PRICE LIMITS, OVERREACTION, AND PRICE RESOLUTION IN FUTURES MARKETS

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INTRODUCTION

This article investigates the overreaction hypothesis and evaluates the effect of price limits on price resolution in futures markets. Do traders overreact systematically to big news? The answer to this question has profound implications on market efficiency, the design of trading rules, and market regulation. Theoretically, the overreaction hypothesis casts doubt on the widely held belief that current financial systems are efficient. It is a challenge for economists to reconcile the overreaction hypothesis with the existing economic theory. From a trading point of view, trading rules may be designed to exploit the systematic mistakes made by traders. Overreaction may make a contrarian investment strategy profitable in practice since trading costs are extremely low and the leverage is high in futures trading compared to those in stock markets.

On the other hand, the overreaction hypothesis challenges policymakers and regulators to improve the efficiency of the financial system so that the overall economy can be improved as well. In fact, the overreaction hypothesis is widely cited as the foundation for many of the existing regulatory features such as the daily price limits rule and the

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latest "circuit breakers" system in the futures and stock markets (Anderson, 1984; Greenwald and Stein, 1988).

Previous empirical evidence on the overreaction hypothesis in futures markets is mixed. Ma, Rao, and Sears (1989) and Ma, Dare, and Donaldson (1990) present evidence of overreaction in some futures markets. In contrast, Gay, Kale, Kolb, and Noe (1994) find little evidence of overreaction but that of delayed reaction, i.e., dependence among consecutive price movements. This article extends previous studies along three lines. First, the difference between the closing price on the "event" day—the day of a big price swing—and the daily average price one day after is used to proxy for overreaction. It is also used in calculating profits from a trading rule designed to exploit such a price anomaly. From the trading point of view, such an estimate of profits is more reliable than that from the difference between closing price on the event day and the opening price one day after, a measurement of overreaction used in previous studies. Second, only consecutive trading days are used so that the well-known weekend and holiday effect on returns will not bias the results.[1] Third, this article uses a larger sample. Consequently, the empirical results in the article are more robust.

In addition, this article evaluates the impact of price limits on price resolution in futures markets. Price limits will inevitably affect price resolution and the magnitude of such impacts would depend on the levels of price limits. Different groups frequently demand that the limit levels be realigned. In general, small investors prefer a smaller price limit, whereas big firms want a larger one.[2] Clearly, price limits will affect price resolution and the larger the price limits are, the less distortion there would be on price resolution. Hence, the debate on the level of price limits is of great interest to the public and policymakers. In practice, such a public policy issue has to be resolved by the Commodity and Futures Trading Commission (CFTC) through its ruling. There are surprisingly few studies on the appropriateness of current levels of price limits in this regard. The lack of understanding on this issue often results in political charges brought against each side involved in the debate. Therefore, it is in the public interest to evaluate whether current limit levels are too narrow or too high in that they severely hinder the equilibrium price from being reached in the market. Such a study can provide a framework for a rational discussion on realignment of price limits.

[1]It is found that nontrading during the weekend results in a higher return on the last trading of the week and a negative return on Monday in both stock and futures markets (e.g., see Bessembinder and Hertzel, 1993).
[2]See *Securities Week*, 22 May 1995, p. 9.

The article is structured as follows. The following section formulates the hypotheses and outlines the testing procedures. The third section discusses data and presents empirical evidence. Implications of the findings are discussed in the conclusions.

HYPOTHESES FORMATION AND TESTING PROCEDURES

Price Limits in Futures Markets

Organized markets for futures trading impose upper and lower limits on daily price movement. These limits are set symmetrically at a fixed dollar amount above and below the previous day's settlement price. The daily price limits rule prohibits traders from buying or selling contracts at a price above the upper or below the lower limit prices on the floor of exchanges. A variation of the normal daily price limits rule is the variable price limits rule which stipulates that daily price limits be expanded automatically on the next trading day if the futures price closes at the limit price. Under the 1974 Commodity Futures Trading Commission Act, any formal change in the price limit level must be approved by the CFTC. Currently, most futures contracts have price limits.

According to the overreaction hypothesis, the price limits rule can be used to prevent short-term overreaction.[3] Among the many candidates, the overreaction hypothesis is the most popular rationale for imposing daily price limits.[4]

Overreaction in Futures Markets

Conceptually, the overreaction hypothesis states that traders systematically overadjust their posterior beliefs to news by more than what is warranted by the news in the short run of a day or two.[5] Evidence from cognitive psychology shows individuals tend to overreact to information (Kahneman and Tversky, 1981). As shown in Figure 1, a big bullish news item hits the market on day 1 and traders overreact. The overreaction

[3]See Anderson (1984), Khoury and Jones (1984), and Ma et al. (1989).

[4]There are four other rationales. First, Telser (1981) suggests that price limits can give traders time to consult their principles during a big price swing. Second, Brennan (1986) presents a model that price limits can be used to substitute for margin requirements. Third, it is believed that exchanges merely use price limits as a bargaining chip with the government (Miller, 1989; Moser, 1990; France, Kodres, and Moser, 1994). Finally, Kodres and O'Brien (1994) present the implementation risk theory that price limits can enhance the total welfare by transferring risk between different groups of traders in the market.

[5]See the pioneering work by De Bondt and Thaler (1985, 1990).

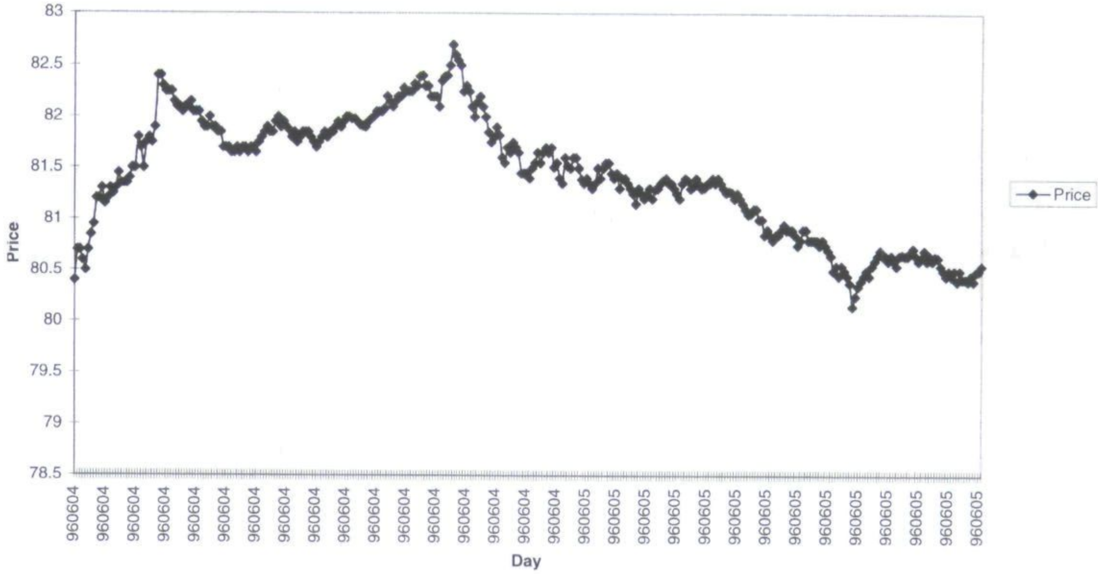

FIGURE 1
Overreaction and price movement. Prices jump on day 1 due to news and overreaction, but reverse themselves on day 2.

hypothesis states that the price level on day 2 is systematically lower than that on day 1. The opposite would be true in the case of negative news.

Overreaction is different from mean reversion. The former is a short-run price anomaly, whereas the latter is a long-run phenomenon.[6] It is known that stock and futures prices reverse themselves after a relatively longer period of time.[7] Such a long-run phenomenon is called mean reversion. Factors such as risk aversion and noise make any long-run investment strategy risky. That is, the longer the time period is, the more uncertainty, and the higher the risk is for investors, including those engaging in various trading strategies to exploit this price anomaly. Consequently, such a long-run phenomenon exists.[8]

In contrast to mean reversion in the long run, overreaction in the short run may create profit opportunities for those applying trading rules designed to exploit such a price anomaly. For example, if overreaction causes the price level on day 2 to be systematically lower/higher than that

[6]Here "mean reversion" is used to describe long-run price reversals. Technically, overreaction is an example of mean reversion. The difference between the two is the speed of adjustment toward the mean price.

[7]See Bailey (1969), De Bondt and Thaler (1985, 1990), Poterba and Summers (1988), and Bessembinder, Coughenour, Seguin, and Smoller (1995).

[8]See Arrow (1982), Shleifer and Vishny (1990), and DeLong, Shleifer, Summers, and Waldman (1991).

on day 1, a trader may earn abnormal returns through a trading scheme of opening a position on day 1 and rolling forward and closing it on day 2. This trading scheme will not be a risk-free arbitrage because it is not made delta-neutral.[9] Risk associated with this trading scheme, however, may not be larger especially after a big price swing. Therefore, overreaction hypothesis cannot be reconciled with the existing economic theory such as the efficient markets theory (Fama, 1970, 1991). Why can naive traders afford to make mistakes repeatedly without being eliminated in an efficient market?[10]

Previous empirical evidence on the overreaction hypothesis in futures markets is mixed. Ma et al. (1989, 1990) present evidence of overreaction in some futures markets. In contrast, Gay et al. (1994) find little evidence of overreaction but rather that of delayed reaction—price dependence. Adopting the event study methodology, these studies more or less follow a three-step procedure to investigate the overreaction hypothesis in futures markets:

Step 1: Identify the days that are associated with big bullish/bearish news, then divide data into two samples, i.e., bull market days and bear market days

Step 2: Calculate price changes ΔP (to be defined later) from t (event day) to $t + 1$

Step 3: Test the following hypotheses

H_0: $E\,(\Delta P \mid \text{bullish}) = 0$ and $E\,(\Delta P \mid \text{bearish}) = 0$

(the efficient markets hypothesis)

H_1: not H_0

i.e., $E\,(\Delta P \mid \text{bullish}) < 0$ and $E\,(\Delta P \mid \text{bearish}) > 0$

(the overreaction hypothesis)

or $E\,(\Delta P \mid \text{bullish}) > 0$ and $E\,(\Delta P \mid \text{bearish}) < 0$

(the delayed/underreaction hypothesis)

Under the assumption that large price movements are associated with big news, this study uses a statistical approach to identify those days associated with big news. First, trading days are identified as bull/bear market days according to the following rule[11]:

[9]An anonymous referee pointed this out in a review.

[10]The debate on whether noise traders may survive in the long run is rekindled (Friedman, 1953; DeLong et al., 1989, 1991). However, there is no reason that noise traders can survive if they overreact systematically in the short run.

[11]This classification criterion is more conservative than the conventional method, which classifies each trading day only by comparing that day's closing price with the previous closing price. However, the results should not be altered much by the classification criterion used because those days associated with big price changes would almost always be picked up regardless of which method is used.

$$\text{day } t = \text{a "bull" market day if } |H_t - C_{t-1}| > |L_t - C_{t-1}|$$
$$\text{and } C_t - C_{t-1} > 0$$
$$\text{day } t = \text{a "bear" market day if } |H_t - C_{t-1}| < |L_t - C_{t-1}|$$
$$\text{and } C_t - C_{t-1} < 0 \tag{1}$$

where C_t = daily closing price; H_t = daily high; and L_t = daily low.

Second, the mean (M) and standard deviation (STD) of price changes are calculated for each sample, i.e., the bull/bear market days. Only those trading days on which the maximum of price changes from the previous day is larger than the mean by two standard deviations are considered big price swings and sampled.[12] Those locked limit days on which markets close at the limit prices are excluded since the true equilibrium prices are unknown.

Two trading sessions are considered long enough for the market to assess fully the impact of news.[13] In addition, the shorter the time span is, the less likely there is for a significant change in the information set of market participants. To measure overreaction and trading profits, this study uses the difference between the closing price on the event day and the daily average price one day after:

$$\Delta P = \text{Avg}\,(P_{t+1}) - C_t \tag{2}$$

where Avg $(P_{t+1}) = (H_{t+1} + C_{t+1} + O_{t+1} + L_{t+1})/4$; O_{t+1} = daily opening price after the event day; and C_t = closing price on the event day.

Previous studies use the difference between the closing price on the event day and the opening/closing price one day after. The use of opening/closing price seemingly has the advantage of providing traders with a fixed trading signal to execute any trading strategy. However, futures prices are extremely noisy in the opening and closing minute.[14] Daily high/low occurs more often in the opening and closing minute than in any other time of the trading session.[15] Investors may execute trades at the opening or

[12]The results are not very different if event days are selected by the one standard deviation criterion.

[13]French, Leftwich, and Uhrig (1989) show that prices for several agricultural commodity futures contracts stabilize in two days after U.S. Department of Agriculture (USDA) announcements of crops forecasts.

[14]See, e.g., Jordan, Seale, Dinehart, and Kenyon (1988) and Lauterbach and Monroe (1989).

[15]Though not reported here, the percentage that daily high/low occurs in the opening and closing minutes is as high as 40% for some contracts. This is consistent with the findings that intraday volume and volatility exhibit a U-shaped pattern in both the stock and futures markets (Lockwood and Linn, 1990).

closing minute and earn more trading profits than otherwise only if the prices (either daily high or daily low) are in their favor. Those who choose to execute trades automatically either at the opening or the closing minutes clearly have to bear the risk that they sell at the daily low or buy at the daily high. This risk can be reduced by not fixing trading at the opening or closing minute. Consequently, daily average prices are better bench prices to measure overreaction and trading profits.[16]

Price Limits and Price Resolution

A trade that is executed at a limit price is called a limit move. If the closing price is at a limit price, that day is called a locked limit day. This section investigates the effect of price limits on price resolution. Specifically, the question of how prices behave after they hit a limit price is examined.[17] Two issues need to be addressed. The first is whether or not, one day after a locked limit day, prices move in the same direction as the one on the locked limit day. If the direction is reversed on the next day, then price limits may have a positive effect as suggested by the advocates.[18]

If price limits are effective in preventing overreaction, there should be many price reversals after limit prices are hit. Therefore, such an effect can be tested through interday returns between the locked limit day and the day after. A positive interday return indicates that subsequent prices one day after move in the same direction as those on the locked limit day. For this purpose, one needs to sample those locked limit days and the next trading days, after which the method represented in eq. (2) can be applied directly to test the effectiveness of price limits in preventing overreaction.

The second issue is the degree of damages on market liquidity done by the price limits rule. It is trivial that price limits impose liquidity costs on traders who want immediate execution, because the price limit rule simply prevents them from doing so. The more interesting issue, relevant to the public policy debate on the appropriateness of limit levels, is how much damage the price limits rule does to market liquidity. The market eventually clears if a limit move does not lead to a locked limit day. There-

[16]Nevertheless, for purpose of comparison, the trading profits are also measured according to different methods used in previous studies.

[17]The issue of how price would behave near the limit prices is embedded in the "absorbing barrier" hypothesis, which states that price limits act as "magnet fields" and pull prices toward the limit prices as prices approach them (Fama, 1988; Chance, 1994).

[18]Futures prices have to reverse themselves or stay the same after reaching their daily high/low. It is not clear if the price reversal after a limit move can be regarded as evidence of overreaction (see Ma et al., 1989, 1991; Kuserk, 1990).

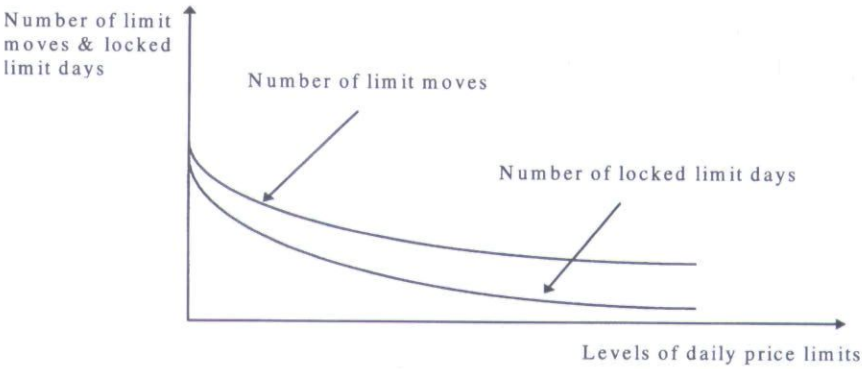

FIGURE 2
The number of limit moves and locked limit days, and limit levels.

fore, a large number of limit moves themselves may not automatically be viewed alone as evidence that market liquidity is severely squeezed by the price limits rule. It is the number of locked limit days that hurts because traders really have a prolonged liquidity problem in these cases.

If limit levels are set too narrowly and price limits prevent the equilibrium price from being reached in the market, there will be a large number of both limit moves and locked limit days. On the other hand, as is shown in Figure 2, the number of both limit moves and locked limit days decreases as the limit levels increase. Since not every limit move leads to a locked limit day, the number of locked limit days is always smaller than that of limit moves (excluding subsequent limit moves).

Advocates acknowledge the potential damage on market liquidity caused by narrow price limits, but argue that the price limits rule can prevent overreaction while not hurting market liquidity too much. Given such a conjecture, a descriptive analysis can be conducted to gauge the effectiveness and appropriateness of a particular limit level in this regard.[19] That is, one can check the ratio of number of locked limit days over that of limit moves. Arguably, the larger the distance is between the two lines in Figure 2, the lower the ratio is, and the more effective the limit level seems to be.

$$Ratio = \frac{Number\ of\ locked\ limit\ days}{Number\ of\ limit\ moves}$$

[19]Ackert and Hunter (1994) develop and test a model of price limits by assuming that exchanges minimize the total costs, i.e., costs of maintaining a continuous trading and costs of limit moves. They find actual limit levels equal to the theoretical ones implied by their model for seven of ten contracts studied. Compared to their model, this descriptive analysis has the advantage of being simple and intuitive.

With the ratios across contracts and over time, one can test whether or not futures exchanges adopt a policy of setting price limit levels that results in consistent ratios across contracts and over time, as they did in setting margin requirements.[20] That is, price limit levels are set such that the probability that a limit move leads to a locked limit day is roughly the same across the contracts and over different time periods. From this perspective, a comparison of the ratios both between contracts and over time for the same contract can also provide insights on whether limit levels need to be realigned.

DATA AND EMPIRICAL RESULTS

Data

Daily prices for 19 futures contracts are obtained from the Futures Industry Institute (FII). The time span of data used in this study varies for contracts due to (i) the original trading date and (ii) the availability of information about the price limits. Summary information for these contracts is provided in Table I. For each commodity, three types of contracts are traded simultaneously on many trading days. They are (i) expiring contracts, (ii) nearby contracts defined as the nearest to expiration other than the expiring contracts, and (iii) more distant contracts. Because trading on those nearby contracts is more active, prices from the nearby contracts are collected and used in this study. Daily closing prices are not available and thus replaced by settlement prices since the two are the same on most days.

Each trading day is classified as a bullish/bearish day according to the rule specified earlier. After deleting those days affected by weekends and holidays, the mean and standard deviation of price changes are then calculated for each sample.[21] Only those days with a price swing that is larger than the mean by two standard deviations are selected. Note that only consecutive trading days are compiled. Therefore, the well-known weekend effect will not influence the empirical results. Summary information is presented in Table II. As shown in Table II, the number of big bullish days is roughly the same as that of big bearish days, suggesting that there is a symmetry between significant bullish and bearish events in nature.

[20]See Figlewski (1984), Gay, Hunter, and Kolb (1986), Estrella (1988), and Fenn and Kupiec (1993).
[21]To account for the changes in price limit levels, subsamples are created and the same procedure outlined is carried out to identify the event date. Otherwise, more weight would be given to a period in which a higher limit level is imposed, which will result in larger price changes in absolute terms.

TABLE I

Contract Summary Information

Category	*Commodity*	*Exchanges*	*Period*	*Number of Observations*	*Daily Price Limit*
Financial	Treasury bill	CME	1/76–3/94	3372	Varies
	Treasury bond	CME	9/77–3/94	3049	Always
Foreign exchanges	British pound	CME	2/85–3/94	3665	Varies
	Deutsche mark	CME	2/85–3/94	2972	Varies
	Japanese yen	CME	2/85–3/94	2972	Varies
	Swiss franc	CME	2/85–3.94	2975	Varies
Grains and oilseeds	Corn	CBT	1/68–3/94	4628	Always
	Soybeans	CBT	1/73–3/94	3730	Always
	Soybean meal	CBT	1/75–3/94	3477	Always
	Soybean oil	CBT	1/70–3/94	4346	Always
	Wheat	CBT	12/68–3/94	4644	Always
Index	Municipal bond	CBT	6/85–3/94	1622	Always
	S&P 500	CME	4/82–3/94	2204	Varies
Livestock	Feeder cattle	CME	3/77–3/94	3130	Always
	Live cattle	CME	2/78–3/94	3304	Always
Metals	Copper	COMEX	1/76–12/89	2541	Varies
	Gold	COMEX	1/80–3/94	2590	Varies
	Silver	COMEX	1/80–3/94	2531	Varies
Fiber	Cotton	NTCE	10/72–3/94	3842	Always

Notes: CME = Chicago Mercantile Exchange; CBT = Chicago Board of Trade; COMEX = Commodity Exchange; and NTCE = New York Cotton Exchange.

Empirical Results

Overreaction Hypothesis

Empirical results are depicted in Table III. Depending on how overreaction is measured, different conclusions are reached. When price reversal is measured by the difference between the closing price on the event day and the daily average price one day after, evidence of overreaction is found only in the gold, live cattle, and soybean meal futures markets. As can be seen in the "Measure 1" column in Table IIIA, it seems that traders in the gold futures contract market tend to overreact to significant bullish news. The average size of unit price reversals in the gold market is more than \$3/ounce and is statistically significant. On the other hand, as shown in the "Measure 1" column in Table IIIB, there is a price reversal after big bearish news in the live cattle futures market.

On the other hand, signs of delayed reaction are found in three markets. As shown in the same column in Table IIIA, it seems that traders in the copper futures and Municipal bond index futures contract markets underestimate the impact of significant bullish news. Meanwhile, the

TABLE II

Price Changes on the Day of Big Bullish/Bearish Price Swing

	Bullish News				Bearish News			
Commodity	Number of Observations	Mean of $\|\Delta P\|$	Maximum of $\|\Delta P\|$	Minimum of $\|\Delta P\|$	Number of Observations	Mean of $\|\Delta P\|$	Maximum of $\|\Delta P\|$	Minimum of $\|\Delta P\|$
Treasury bill	70	0.5374	2.3	0.31	72	0.4357	0.680	0.210
Treasury bond	63	1.8710	3	1.4375	67	1.9286	3	1.5625
British pound	87	0.038	0.066	0.03	81	0.042	0.113	0.033
Deutsche mark	59	0.012	0.022	0.008	66	0.012	0.028	0.007
Japanese yen	71	0.0136	0.0268	0.008	62	0.0140	0.047	0.0070
Swiss franc	61	0.0152	0.0275	0.0106	57	0.016	0.0377	0.0095
Corn	119	9.559	15	6.75	129	9.52	15	6.75
Soybeans	92	27.32	39.5	22.75	84	28.23	45	23.5
Soybean meal	91	8.9473	15	7.4	90	8.9311	15	7.3
Soybean oil	124	1.015	1.5	0.94	130	1.002	1.5	0.92
Wheat	117	16.90	20	13.75	95	17.18	28.50	13.75
Municipal bond	29	1.67	3	1.25	30	1.86	3	1.34
S&P 500 index	20	14.68	43.25	5.25	23	17.97	84.25	7.75
Feeder cattle	89	1.454	1.5	1.38	83	1.492	1.5	1.45
Live cattle	78	1.463	1.5	1.40	78	1.477	1.5	1.42
Copper	53	4.51	9	2.9	50	5.09	11.15	3.15
Gold	55	16.81	37.1	7.2	54	20.47	33	8.8
Silver	35	44.71	75	17.5	31	56.86	158	20
Cotton	95	1.976	2	1.91	94	1.983	2	1.91

Notes: $\Delta P = C_{t+1} - C_t$, where C_t = closing price on the event day—the day a big price swing occurs.

TABLE III

Empirical Results of the Overreaction Hypothesis

Category	Commodity	Measure 1 Mean (ΔP)	Measure 1 t-Statistic	Measure 2 Mean (ΔP)	Measure 2 t-Statistic	Measure 3 Mean (ΔP)	Measure 3 t-Statistic
		A. Bullish News					
Financial	Treasury bill	0.0411	1.9[a]	0.0431	1.9[a]	0.038	1.2
	Treasury bond	0.060	1.0	0.014	0.2	0.071	0.8
Foreign exchanges	British pound	−0.00023	−0.19	0.00087	0.77	−0.00095	−0.62
	Deutsche mark	0.0002	0.44	−0.00024	−0.57	−0.00062	1.05
	Japanese yen	0.00052	1.0	0.00025	0.5	0.0010	1.6
	Swiss franc	0.00002	0.02	−0.00005	−0.1	−0.00008	−0.1
Grain and oilseeds	Corn	−0.5853	−1.7[a]	0.2585	0.8	−1.4906	−3.2[c]
	Soybeans	−0.5122	−0.5	0.1902	0.2	−0.8723	−0.6
	Soybean meal	−0.4168	−1.4	0.0264	0.1	−0.6868	−1.5
	Soybean oil	−0.040	−1.1	0.0174	0.5	−0.0885	−1.5
	Wheat	0.169	0.275	1.22	2.36[b]	−0.698	−0.749
Index	Municipal bond	0.28	2.34[b]	0.31	2.63[b]	0.199	1.4
	S&P 500 index	0.4669	0.2	−1.650	−0.5	2.62	1.1
Livestock	Feeder cattle	0.0774	1.4	0.1208	2.5[b]	0.0812	1.0
	Live cattle	0.0238	0.5	0.047	1.3	−0.003	−0.04
Metals	Copper	0.7431	2.3[b]	0.7217	2.4[b]	0.6972	1.6
	Gold	−3.1759	−3.1[c]	−6.5686	−2.8[c]	−4.0455	−2.8[c]
	Silver	−4.9271	−1.3	−6.57	−1.8[a]	−3.5457	−0.8
Fiber	Cotton	−0.0528	−0.7	−0.041	−0.6	−0.096	−0.8
		B. Bearish News					
Financial	Treasury bill	−0.0237	−1.1	−0.0036	−0.2	−0.034	−1.0
	Treasury bond	−0.0144	−0.2	−0.0854	−1.3	0.0914	0.9
Foreign exchanges	British pound	−0.0044	−2.8[c]	−0.0037	−2.3[b]	−0.0043	−2.4[b]
	Deutsche mark	−0.000066	−0.16	0.000035	0.1	−0.00003	−0.1
	Japanese yen	0.00034	0.6	0.0004	0.7	0.00015	0.3
	Swiss franc	0.00056	0.8	0.0004	0.7	0.0005	0.5
Grain	Corn	0.0625	0.2	−0.092	−0.4	0.3924	0.8
	Soybeans	1.5380	1.4	1.2470	1.5	2.1786	1.3
	Soybean meal	0.2300	0.7	−0.0256	−0.1	0.6678	1.2
	Soybean oil	−0.0012	−0.04	0.0066	−0.3	−0.019	−0.4
	Wheat	−0.0237	−0.02	−0.8026	−1.3	0.5947	0.5
Index	Municipal bond	−0.04	−0.2	−0.07	−0.4	−0.05	−0.2
	S&P 500 index	0.6967	0.7	2.4109	1.9[a]	−0.2065	−0.2
Livestock	Feeder cattle	−0.0692	−1.1	0.0154	0.4	−0.1280	−1.3
	Live cattle	0.124	2.1[b]	0.071	1.4	0.195	2.1[b]
Metals	Copper	0.2335	0.8	0.059	0.2	0.388	1.1
	Gold	0.4301	0.1	−0.2764	−0.4	0.6639	0.6
	Silver	2.09	0.7	0.90	0.3	2.87	0.7
Fiber	Cotton	0.084	1.1	0.091	1.31	0.098	0.9

Notes:

Measure I: $\Delta P = ((H_{t+1} + L_{t+1} + O_{t+1} + C_{t+1})/4) - C_t$
Measure 2: $\Delta P = (O_{t+1} - C_t)$
Measure 3: $\Delta P = (C_{t+1} - C_t)$
H_0: mean $(\Delta P) = 0$, i.e., traders do not overreact
H_1: not H_0

[a]Significant at the 0.10 level in a two-tailed test.
[b]Significant at the 0.05 level in a two-tailed test.
[c]Significant at the 0.01 level in a two-tailed test.

results in the same column in Table IIIB show that traders in the British pound futures market underestimate the impact of significant bearish news. Other than these five markets, the direction of the overall price movements one day after a big price swing is, in general, unpredictable.

However, if price reversal is measured by the difference between the closing prices on the event day and the opening prices one day after, there is more evidence for delayed reaction than overreaction. As shown in the "Measure 2" column in Table IIIA, sign of overreaction is still shown in the gold futures market but not in the live cattle futures market. On the other hand, the results in the "Measure 2" column in Table IIIA suggest that traders in wheat, Municipal bond index, and copper futures markets underestimate the impact of significant bullish news. Note traders in the British pound futures market still remain slow in digesting significant bearish news, as shown in the same column in Table IIIB. Overall, evidence suggests that traders seem to underreact to big bullish news more than to big bearish news. This is in contrast to the findings in Gay et al. (1994). They found that traders seemingly underreact to big bearish news more than to big bullish news.[22]

When price reversal is measured by the difference between the closing price on the event day and the closing price one day after, a slightly different conclusion is reached. As shown in the "Measure 3" column in Table IIIA, B, in addition to the gold and live cattle futures markets, the corn futures market also shows signs of overreaction. However, using this measurement, one finds no evidence of delayed reaction in copper and Municipal bond index futures markets, though traders in the British pound futures market remain to be more likely to underestimate the impact of significant bearish news.

As discussed previously, overreaction should be measured by the difference between the closing price on the event day and the average price one day after. The empirical results based on this measurement suggest that only the gold and live cattle futures markets show signs of overreaction. On the other hand, three markets, namely the Municipal bond index, copper, and British pound futures markets, show signs of delayed reaction. Under the assumption of a binomial distribution, the probabilities of finding one and two cases of overreaction, due to pure chance, in 38 trials at 5% significance level would be 0.37 and 0.18, respectively. As a result, one cannot reject in a two-tailed test the null hypothesis that three cases of overreaction may be caused by pure chance.[23] Therefore,

[22]This phenomenon shows that the use of the difference between opening price and closing price to test the overreaction hypothesis will result in a bias of a lower probability of rejecting the null hypothesis.

[23]Martin J. Bailey and an anonymous referee pointed this out.

TABLE IV

Subsequent Price Movement after a Locked Limit Day

		Locked Limit Up			*Locked Limit Down*		
Category	*Commodity*	*Number of Days*	*Mean (ΔP)*	*t-Statistic*	*Number of days*	*Mean (ΔP)*	*t-Statistic*
Financial	Treasury bill	12	0.1369	2.4[b]	14	−0.1313	−2.4[b]
	Treasury bond	13	0.529	2.3[b]	14	−0.1245	−0.6
Grain	Corn	83	3.0528	5.2[c]	67	−3.35	−4.9[c]
	Soybeans	96	6.005	4.8[c]	125	−7.314	−5.8[c]
	Soybean meal	68	3.5882	4.9[c]	69	−3.8627	−5.2[c]
	Soybean oil	139	0.332	7.9[c]	128	−0.335	−8.3[c]
	Wheat	47	0.844	0.6	41	−3.54	−2.5[b]
Index	Municipal bond	2	1.02	1.4	4	0.15	0.3
Livestock	Feeder cattle	87	0.3056	5.1[c]	103	−0.3369	−5.9[c]
	Live cattle	56	0.284	3.9[c]	91	−0.179	−3.2[c]
Metals	Copper	6	2.16	2.5[a]	9	−1.047	−1.1
	Gold	14	10.57	2.3[b]	18	−7.38	−2.5[b]
	Silver	28	14.52	1.7[a]	46	−23.75	−5.7[c]
Fiber	Cotton	116	0.4841	5.6[c]	126	−0.579	−7.4[c]

Notes:

$\Delta P = ((H_{t+1} + L_{t+1} + O_{t+1} + C_{t+1})/4) - C_t$
H_0: mean $(\Delta P) = 0$
H_1: not H_0

[a]Significant at the 0.10 level in a two-tailed test.
[b]Significant at the 0.05 level in a two-tailed test.
[c]Significant at the 0.01 level in a two-tailed test.

these results, overall, lead one to conclude that there is no sufficient evidence for the overreaction hypothesis.

Subsequent Price Movement after a Locked Limit Day

As discussed above, interday returns are used to test hypothesis 2 that price limits can cause the market to reverse its momentum. This hypothesis is rejected at conventional significance levels as shown in Table IV. There is little evidence that price reverses itself one day after a locked limit day. In contrast, price tends to stabilize after locked in the limit prices in only a few cases, i.e., the cases of locked limit up in the silver and wheat futures markets and locked limit down in the Treasury bond market. For the rest of the cases, prices on the very next day after a locked limit day move in the same direction as those of the previous day. Such a finding is not surprising since it is more likely that price limits prevent

TABLE V

Limit Moves and Locked Limit Days

Category	*Commodity*	*Number of Limit Moves at Limit 1/Limit 2*	*Number of Locked Limit Days at Limit 1/Limit 2*	*Ratios*
Financial	Treasury bill	46/0	26/0	0.57/NA
	Treasury bond	46/4	32/1	0.70/0.25
Foreign exchanges	British pound	0/NA	0	NA
	Deutsche mark	0/NA	0	NA
	Japanese yen	0/NA	0	NA
	Swiss franc	0/NA	0	NA
Grain	Corn	272/4	171/1	0.63/0.25
	Soybeans	217/163	156/108	0.72/0.66
	Soybean meal	259[a]	161	0.62
	Soybean oil	527[a]	330	0.63
	Wheat	148[a]	88	0.60
Index	Municipal bond	5/4	4/2	0.8/0.5
	S&P 500 index	1	1	1
Livestock	Feeder cattle	329[a]	190	0.58
	Live cattle	263[a]	181	0.69
Metals	Copper	36/0	22/0	0.61/NA
	Gold	59/0	37/0	0.63/NA
	Silver	147/0	89/0	0.61/NA
Fiber	Cotton	433[a]	288	0.67

Notes: Limit 1 = first limit level and limit 2 = second limit level. NA = not applicable.
[a]No change in the limit levels during the sample period.

the markets from clearing on those locked limit days. Also, as the markets reopen, prices are moving in the same direction to exhaust the previously contained impact of news. Clearly, price limits impose a liquidity cost on traders on those locked limit days since anxious traders cannot get out of or into a position. These results, in general, undermine the argument that price limits help cool down the market and prevent overreaction.

Limit Moves and Locked Limit Days

The relationship between limit moves and locked limit days is shown in Table V. The higher the ratio, i.e., the number of limit moves over that of locked limit days, the more likely a limit move would lead to a locked limit day. As discussed previously, this ratio can be regarded as an indicator of the effectiveness of price limits in preventing price from overswinging without hurting market liquidity too much. The results confirm the worry by many traders that the market, in general, becomes very illiquid after a limit move for the rest of the day as evidenced by the higher ratios.[24]

The ratio of the number of locked limit days over that of limit moves varies across contracts. At current limit levels, the corn and Treasury bond futures contracts have the lowest ratio of 0.25, whereas the cotton futures contract has the highest ratio of 0.67. For livestock, grain, and oilseeds, the ratio is generally above 0.6. On the other hand, the ratio between the number of locked limit days and that of limit moves varies over different limit levels for the same contracts. Limit levels have been increased for some contracts in the past. Such an increase generally results in a drop in both the number of locked limit days and that of limit moves. Also, such an increase reduces that ratio.

If limit levels are set to maintain an equal probability that a limit move leads to a locked limit day across the contracts, then price limit levels need to be increased for the corn, wheat, feeder cattle, live cattle, cotton, and all soybean products futures contracts. On the other hand, advocates of the price limits rule may argue that the current limit levels for the copper, gold, and silver futures contracts are too high and should be reduced because no limit move has been observed during the past three years in all those markets. By contrast, those traders concerned with liquidity costs (inability to trade) would probably prefer that all limits either be removed or be set like those in copper, gold, and silver, so that no "limit moves" are observed.

Profitability of Trading Rules

Evidence in Table IIIA,B suggests, statistically, that there exists a strong correlation between the closing prices on a day associated with big price movements and the opening prices one day after. Naturally, one may ask if a trading rule designed to exploit these price anomalies can be economically profitable. Transaction costs of trading on futures are much less than those on equity for two reasons. First, margin requirements are substantially lower in futures trading than in equity markets. More importantly, futures traders are allowed to post interest-bearing securities as margin, but equity traders cannot. Second, the leverage in futures trading is much higher than that in equity trading because of the higher value of the futures contracts. A commodity or stock index futures con-

[24]With daily data, the number of trades around the limit prices is not observable. However, it is generally known that few trades are made at the limit prices. Therefore, such a bias in this descriptive analysis may not be severe enough to alter the conclusion.

TABLE VI

Trading Rules Profitability

Commodity	*Trading Rule*	*Number of Days*	*Average Raw Profits*	*Average Net Profits*
British pound	When big bearish news occurs, short a contract at the closing price and buy one at the opening price the day after	81	$275	$244
Corn	When big bullish news occurs, short a contract at the closing price and buy it at the closing price the day after	119	$75	$44
Wheat	When big bullish news occurs, long a contract at the closing price and sell it at the opening price the day after	117	$61	$30
Municipal bond	When big bullish news occurs, long a contract at the closing price and sell it at the opening price the day after	29	$310	$279
Feeder cattle	When big bullish news occurs, long a contract at the closing price and sell it at the opening price the day after	89	$53	$22
Live cattle	When big bearish news occurs, buy a contract at the closing price and sell it at the opening price the day after	78	$50	$19
Copper	When big bullish news occurs, long a contract at the closing price and sell it at the opening price the day after	53	$180	$149
Gold	When big bullish news occurs, short a contract at the closing price and buy one at the closing price the day after	55	$657	$626

Notes: Transaction costs = clearing fee + commission fee, where clearing fee = $1 and commission fee = $30. All profits are not adjusted for risk.

tract gives its holder or seller a leverage that can only be matched by holding or selling hundreds of shares/units of the underlying securities.

The clearing fee and the retail round-trip commissions are the two most important components of the transaction costs in futures trading (Chance, 1989). The clearing fee and the retail round-trip commissions are estimated to be $1 and $30, respectively (Chance, 1989; Gay et al., 1994). As shown in Table VI, net profits of various trading rules designed to exploit the price anomalies appear to be economically significant. For example, using a big upswing in price as the buying signal, a trader can earn a risk-unadjusted average profit of $657 by buying a gold futures contract at the closing price and selling it at the opening price on next trading day. For trading purposes, one may want to ask the question of whether it is riskier to hold a position overnight. To address this concern, one could compare the standard deviation of daytime returns with that

TABLE VII

Overnight Return Volatility and Daytime Return Volatility

	All Samples		*Targeted Days*	
Commodity	*Overnight Return Volatility*	*Daytime Return Volatility*	*Overnight Return Volatility*	*Daytime Return Volatility*
British pound	0.0076	0.0088	0.0147	0.01821
Corn	1.9093	2.7070	3.5740	4.4374
Wheat	3.0439	4.6743	6.5975	7.1221
Municipal bond	0.2906	0.4518	0.6263	0.6531
Feeder cattle	0.3497	0.5867	0.4631	0.6390
Live cattle	0.3060	0.5684	0.4614	0.6594
Gold	3.9328	4.7786	7.0504	8.4611
Copper	0.8604	1.2780	2.2364	2.3559

Notes: Overnight return = ln (O_{t+1}/C_t) and daytime return = ln (C_t/O_t).

of overnight returns. A lower standard deviation of overnight returns would indict that it is not as risky to hold a position overnight as commonly perceived.

In the eight targeted markets when a strategy of holding a position overnight and reversing it at the opening next day is applied, the volatility of overnight returns, in general, is much lower than that of daytime returns as shown in Table VII. Such a comparison suggests that the trading rules discussed above generate profits without taking more risk. Nevertheless, until a better measurement of risk is found to incorporate expected returns into this kind of analysis, it is an open question whether or not these profits are truly risk-adjusted and these trading rules are economically sensible.

CONCLUSIONS

This article investigates the overreaction hypothesis and the effect of price limits on price resolution. In contrast to the findings in previous studies, using the difference between the closing price and the next day's opening price as a proxy of overreaction, little evidence is found to support the overreaction hypothesis. The direction of price movements on the very next day after a big price swing is generally unpredictable in most of the contract markets studied. Clearly, the overreaction hypothesis, as perceived by many, cannot be a sound rationale for the price limits rule in futures markets. The results confirm that individuals and the market as a whole do not make mistakes systematically. The results provide evidence that the market is relatively efficient in processing information, in general. Nevertheless, the results here do not rule out the occasional occurrence of overreaction. Traders do overreact sometimes. Talented traders may be able to detect such a price anomaly and to profit from such a superior skill.

It is also found that price one day after a locked limit day tends to move in the same direction as that on the locked limit day. This provides evidence that price limits merely delay the price discovery process and impose on market participants a liquidity cost. In addition, evidence is found that price limit levels for the periods examined are too narrow in corn, wheat, feeder cattle, live cattle, cotton, and soybean products futures contract markets. The ratio between locked limit days and limit moves is very high in these markets. It is in these markets that the price discovery process is severely hindered by the lower price limit levels. An increase in the limit levels in these futures contract markets could reduce the number of locked limit days and allow the market to clear.

For some futures contract markets, there is a strong positive correlation between the opening prices and the previous closing prices even after controlling for the well-known weekend effect. Trading rules designed to exploit such a correlation prove to be profitable in these markets. A crude comparison of the daily and overnight return volatility shows that these trading rules seem to generate profits without taking more risk. Nevertheless, it is not yet clear how to assess the risk of these trading rules and to adjust trading profits accordingly.

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