is released. The efficient markets hypothesis is rejected if empirical findings support either the overreaction hypothesis (Hypothesis 2) or the underreaction hypothesis (Hypothesis 3). The overreaction hypothesis asserts the responses of investors are too strong to new information and subsequently revise their estimates of futures price. The underreaction hypothesis asserts investors do not respond strongly enough to new information and subsequently revise their futures price. These three hypotheses are examined by assessing futures price change following extreme one-day changes in futures prices. Three hypotheses are respectively stated as follows.

***Efficient Markets Hypothesis (Hypothesis 1)*****:** Extreme one-day (event day) changes in futures price are not followed by significant futures price changes.

***Overreaction Hypothesis (Hypothesis 2)*****:** Extreme one-day (event day) changes in futures price are followed by significant futures price changes in the opposite direction.

***Underreaction Hypothesis (Hypothesis 3)*****:** Extreme one-day (event day) changes in futures price are followed by significant futures changes in the same direction.

As noted above, Larson and Madura (2001) have documented that the political events have a higher degree of overreaction than economic events in the foreign exchange markets as the political events should be more difficult for investors to assess than economic events. As noted above, it is reasonably conjecture that the non-agricultural commodities (energies and metals) are more easily affected by the geopolitical risks than agricultural commodities. The geopolitical risks hypothesis is stated below.

***Geopolitical Risks Hypothesis (Hypothesis 4)***: The degree of overreaction is stronger for non-agricultural commodity futures.

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[25]. Six hypotheses are examined by some previous studies, such as Akhigbe *et al*. (1998), Atkins and Dyl, (1990), Larson and Madura (2001) and so on, for different markets except Hypothesis 4.

Some studies, such as Brown and Harlow (1988), Bremer and Sweeney (1991) and Akhigbe *et al.* (1998), assert that larger initial stock price changes are associated with higher degrees of uncertainty, and their results show that the tendency for a reversal is stronger when the initial stock price changes is more extreme.[26] Larson and Madura (2001) find the same phenomenon in the exchange rate markets as well. The similar phenomenon may exist in commodity futures markets, so the following hypothesis is also developed in this study.

***Initial Futures Price Changes Hypothesis (Hypothesis 5)*:** Larger initial futures price changes (futures price changes on event day) are expected to be associated with stronger degrees of overreaction.

Daniel *et al.* (1998) also assert that investors overweigh private signals causing stock price overreaction. In addition, Larson and Madura (2001) find that larger degrees of leakage are associated with larger degrees of overreaction for losers in the exchange rate markets. Based on the findings of these studies, the following hypothesis is developed for commodity futures markets.

***Private Information Leakage Hypothesis (Hypothesis 6)*:** Higher degrees of information leakage, as evidenced by pre-event futures price changes that are in the same direction as the extreme futures price changes, are expected to be associated with larger degrees of overreaction.

## 3. Data and Event Definition

The daily settlement prices on 28 commodity futures for different maturity contracts are obtained from *Datastream* over the period January 1979 to December 2012. Our sample consists of 8 metal futures (aluminum, copper high grade, gold 100oz, lead, nickel, silver 5000oz, tin and zinc), 6 soft futures (cocoa, coffee C, cotton #2, lumber, orange juice FCOJ-A and sugar #11), 7 grain futures (corn, oats, rough rice, soybeans, soybean oil, soybean meal and wheat), 4 livestock futures (feeder cattle, lean hogs, live cattle and frozen pork bellies) and 3 energy futures (light sweet crude oil, New York heating oil and natural gas). Details of the each futures contract used in this paper can be found in Appendix.

[26]. “initial stock price changes” means stock price changes on event day.

This study compiles the time series of futures returns to avoid unusual activity associating with the expiration of the futures contracts. The first nearest daily contract is selected to calculate the returns, unless the contract expires in that month, in which case we roll into the second nearest contract.[27] In other words, we roll into the second nearest contract on the first day of the expiration month of the first nearest contract. The daily returns are calculated as follows.

$$R_t = (P_t - P_{t-1}) / P_{t-1} \tag{1}$$

where $R_t$ is the return on day *t*, and $P_t$ and $P_{t-1}$ are the settlement price on days *t* and *t-1*.

For each commodity futures, the mean and standard deviation of daily returns are calculated. Table 1 presents summary statistics of daily returns for the 28 commodity futures during the sample period. A critical value of 2 standard deviations is used to identify the boundaries for price fluctuations. A daily return is considered “extreme” if it were more than 2 standard deviations from the mean of the daily return distribution. Furthermore, the “extreme” events of the left tail of the distribution are considered as the losers, and the “extreme” events of the right tail of the distribution are considered as the winners.

[27]. The method of calculating the futures returns can consult Roll (1984), Szkmary and Kiefer (2004), Miffre and Rallis (2007) and Fuertes *et al*. (2010).

**Table 1: Summary statistics of daily returns for each commodity futures during the sample period**

| | Mean | S.D. | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| ***Softs*** | | | | | | |
| Cocoa | -0.01% | 1.88 | -9.52 | 13.38 | 0.19 | 5.56 |
| Coffee | 0.01 | 2.20 | -13.96 | 26.84 | 0.55 | 12.81 |
| Cotton | 0.01 | 1.54 | -7.78 | 12.02 | 0.09 | 5.35 |
| Lumber | -0.04 | 1.72 | -5.88 | 7.24 | 0.11 | 2.92 |
| Orange Juice | 0.01 | 1.81 | -12.90 | 26.99 | 0.95 | 19.81 |
| Sugar | 0.02 | 2.46 | -16.66 | 15.25 | -0.01 | 6.05 |
| ***Grains*** | | | | | | |
| Corn | -0.02 | 1.44 | -9.89 | 9.05 | 0.05 | 6.37 |
| Oats | -0.01 | 1.84 | -11.25 | 11.74 | 0.07 | 5.50 |
| Rough Rice | -0.02 | 1.63 | -8.70 | 9.71 | 0.13 | 5.09 |
| Soybeans | 0.01 | 1.40 | -8.23 | 6.96 | -0.12 | 5.48 |
| Soybean Oil | 0.00 | 1.50 | -6.98 | 8.37 | 0.20 | 4.68 |
| Soybean Meal | 0.02 | 1.50 | -9.00 | 7.82 | 0.00 | 5.53 |
| Wheat | -0.02 | 1.62 | -9.49 | 9.48 | 0.15 | 6.03 |
| ***Livestock*** | | | | | | |
| Feeder Cattle | 0.01 | 0.87 | -5.83 | 3.69 | -0.11 | 4.16 |
| Lean Hogs | 0.00 | 1.45 | -6.65 | 7.12 | -0.04 | 4.07 |
| Live Cattle | 0.01 | 0.94 | -6.16 | 3.78 | -0.07 | 4.02 |
| Pork Bellies | -0.01 | 2.11 | -7.33 | 8.67 | 0.07 | 3.06 |
| ***Energies*** | | | | | | |
| Crude Oil | 0.06 | 2.28 | -33.00 | 15.66 | -0.38 | 14.38 |
| Heating Oil | 0.06 | 2.10 | -32.36 | 15.02 | -0.41 | 14.21 |
| Natural Gas | -0.01 | 3.21 | -19.46 | 38.31 | 0.51 | 9.42 |
| ***Metals*** | | | | | | |
| Aluminum | 0.00 | 1.31 | -7.93 | 6.17 | -0.22 | 5.59 |
| Copper | 0.04 | 1.70 | -10.93 | 12.46 | -0.05 | 7.08 |
| Gold | 0.01 | 1.22 | -9.59 | 10.24 | 0.06 | 11.07 |
| Lead | 0.04 | 1.99 | -12.32 | 13.73 | -0.04 | 6.62 |
| Nickel | 0.06 | 2.27 | -16.75 | 14.17 | 0.06 | 6.76 |
| Silver | 0.03 | 1.77 | -17.73 | 13.15 | -0.55 | 10.62 |
| Tin | 0.05 | 1.61 | -10.83 | 16.75 | 0.07 | 11.33 |
| Zinc | 0.01 | 1.80 | -11.81 | 9.96 | -0.14 | 6.59 |

Table 2 shows the average returns for losers and winners by type of commodity in the event window. The pre-event period results are disclosed in order to assess leakage, and the post-event period results are useful for assessing the economic significance of overreaction and underreaction. As mentioned above, an overreaction of market participants is observed when the price reverses shortly after the event date and an underreaction is observed when the price exhibits persistent patterns after the event date. In either case, the market price does not adjust to the event instantaneously. In loser panel, the mean returns are positive on Day 1 for energies, and those are negative on Day 1 for the metals, softs, grains and livestocks. In winner panel, the mean returns are negative on Day 1 for metals and energies, and those are positive on Day 1 for the softs, grains and livestocks. Furthermore, regardless of losers or winners for all commodities, the same sign of returns on Day -1 and Day 0 is observed.

**Table 2: Event window average returns by type of commodity futures for losers and winners during the sample period**

| | N | Day -3 | Day -2 | Day -1 | Day 0 | Day 1 | Day 2 | Day 3 |
|---|---|---|---|---|---|---|---|---|
| *Losers* | | | | | | | | |
| Softs | 1,243 | -0.114% | 0.199 | -0.187 | -5.197 | -0.072 | 0.336 | -0.147 |
| Grains | 1,402 | -0.058 | -0.125 | -0.306 | -4.149 | -0.193 | 0.029 | 0.017 |
| Livestocks | 925 | -0.211 | -0.293 | -0.393 | -3.064 | -0.229 | -0.029 | -0.074 |
| Energies | 517 | 0.019 | 0.131 | -0.054 | -6.954 | 0.097 | 0.150 | 0.284 |
| Metals | 1,117 | -0.048 | -0.078 | -0.239 | -4.776 | -0.006 | 0.088 | -0.052 |
| *Winners* | | | | | | | | |
| Softs | 1,279 | 0.298 | 0.099 | 0.563 | 5.348 | 0.221 | 0.068 | 0.225 |
| Grains | 1,552 | 0.141 | 0.097 | 0.365 | 4.177 | 0.108 | -0.008 | 0.133 |
| Livestocks | 862 | -0.041 | -0.025 | 0.206 | 3.195 | 0.311 | 0.252 | -0.044 |
| Energies | 586 | -0.119 | 0.084 | 0.172 | 7.135 | -0.243 | 0.292 | 0.187 |
| Metals | 1,048 | 0.113 | -0.023 | 0.189 | 4.779 | -0.133 | 0.007 | -0.054 |

# 4. Methodology

## 4.1 Event-study methodology[28]

For each event, commodity futures returns for the estimation period (Day -260 to -41) and the event period (Day -3 to 3) are selected. An event-study methodology for commodity futures that is based on Brown and Warner (1980) or Larson and Madura's (2001) mean-adjusted returns model is used to document the market's response to extreme futures returns:

$$SAR_{it} = (R_{it} - \overline{R}_i) / SD(R_i) \tag{2}$$

where $SAR_{it}$ is the standardized abnormal return for event *i* on day *t* and $R_{it}$ is the one-day return for event *i* on day *t*. $\overline{R}_i$ and $SD(R_i)$ are the sample mean and standard deviation for event *i* during the estimation period.[29]

To examine statistical significance (*t* statistic) for Day *d*, the following test statistic is used (Equations (3) and (3a)):

$$\frac{1}{n}\sum_{i=1}^{n} SAR_{id} \Bigg/ \left[ \frac{1}{ED} \left( \sum_{i=-260}^{-41} \left[ \left( \frac{1}{n}\sum_{i=1}^{n} SAR_{it} \right) - X^{*} \right]^{2} \right) \right]^{1/2} \tag{3}$$

where

$$X^{*} = \left[ \sum_{t=-260}^{-41} \sum_{i=1}^{n} SAR_{it} \right] \frac{1}{ED * n} \tag{3a}$$

$SAR_{IT}$ is defined in Equation (2), *n* is the number of events in the sample, and *ED* is the number of days in the estimation period.

To examine significance for the three-day post-event interval (Days 1-3), the numerator in Equation (3) is used to obtain Equation (4):

$$\frac{1}{3n}\sum_{t=1}^{3}\sum_{i=1}^{n} SAR_{it} \tag{4}$$

Nonparametric tests using the binomial *Z* statistic is included in consideration of outliers and non-normality. The technique tests the null hypothesis that the ratio of

28. The readers interested in more details about the event-study methodology can consult Brown and Warner (1980), Brown and Warner (1985), Howe (1986), Brown *et al*. (1988), Atkins and Dyl (1990), Bremer and Sweeney (1991), Cox and Peterson (1994), Peterson (1995), Akhigbe *et al*. (1998) and Larson and Madura (2001). The event-study methodology given here is slightly modified from these papers.

29. For robustness tests, the sample mean and standard deviation of the futures returns for the post-event estimation period (Day 81 to 300) are also estimated. The results are similar to the pre-event estimation period.

positive return observations on Day *d* is different from 50%. The corresponding *Z* statistic $= (P-0.5)/\sqrt{[(0.5)(0.5)]/n}$, where $P$ is the ratio of positive returns on Day *d* and *n* is the number of events on Day *d*.

## 4.2 Regression Analysis

In order to control for potentially confounding factors while assessing the above hypotheses, post-event returns (Day 1 or Days 1-3) are regressed on the initial returns (Day 0), the degree of information leakage and geopolitical risks. Moreover, some dummy variables, the day of the week and month of the year (January and December), are also considered. The following regression model is used to test the stated hypotheses.[30]

$$\begin{aligned} SAR_i = \alpha_0 + \alpha_1 Ar0_i + \alpha_2 Leak_i + \alpha_3 Nonagr_i + \alpha_4 Dec_i + \alpha_5 Jan_i + \\ \alpha_6 Mon_i + \alpha_7 Tue_i + \alpha_8 Thu + \alpha_9 Fri_i + e_i \end{aligned} \tag{5}$$

where $SAR_i$ is the post-event standardized abnormal return, $Ar0_i$ is the standardized abnormal return on the event day (Day 0), $Leak_i$ is the three-day pre-event period cumulative abnormal return and $Nonagr_i$ is a dummy variable equal to 1 if the event corresponds to non-agricultural commodities (energies and metals). As the seasonality effects may exist in commodity futures, such as the day-of-the-week and the monthly effects. Several dummy variables are included in Equation (5). $Dec_i$ (December) or $Jan_i$ (January) is a dummy variable equal to 1 if the event occurs in that month, otherwise 0. $Mon_i$ (Monday), $Tue_i$ (Tuesday), $Thu_i$ (Thursday), or $Fri_i$ (Friday) is a dummy variable equal to 1 if the event occurs on that weekday, otherwise 0.

$Ar0_i$, the standardized abnormal return on the event day, is included in Equation (5) to test the initial futures price changes (Hypothesis 5) that larger initial returns are expected to be associated with stronger degrees of overreaction. The hypothesis is supported if the sign on the coefficient $(\alpha_1)$ is negative and statistically significant.

As mentioned above, some previous studies have found that larger degrees of leakage are associated with larger degrees of overreaction for various financial markets

[30]. The regression analysis model and contents are slightly modified from Larson and Madura (2001).

during the significant events. Therefore, this study conjectures that higher degrees of information leakage, as evidenced by pre-event futures price changes that are in the same direction as the extreme futures price changes, is associated with larger degrees of overreaction. The private information leakage hypothesis (Hypothesis 6) is accepted if the sign on this coefficient ($\alpha_2$) is negative and statistically significant at the chosen levels.

As mentioned above, the dummy variable, $Nonagr_i$, is examined to check whether the degree of overreaction is stronger when the commodities are related to the non-agricultural commodities (Hypothesis 4). The geopolitical risk hypothesis is accepted if the sign on the coefficient ($\alpha_3$) for losers (winners) is positive (negative) when the dummy variable corresponds to the non-agricultural commodities (energies and metals).

## 5. Empirical results

### 5.1 Event-study results

Tables 3 and 4 display the event-study results pursuant to overreaction and underreaction for losers and winners, respectively. The first row for any type of commodity discloses the standardized abnormal returns, the second row discloses the *t* statistic for the standardized abnormal returns, and the third row discloses the results of the binomial *Z* tests.

Table 3 shows that the efficient markets hypothesis (Hypothesis 1) is rejected in favor of the underreaction hypothesis (Hypothesis 3) for all agricultural losers. The signs of the standardized abnormal returns for the softs, grains and livestocks on Day 1 are negative and significant at 5% or 1% level. However, the efficient markets hypothesis (Hypothesis 1) is not rejected for two non-agricultural losers (metal and energy futures). In other words, the signs of the standardized abnormal returns for metal and energy futures on Day 1 are not significant.

**Table 3: Average standardized commodity returns for losers during the sample period**

| | $N$[2] | Day -3 | Day -2 | Day -1 | Day 0 | Day 1 | Day 2 | Day 3 |
|---|---|---|---|---|---|---|---|---|
| Softs | 1,243 | -0.03*[3] | 0.12*** | -0.10*** | -2.56*** | -0.04** | 0.16*** | -0.06*** |
| *t* Statistic | | -1.69 | 6.31 | -5.16 | -137.24 | -2.39 | 8.72 | -3.12 |
| % of *Rtn*>0[1] | | 46** | 51 | 41*** | 0*** | 51 | 53** | 46*** |
| Grains | 1,402 | -0.04 | -0.09*** | -0.24*** | -2.64*** | -0.14*** | 0.01 | 0.00 |
| *t* Statistic | | -1.60 | -3.72 | -9.93 | -109.39 | -5.97 | 0.40 | -0.11 |
| % of *Rtn*>0 | | 45*** | 43*** | 39*** | 0*** | 49 | 49 | 47** |
| Livestocks | 925 | -0.16*** | -0.22*** | -0.32*** | -2.34*** | -0.13*** | -0.01 | -0.02 |
| *t* Statistic | | -5.37 | -7.55 | -10.91 | -78.85 | -4.41 | -0.27 | -0.84 |
| % of *Rtn*>0 | | 44*** | 42*** | 38*** | 0*** | 46** | 50 | 47** |
| Energies | 517 | -0.01 | -0.03 | -0.10*** | -2.96*** | -0.01 | 0.04 | 0.10*** |
| *t* Statistic | | -0.22 | -0.92 | -2.70 | -81.19 | -0.15 | 1.18 | 2.71 |
| % of *Rtn*>0 | | 49 | 48 | 40*** | 0*** | 52 | 51 | 49 |
| Metals | 1,117 | -0.07*** | -0.05** | -0.17*** | -2.73*** | -0.02 | 0.05** | -0.09*** |
| *t* Statistic | | -2.85 | -2.11 | -7.30 | -115.88 | -0.89 | 2.14 | -4.03 |
| % of *Rtn*>0 | | 48 | 44*** | 41*** | 0*** | 54** | 52 | 49 |

1. "% of *Rtn*>0" is the ratio of positive returns.

2. *N* is the number of the observations.

3. *, ** and *** indicate statistically significant at 10%, 5% and 1%, respectively.

The efficient markets hypothesis (Hypothesis 1) is rejected, shown in Table 4, in favor of the underreaction hypothesis (Hypothesis 3) for all agricultural winners. For Day 1, the signs of the standardized abnormal returns are positive and significant for the softs, grains and livestocks at 1% level. In addition, the efficient markets hypothesis (Hypothesis 1) is also rejected in favor of the overreaction hypothesis (Hypothesis 2) for metal and energy winners. The signs of the standardized abnormal returns for metal and energy winners on Day 1 are negative and statistically significant at 1% level.

The pre-event standardized abnormal daily returns are used to determine whether there is leakage of information before the extreme change in commodity prices. The findings of Table 3 for all losers show that all signs of the standardized abnormal returns on Day -1 are negative and statistically significant at the 1% level. The results of Table 4 for all winners also present the similar phenomenon except for energy winner. The evidence indicates that there is leakage of information prior to the extreme change in commodity prices.

**Table 4: Average standardized commodity returns for winners during the sample period**

| | $N$[2] | Day -3 | Day -2 | Day -1 | Day 0 | Day 1 | Day 2 | Day 3 |
|---|---|---|---|---|---|---|---|---|
| Softs | 1,279 | 0.17***[3] | 0.09*** | 0.30*** | 2.70*** | 0.14*** | 0.06*** | 0.11*** |
| $t$ Statistic | | 8.99 | 4.91 | 16.32 | 144.56 | 7.65 | 3.00 | 5.98 |
| % of *Rtn*>0[1] | | 50 | 47** | 55*** | 100*** | 49 | 47** | 50 |
| Grains | 1,552 | 0.09*** | 0.05** | 0.25*** | 2.67*** | 0.08*** | -0.03 | 0.07*** |
| $t$ Statistic | | 3.80 | 2.26 | 10.54 | 110.97 | 3.19 | -1.13 | 2.97 |
| % of *Rtn*>0 | | 50 | 49 | 53** | 100*** | 45*** | 45*** | 49 |
| Livestocks | 862 | -0.03 | -0.05* | 0.14*** | 2.32*** | 0.24*** | 0.18*** | 0.01 |
| $t$ Statistic | | -0.86 | -1.73 | 4.59 | 78.22 | 7.97 | 6.15 | 0.33 |
| % of *Rtn*>0 | | 48 | 45*** | 51 | 100*** | 52 | 50 | 46*** |
| Energies | 586 | -0.11*** | 0.00 | 0.03 | 2.93*** | -0.13*** | 0.10*** | 0.06 |
| $t$ Statistic | | -2.97 | -0.12 | 0.88 | 80.17 | -3.68 | 2.86 | 1.56 |
| % of *Rtn*>0 | | 46** | 50 | 51 | 100*** | 42*** | 52 | 50 |
| Metals | 1,048 | 0.05* | -0.02 | 0.10*** | 2.56*** | -0.09*** | -0.04 | -0.04 |
| $t$ Statistic | | 1.93 | -0.95 | 4.46 | 108.72 | -3.97 | -1.55 | -1.52 |
| % of *Rtn*>0 | | 49 | 47* | 51 | 100*** | 43*** | 47* | 47** |

1. "% of *Rtn*>0" is the ratio of positive returns.

2. $N$ is the number of the observations.

3. *, ** and *** indicate statistically significant at 10%, 5% and 1%, respectively

## 5.2 Cross-sectional results

Cross-sectional results are exhibited in Table 5. Panel A contains results for all (agricultural and non-agricultural futures) losers. As noted above, *Nonagr*, was set equal to 1 if the event corresponds to non-agricultural commodity futures. The coefficient on *Nonagr* for Day 1 is positive and statistically significant at 5% level. Thus, the geopolitical risks hypothesis (Hypothesis 4), non-agricultural commodities will be associated with a stronger tendency toward overreaction than agricultural commodities, is supported. The variable *Ar0* pertains to the initial futures price changes. The coefficient on *Ar*0 for Days 1-3 is negative and statistically significant at 10% level. That is to say, the initial price change hypothesis (Hypothesis 5), larger initial futures price changes will be associated with larger degrees of overreaction, is supported. The variable *Leak* pertains to the degree of pre-event leakage. For Day 1 and Days 1-3, the signs of the coefficients are negative and statistically significant at 5% and 1%, respectively. These findings support that higher degrees of information leakage are expected to be associated with larger degrees of overreaction (Hypothesis 6).

Panel B contains results for all (agricultural and non-agricultural futures) winners. The coefficients on *Nonagr* for Day 1 and Days 1-3 are negative and statistically significant at 1% level. Thus, the geopolitical risks hypothesis (Hypothesis 4), non-agricultural commodities will be associated with a stronger tendency toward overreaction than agricultural commodities, is obviously supported. The coefficients on *Ar*0 for Day 1 and Days 1-3 are not statistically significant. Thus, there is no evidence in favor of the initial price changes hypothesis (Hypothesis 5), i.e., larger initial price changes will not be associated with larger degrees of overreaction. In addition, the coefficient on *Leak* for Days 1-3 is negative and significant at 10% level, which evidence weakly supports that larger degrees of leakage will be associated with larger degrees of overreaction (Hypothesis 6).

**Table 5: Least squares estimates of cross-sectional regressions for losers and winners during the sample period**

(A) Losers

| $SAR_i$ | *Ar*0 | *Leak* | *Nonagr* | *Dec* | *Jan* | *Mon* | *Tue* | *Thu* | *Fri* | *N* |
|---|---|---|---|---|---|---|---|---|---|---|
| Day 1 | -0.0159 | -1.2008**[1] | 0.1011** | -0.3101*** | -0.0862 | -0.0369 | 0.0009 | -0.1475** | -0.1797** | 5,204 |
| | (-0.47) | (-2.28) | (2.19) | (-3.51) | (-1.28) | (-0.59) | (0.01) | (-2.24) | (-2.42) | |
| Days 1-3 | -0.0404* | -1.0728*** | 0.0199 | -0.1108** | -0.0004 | -0.0343 | 0.0359 | -0.0103 | 0.0192 | 5,204 |
| | (-2.34) | (-3.32) | (0.78) | (-2.11) | (-0.01) | (-1.00) | (1.00) | (-0.27) | (0.49) | |

(B) Winners

| $SAR_i$ | *Ar*0 | *Leak* | *Nonagr* | *Dec* | *Jan* | *Mon* | *Tue* | *Thu* | *Fri* | *N* |
|---|---|---|---|---|---|---|---|---|---|---|
| Day 1 | -0.0279 | 0.2367 | -0.2447*** | -0.0968 | 0.0303 | -0.0864 | -0.0129 | 0.0856 | 0.2175*** | 5,327 |
| | (-0.77) | (0.39) | (-4.90) | (-1.31) | (0.39) | (-1.28) | (-0.19) | (1.32) | (2.97) | |
| Days 1-3 | 0.0044 | -0.5653* | -0.1259*** | 0.0724* | 0.0501 | -0.0437 | -0.0018 | -0.0355 | -0.0274 | 5,327 |
| | (0.30) | (-1.85) | (-4.92) | (1.77) | (1.13) | (-1.21) | (-0.05) | (-0.96) | (-0.71) | |

1. *, ** and *** indicate statistically significant at 10%, 5% and 1%, respectively.

In general, the results of this study suggest that commodity futures market participants overreact to information pursuant to non-agriculture commodities, but they underreact information pursuant to agriculture commodities. The cross-sectional analysis confirms that non-agriculture commodities experience stronger degrees of overreaction than agriculture commodities, even after controlling for potentially confounding factors.

## 6. Conclusion

Using the event-study methodology, this study examines the overreaction and underreaction in the commodity futures markets, including softs, grains, livestocks, metals and energies. The findings of this study suggest that the efficient market hypothesis should be rejected with regard to extreme fluctuations pursuant to commodity futures. For losers and winners of agriculture commodity futures, the evidence suggests that market participants underreact, but for winners of non-agriculture commodity futures, the evidence suggests that market participants overreact.

Cross-sectional regression analyses control for other possibly confounding factors, such as initial price change, leakage, day of the week and change in the year. Even when controlling for these factors, there is still evidence that non-agriculture commodity futures are associated with stronger degrees of overreaction than those of agricultural futures.

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**Appendix: Sample Description**

| | Class ticker | Start date | End date | Exchange |
|---|---|---|---|---|
| *Softs* | | | | |
| Cocoa | NCC | 1979/1/3 | 2012/2/29 | New York Board of Trade |
| Coffee | NKC | 1979/1/3 | 2012/2/29 | New York Board of Trade |
| Cotton | NCT | 1979/1/3 | 2012/2/29 | New York Board of Trade |
| Lumber | CLB | 1979/1/3 | 2012/2/29 | Chicago Mercantile Exchange |
| Orange Juice | NJO | 1979/1/3 | 2012/2/29 | New York Board of Trade |
| Sugar | NSB | 1979/1/3 | 2012/2/29 | New York Board of Trade |
| *Grains* | | | | |
| Corn | CC. | 1979/1/5 | 2012/2/29 | Chicago Board of Trade |
| Oats | CO. | 1979/1/3 | 2012/2/29 | Chicago Board of Trade |
| Rough Rice | CNR | 2000/1/10 | 2012/2/29 | Chicago Board of Trade |
| Soybeans | CS. | 1979/1/3 | 2012/2/29 | Chicago Board of Trade |
| Soybean Oil | CBO | 1979/1/3 | 2012/2/29 | Chicago Board of Trade |
| Soybean Meal | CSM | 1979/1/3 | 2012/2/29 | Chicago Board of Trade |
| Wheat | CW. | 1979/1/3 | 2012/2/29 | Chicago Board of Trade |
| *Livestocks* | | | | |
| Feeder Cattle | CFC | 1979/1/3 | 2012/2/29 | Chicago Mercantile Exchange |
| Lean Hogs | CLH | 1979/1/3 | 2012/2/29 | Chicago Mercantile Exchange |
| Live Cattle | CLC | 1979/1/3 | 2012/2/29 | Chicago Mercantile Exchange |
| Pork Bellies | CPB | 1979/1/3 | 2009/12/31 | Chicago Mercantile Exchange |
| *Energies* | | | | |
| Crude Oil | NCL | 1983/3/31 | 2012/2/29 | New York Mercantile Exchange (NYMEX) |
| Heating Oil | NHO | 1979/1/3 | 2012/2/29 | New York Mercantile Exchange (NYMEX) |
| Natural Gas | NNG | 1990/4/4 | 2012/2/29 | New York Mercantile Exchange (NYMEX) |

*Metals*

| | | | | |
|---|---|---|---|---|
| Aluminum | LAH | 1993/9/1 | 2012/2/29 | London Metal Exchange |
| Copper | NHG | 1989/9/4 | 2012/2/29 | New York Mercantile Exchange (COMEX) |
| Gold | NGC | 1979/1/3 | 2012/2/29 | New York Mercantile Exchange (COMEX) |
| Lead | LED | 1993/12/1 | 2012/2/29 | London Metal Exchange |
| Nickel | LNI | 1993/12/1 | 2012/2/29 | London Metal Exchange |
| Silver | NSL | 1988/5/24 | 2012/2/29 | New York Mercantile Exchange (COMEX) |
| Tin | LTI | 1993/12/1 | 2012/2/29 | London Metal Exchange |
| Zinc | LZZ | 1993/12/1 | 2012/2/29 | London Metal Exchange |