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Holiday Trading in Futures Markets

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ABSTRACT

In this paper, we find significantly higher preholiday returns in futures contracts compared to nonholiday returns. The findings are consistent with the inventory adjustment hypothesis, since higher preholiday returns associated with lower trading volume are most pronounced for exchange-closed holidays. There is evidence of positive postholiday returns associated with higher trading volume for exchange-open holidays. This is consistent with positive holiday sentiments. The holiday effect is uniquely independent: The magnitude of excess holiday returns is the largest among all seasonal variations.

IN RECENT YEARS, A growing body of literature suggests the presence of abnormal returns for exchange holidays in the equity markets. In particular, Ariel (1990) and Lakonishok and Smidt (1988) find that stock market returns for the days prior to holidays are significantly higher than returns for other days. Pettengill (1989) shows that while preholiday and other days' returns differ significantly, preholiday returns vary by holiday, firm size, and day of the week on which the holiday falls.[1] Various theories have been proposed to explain the type of return-generating process surrounding holidays. Since holidays are often considered another form of market closing, similar to weekends, it seems reasonable that an explanation for one might help explain the other.[2] For example, if the weekend effect could be explained by settlement procedures, then this argument is relevant because holidays can delay settlement for up to two days and could have an effect on returns up to a week prior to the holiday. Accordingly, Lakonishok and Levi (1982) postulate that Friday and perhaps Tuesday holidays would generate high Thursday and Monday returns. The holiday effect has also been considered a result of the inventory adjustment process. Since the loss potential of a short position is more than that of a long position, traders may be reluctant to take short positions prior to a nontrading period. This would suggest a lesser selling

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[1] Postholiday findings are mixed French (1980) and Lakonishok and Smidt (1988) find no significant difference in postholiday and other day returns while Pettengill (1980) does.

[2] Lakonishok and Smidt (1988) note that preholiday returns are generally two to five times greater than pre-weekend returns, so another factor other than market closing seems to be present.

pressure prior to a holiday, leading to a positive preholiday return and a lower trading volume. Alternatively, Deldin, Levin, and Irwin (1986) show psychological and physiological differences in subjects that vary by day of the week, and good moods may be responsible for higher Friday returns. Thus, it could be a logical extension that holidays may produce similar favorable results.

The purpose of this paper is to test the holiday effect in the futures markets. While testing of the holiday effect in instruments other than equities will suggest the robustness of such return irregularities, it also allows us to test various hypotheses in markets with different institutional structures. As futures trades are settled on the same day and the settlement is marked to the market, the delayed settlement procedure hypothesis becomes irrelevant in explaining futures prices seasonality. Similarly, because daily settlement prices in future markets (determined by the Pit Committee) are usually at the midpoint of the closing (opening) ranges, any measurement error related to transaction type should be minimal. Furthermore, Penman (1987) argues that daily seasonality in the stock market may reflect similar seasonality in the release of corporate information. This argument is also less relevant in futures markets because most futures prices are affected by macroeconomic news, which tends to be released by public agencies on a scheduled basis; announcement timing is not usually altered because of the nature of the news. The timing of other relevant informational factors, such as weather for agricultural commodities or Mideast political stability to oil futures, cannot be as easily altered as corporate news. The irrelevance of these hypotheses for the futures markets actually makes such markets a good control sample for testing seasonal effects. If a seasonal return regularity exists in futures markets, this implies that, at a minimum, the holiday effect cannot be fully explained by these hypotheses. The empirical evidence from futures markets may help identify a more limited set of reasonable and comprehensive rationales.

The remainder of the paper is organized as follows: Section I describes the sample. Section II presents the regression model and results, and Section III discusses and summarizes the findings.

I. Sample Screening Procedures

There are institutional differences between the futures market and the stock market. A methodology designed to test for the holiday effect in futures prices must take into consideration these differences. Even what appears to be the simplest decision in developing a methodology, the selection of the relevant holidays, is complicated by the nature of futures trading. This arises because some futures contracts are traded internationally, or globally over a 24-hour span. Consequently, the holiday effect is only meaningful if the "holiday" applies to the country or region. Moreover, the selection of certain holidays is influenced by the particular hypothesis described in the previous

section that is to be tested. For example, testing the market-closing hypothesis and seasonal proxy hypothesis requires the inclusion of both holidays with and without trading. As the calendar time hypothesis suggests that holiday returns vary with the day of the week, holidays that fall on different weekdays, as well as over the weekend, should be included in the sample. In designing a test for favorable holiday psychology, returns for major holidays and minor holidays can be compared. Therefore, without being biased to any particular hypothesis, we seek to include typical holidays of all kinds. The 20 holidays investigated in this study are listed in Table I. Since return regularities can be a result of the passage of trading time or calendar time, holidays selected are classified both by whether the exchange is open or closed and by the day of the week of the holiday. Of the 20 holidays, the market is closed for nine and open for the rest. With a predominant portion, 45 percent (or 16 percent), of the exchange-closed (or open) holidays on Monday, our methodology separates the holiday effect from the well-known weekend effect. Since a holiday psychology possibly contributes to the unusual return, some minor holidays are also included to permit contrasting competitive hypotheses.[3]

Since the contract has zero value at the close of the trade, the "return" is defined as the first difference of the price series of the adjacent trading day. Measuring returns using price changes may be heteroskedastic over the life of a typical contract approaching maturity, or whenever price volatility changes dramatically. Furthermore, due to the thin trading of distant contracts, daily price changes are often positively serially correlated. To mitigate these potential statistical problems, the raw return is measured by the logarithm of successive price relatives. We further eliminated a daily observation when any one of the following occurs: (1) there is no trading volume for the day, (2) the observation falls in the last trading week, (3) the observation is too far distant from maturity (longer than one year), and (4) an observation lies outside three standard deviations of the return distribution.[4] For each future contract in our study, we collected daily open and closed (settlement) prices and trading volume.[5] Twenty-eight futures contracts are investigated in this study.[6] More than half of the sample consists of futures contracts where trading is largely in the United States, while 12 out of the 28 are more actively traded in world markets. In general, there are less exchange-closed

[3]Some minor holidays are included since the exclusion of any special group of holidays appears to preempt the acceptance of some of the hypotheses.

[4]Most of the sample screening procedure was suggested by the referee.

[5]We use daily settlement prices to avoid the bias often generated by using closing transaction prices. Prior studies (Porter (1992), Harris (1980)) have shown measurement errors if the transaction types of the closing prices used in computing returns also follow some regularities. However, the bid-asked spread bias, while significant, has been demonstrated in most studies to be insufficient to explain the seasonalities. Further, the Pit Committee meets at the end of the day to decide the settlement price for each contract. The settlement price is widely considered a market-based price despite the fact that it is determined by a committee. There is evidence of market discipline on the determination of the settlement price. Whenever the price is set out of line, significant public pressure is created from general market participants.

[6]The detailed sample descriptions are available upon request from the authors.

Table I

Holiday Descriptions

This table indicates the holidays used in this study and provides frequency distributions of those holidays by the day of the week.

Panel A: Distribution of Exchange-closed Holidays by Day of the Week (1969 to 1989)

Exchange-closed Holiday	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.	Total
New Years Day	5	3	3	4	6	—	—	21
Presidents Day	20	—	—	—	1	—	—	21
Good Friday	—	—	—	—	21	—	—	21
Memorial Day	19	—	—	—	2	—	—	21
Fourth of July	6	3	3	2	7	—	—	21
Labor Day	21	—	—	—	—	—	—	21
Election Day	—	3	—	—	—	—	—	3
Thanksgiving Day	—	—	—	21	—	—	—	21
Christmas Day	6	3	2	4	6	—	—	21
Total	77	12	8	31	43	—	—	171

Panel B: Distribution of Exchange-open Holidays by Day of the Week (1969 to 1989)

Exchange-open Holiday	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.	Total
Groundhog Day	4	3	3	3	2	3	3	21
M.L. King's Birthday	1	1	1	1	—	—	—	4
Valentine's Day	3	3	2	3	3	4	3	21
St. Patrick's Day	4	3	3	3	3	3	2	21
Mother's Day	—	—	—	—	—	—	21	21
Flag Day	3	3	3	3	2	4	3	21
Father's Day	—	—	—	—	—	—	21	21
Columbus Day	11	2	2	2	1	1	2	21
Halloween	3	3	3	2	4	3	3	21
Election Day	—	2	—	—	—	—	—	2
Veterans Day	2	4	3	3	—	3	3	21
Total	31	24	20	20	18	21	61	195

Panel C: Distribution of Holidays by Day of the Week (1969 to 1989)

Day	Observations	% of All Holidays	% Exchange Closed	% Exchange Open
Monday	108	29.5	45.0	15.9
Tuesday	36	9.8	7.0	12.3
Wednesday	28	7.7	4.7	10.3
Thursday	51	13.9	18.1	10.3
Friday	61	16.7	25.2	9.2
Saturday	21	5.7	—	10.8
Sunday	61	16.7	—	31.2
Total	366	100%	100%	100%

holidays. As most of the "major" holidays are associated with the closing of the exchanges, there is the possibility that the holiday effect may be an artifact of the general market closing.

A. Exchange-closed Holidays

To examine the holiday effects in futures returns, we compute and compare the mean preholiday return, the mean postholiday return, and the mean nonholiday return. The preholiday return is the difference between the close-to-close prices for the calendar days prior to the holiday. The postholiday return is a two-day return which is the difference between the closing price of the calendar day prior to the holiday and that of the day immediately following the holiday. The nonholiday return is the return over a one-day period, excluding days surrounding holidays.[7] In Panel A of Table II, we report the preholiday and postholiday mean raw returns and provide comparisons between the holiday returns and the nonholiday returns for both exchange-open and exchange-closed holidays. Since the distribution of expected futures returns could be nonnormal, we performed both the standard t (ratio) tests as well as the nonparametric Kruskal-Wallis tests, to test for the differences. We first report the comparison of the 16 futures contracts that are traded predominantly in the U.S. markets.[8] Based on the chi-square statistics from the Kruskal-Wallis tests, all 16 contracts exhibit significantly higher pre-exchange-closed-holiday, close-to-close returns than nonholiday, close-to-close returns, at the 5 percent level.[9] On average, the preholiday return ranges from 12 times higher than the nonholiday return for the copper futures contract to 170 times for Treasury bill contracts.[10]

While all 16 futures contracts exhibit higher close-to-close preholiday returns, 15 demonstrate higher trading time (open-to-close) returns, and, more interestingly, 14 also have higher nontrading time (close-to-open) returns. The distinction between trading and nontrading returns provides insight as to whether the higher return is associated only with trading in the market, or is a result of valuation regardless of trading. The fact that the nontrading return is also higher than usual may suggest the need of higher nontrading returns to induce traders to hold inventories over nontrading periods. Since the higher preholiday return goes beyond the impact of demand and supply of market trading, it implies that there is a valuation component in the higher return that does not depend on whether the trading takes place prior to holidays. The fact that the higher return is not driven by "price pressure" from the demand and supply of trading would imply some evidence of favorable holiday psychology. The postholiday return is less significant, how-

[7] The "close" and "open" prices refer to the settlement prices rather than the actual transaction prices.

[8] In so-called U. S.–traded contracts, the factor that determine the demand and supply or the pricing of the commodity are dominated by U. S. participants.

[9] The parametric t tests give the same conclusions.

[10] The one-day, exchange-open holiday return is also available upon request.

Table II

Comparisons of Mean Pre- and Postholiday Returns by Exchange-closed Holidays and Exchange-open Holidays

For each contract, the first line represents the mean percentage return for one day. The second line shows the chi-square statistics for the comparisons between the preholiday returns (postholiday returns) and the nonholiday returns, assuming unequal variances. The three returns represent the trading return (Op–Cl), nontrading return (Cl–Op), and the total return (Cl–Cl). The mean nonholiday returns can be obtained from the authors. The domestically traded contracts are those in which pricing is mainly determined by U.S. domestic factors. The sample period starts from the inception of each contract to the end of 1990. Most commodity contracts start from 1965 and financial futures from mid-1970.

Panel A: Domestically Traded Contracts

	Pre–Exchange-closed Holiday			Post–Exchange-closed Holiday			Pre–Exchange-open Holiday			Post–Exchange-open Holiday		
Commodity	Cl–Cl	Cl–Op	Op–Cl	Cl–Cl	Cl–Op	Op–Cl	Cl–Cl	Cl–Op	Op–Cl	Cl–Cl	Cl–Op	Op–Cl
Corn	0.155**	0.078**	0.077**	0.104**	0.095**	0.009	−.072	−.151	0.079	0.004	−.011	0.015
	(40.99)	(34.61)	(13.86)	(8.75)	(9.99)	(1.46)	(−1.59)	(−1.07)	(3.51)	(0.88)	(−0.60)	(0.33)
Soybeans	0.171**	−0.011*	0.182**	0.045	0.059	−0.014	−0.046	−0.095	0.049	0.063**	0.029	0.034
	(52.41)	(−9.21)	(40.17)	(0.97)	(1.12)	(−0.19)	(−0.15)	(−2.57)	(1.21)	(6.81)	(0.42)	(4.34)
Soybean oil	232**	0.144*	0.088**	−0.038	0.1330	−0.171	0.004	0.111	−.107	−0.048	0.092	−0.140*
	(12.77)	(17.72)	(7.45)	(−0.85)	(0.15)	(−1.92)	(0.80)	(2.37)	(−0.30)	(−0.94)	(0.82)	(−2.51)
Soymeal	0.265**	0.111**	0.154**	0.136**	0.111**	0.025*	−0.070	−0.112*	0.042	0.084	0.04	0.041**
	(63.84)	(28.26)	(45.12)	(8.61)	(8.21)	(6.27)	(−0.12)	(−8.40)	(3.09)	(14.62)	(0.44)	(7.05)
Oats	0.315**	0.262**	0.053*	0.004	0.073	−0.069	0.153	0.149*	0.004	0.148*	0.133	0.035
	(10.02)	(8.40)	(5.40)	(0.52)	(0.21)	(−0.51)	(2.68)	(9.86)	(0.02)	(2.04)	(1.75)	(0.49)
Wheat	0.275**	0.153**	0.122**	0.143*	0.136**	0.007	−0.051	−0.087**	0.036	0.133	0.070	0.063
	(42.40)	(46.23)	(11.31)	(5.00)	(13.81)	(0.18)	(−0.98)	(−7.83)	(0.69)	(1.13)	(0.96)	(1.13)
Live cattle	0.191**	0.060**	0.131**	0.028	0.121**	−0.093	−0.091	−0.085	−0.006	−0.021	−0.057	0.036
	(48.88)	(14.74)	(34.07)	(0.91)	(38.63)	(−3.27)	(−0.55)	(−1.52)	(−0.20)	(−0.35)	(−1.11)	(2.25)
Feeder cattle	0.216**	0.029**	0.187**	0.076	0.080**	−0.004	0.022	0.002	0.020	−0.033	−0.031	−0.002
	(33.75)	(7.14)	(29.89)	(2.64)	(13.13)	(−1.69)	(2.67)	(1.18)	(1.76)	(−1.00)	(−0.52)	(−0.75)
Live hogs	0.203**	0.106**	0.097*	0.106	0.156**	−0.051*	0.032	−0.017	0.049	−0.116	−0.108	−0.008
	(22.86)	(18.50)	(4.74)	(1.56)	(11.88)	(−8.71)	(1.28)	(−0.90)	(0.00)	(−1.08)	(−1.10)	(−1.18)
Pork bellies	0.373**	0.298**	0.075**	0.048	0.185**	−0.137*	−0.218	−0.114	−0.104	0.123	0.008	0.115*
	(39.72)	(56.59)	(8.66)	(1.26)	(14.98)	(−5.80)	(−3.12)	(−0.41)	(−3.34)	(2.35)	(0.87)	(5.97)
Orange juice	0.176**	0.077**	0.099	−0.271**	−0.187**	−0.084**	0.096	−0.003	0.099	−0.018	−0.111	0.093
	(11.22)	(12.96)	(0.03)	(−33.22)	(−28.76)	(−21.12)	(0.08)	(−0.06)	(0.76)	(−0.58)	(−1.05)	(0.50)
Lumber	0.204**	0.074*	0.130**	−0.005	0.084	−0.089	0.159**	0.112	0.047*	0.291**	0.108	0.183**
	(32.64)	(4.31)	(31.13)	(−0.86)	(2.14)	(−0.01)	(12.24)	(10.98)	(5.80)	(37.04)	(1.05)	(25.81)
Silver	0.257**	0.181*	0.076**	−0.031	−0.023	−0.008	−0.386**	−0.146	−0.240**	−0.067	−0.122**	0.055
	(30.96)	(6.16)	(19.00)	(−0.68)	(−0.22)	(−0.60)	(−8.56)	(−0.00)	(−4.64)	(−0.08)	(−3.52)	(3.54)
Copper	0.249**	0.197*	0.052**	0.173**	0.130	0.043**	0.085	0.191**	−0.106	0.117*	0.124	−0.007
	(4.49)	(2.44)	(4.84)	(3.57)	(1.64)	(3.64)	(0.89)	(9.49)	(−2.42)	(9.85)	(1.51)	(−10.40)
Treasury bills	0.049**	0.006	0.043**	0.000	0.012	−0.012**	0.001	0.002	−0.001	0.028*	0.019**	0.009*
	(80.76)	(0.00)	(111.36)	(1.20)	(0.58)	(−6.66)	(0.03)	(0.00)	(−0.22)	(4.57)	(3.29)	(4.69)
Treasury bonds	0.359**	0.172**	0.187**	0.012	0.069**	−0.058	0.125**	0.084**	0.041**	0.255**	0.173**	0.082**
	(105.42)	(10.50)	(93.71)	(0.78)	(9.83)	(−0.04)	(22.49)	(10.61)	(7.01)	(28.88)	(6.33)	(23.08)

Table II—*Continued*

Panel B: Internationally Traded Contracts

(The twelve futures contracts in this panel are traded on the world exchanges around the clock. The sample period covers the entire trading history of each contract till the end of 1990.)

	Pre-Exchange-closed Holiday			Post-Exchange-closed Holiday			Pre-Exchange-open Holiday			Post-Exchange-open Holiday		
Commodity	Cl-Cl	Cl-Op	Op-Cl	Cl-Cl	Cl-Op	Op-Cl	Cl-Cl	Cl-Op	Op-Cl	Cl-Cl	Cl-Op	Op-Cl
Coffee	−0.090	−0.120	0.030	0.027	0.169**	−0.142**	−0.038	0.005	−0.043*	−0.038	−0.124**	−0.086*
	(−1.13)	(−0.00)	(0.07)	(0.33)	(3.77)	(−6.31)	(−0.64)	(0.00)	(−1.03)	(−0.65)	(−10.12)	(−4.51)
Sugar	0.258**	0.206**	0.052	0.056	0.206**	−0.150	−0.012	0.142	−0.154*	0.194	0.063	0.131*
	(15.89)	(16.36)	(1.09)	(1.73)	(17.47)	(−3.30)	(−0.27)	(3.08)	(−3.95)	(2.52)	(0.01)	(4.04)
Crude oil	−0.191	0.018	−0.209**	−0.385**	−0.099	−0.286**	0.606**	0.231**	0.375**	0.226**	0.307**	−0.081
	(−2.37)	(0.22)	(−11.45)	(−3.39)	(−2.29)	(−2.39)	(36.58)	(22.90)	(20.18)	(21.09)	(49.76)	(−0.44)
Heating oil	−0.009	0.181**	−0.190	−0.810**	−0.464**	−0.346**	0.113	0.007	0.106	0.183	0.174**	0.009
	(−2.38)	(14.46)	(−1.12)	(−6.96)	(−44.67)	(−30.33)	(0.59)	(1.29)	(1.12)	(3.07)	(14.25)	(1.21)
Unleaded gas	0.152	0.265	−0.113	−0.198	−0.151	−0.047	0.662**	0.306	0.356**	0.540**	0.610**	−0.070
	(0.43)	(0.50)	(−1.43)	(−79.16)	(−0.22)	(−2.84)	(37.79)	(13.31)	(15.99)	(14.88)	(33.49)	(−0.00)
British pound	0.106	0.079	0.027	−0.018	−0.072	0.054*	−0.013	0.010	−0.023	−0.021	0.041	−0.062*
	(1.55)	(1.30)	(1.17)	(−0.20)	(−1.69)	(2.36)	(−0.94)	(0.06)	(−0.14)	(−0.28)	(0.98)	(−4.98)
Japanese yen	−0.031	−0.058**	0.027	−0.025	−0.027	0.002	0.223	0.177	0.046**	−0.041	0.018	−0.059
	(−2.71)	(−14.22)	(2.40)	(−0.00)	(−0.27)	(1.11)	(1.74)	(2.65)	(8.36)	(−0.20)	(0.01)	(−2.24)
German mark	−0.005	−0.030*	0.025	−0.015	−0.068	−0.53*	0.180*	0.174**	0.006	−0.044	0.015	−0.059*
	(−0.26)	(−5.00)	(1.65)	(−0.88)	(−0.82)	(5.94)	(10.31)	(15.26)	(2.66)	(−0.00)	(2.44)	(−0.61)
Swiss franc	0.021	−0.011	0.032*	−0.012	−0.030	0.018	0.083	0.088	−0.005	−0.131	−0.076**	−0.055
	(1.87)	(−0.41)	(5.20)	(−0.55)	(−0.25)	(1.68)	(3.63)	(5.92)	(−0.22)	(−1.88)	(−7.77)	(−0.67)
Eurodollar	0.019*	0.012	0.007	−0.016**	0.002*	−0.018*	0.021*	0.017	0.004	0.054**	0.025	0.029**
	(5.19)	(0.13)	(3.50)	(−7.44)	(5.78)	(−4.93)	(4.44)	(0.01)	(1.29)	(33.39)	(1.79)	(41.10)
Gold	0.387**	0.223**	0.164**	0.003	0.085	−0.082	0.011	0.037	−0.026	−0.049	−0.153**	0.104*
	(56.48)	(16.91)	(52.99)	(0.31)	(0.10)	(−1.66)	(0.16)	(2.26)	(−0.01)	(−1.20)	(−29.67)	(6.15)
Platinum	−0.020	−0.120**	0.100*	0.449**	0.274**	0.175**	−0.146	0.098	−0.244*	0.047	−0.082	0.129*
	(−0.01)	(−7.22)	(4.78)	(28.42)	(9.98)	(21.05)	(−1.42)	(0.77)	(−5.16)	(1.07)	(−1.38)	(4.55)

*Significant at the 5 percent level.
**Significant at the 1 percent level.

ever: only 4 out of the 16 futures contracts exhibit a significant positive difference between the postholiday close-to-close return and the nonholiday close-to-close return. This evidence might be considered to support the inventory adjustment argument in that the lack of positive postholiday return is caused mainly by the offset between positive nontrading return and negative trading return. An apparent "reversal" in the trading period immediately after a holiday is consistent with speculators reestablishing short positions.

B. Exchange-open Holidays

Holidays when exchanges are closed may be considered another form of market closing, like weekends. Thus, higher returns prior to holiday closings are similar to higher returns before the weekend and before the end of the day. To examine the holiday effect in the absence of the holiday closings, we compare the preholiday returns for holidays when exchanges are open with the nonholiday returns. In Panel A of Table II, we also report the same comparisons for the 16 futures contracts. Compared to the exchange-closed holidays, the majority of the pre-holiday returns are no different from the regular returns. While only two contracts exhibit significantly higher preholiday returns, six of the 16 futures contracts show higher postholiday returns.

The comparisons between exchange-closed and exchange-open holidays provide additional evidence on the relevance of the inventory adjustments hypothesis and the holiday psychology hypothesis.[11] Given that an inventory adjustment process is not applicable in the case of exchange-open holidays, any unusual pattern in market trading detected around such holidays must be attributable to other factors. The fact that there are also six contracts exhibiting positive postholiday returns suggests the working of some favorable feelings related to holidays. This is all the more significant when the postholiday returns for exchange-open holidays are measured during a holiday period when there is trading.

C. Internationally Traded Futures Contracts

Unlike other calendar time seasonalities, a holiday effect, if there is one, should be area specific. That is, a holiday is relevant only to the country or region where it is celebrated. Assets traded on the world markets around the clock presumably should be less affected by holidays unique to the United States, for example. The numerous international futures contracts in our sample allow us to test the significance of the holiday effect when assets are traded beyond borders or time zones. Extension of the trading hours should mitigate some of the unique trading pattern attributable to the information specific to a certain area. The distinction between international futures contracts and domestic futures contracts gives further insight into the merit

[11] Even for exchange-open holidays, there is some evidence of positive preholiday returns. The somewhat similar findings imply that the market-closing hypothesis cannot fully explain the higher preholiday return.

of various hypotheses. While not preempting other possibilities, for international futures contracts where U.S. trading is not unique, the portion of the higher preholiday return resulting from inventory adjustment should be small, because the inventory risk over a nontrading period is less for international futures contracts. At the same time, the portion of positive pre- and postholiday returns associated with the favorable psychology should be preserved even in the case of internationally traded futures contracts.

To test these assumptions, we conduct the same comparisons as in Panel A of Table II on a sample of 12 futures contracts that are traded actively on the world exchanges.[12] The results are presented in Panel B of Table II. Only three of the 12 contracts exhibit higher preholiday returns when the holiday is associated with the closing of the exchanges; this is in contrast to results for futures contracts traded mainly in the United States. More interestingly, two of the three contracts exhibiting similar holiday effects are the Eurodollar and gold futures contracts, whose prices are closely related to the U.S. economy, suggesting that a resemblance to the holiday effect in the domestic futures contracts should be expected.[13] When the exchange is open, four of the 12 contracts show positive preholiday returns, while three contracts exhibit positive postholiday returns. This pattern is consistent with domestic futures contracts for exchange-open holidays. Some evidence of postholiday higher returns suggests that holiday enthusiasm is also country exchange specific.[14]

D. Trading Volume

Distinguishing among the various hypotheses can be further aided by examining the trading activity around holidays. For the sake of brevity, while the comparisons of the average trading volume are not reported in this article,[15] all 16 futures contracts exhibit significantly lower than usual trading volume in the day prior to the holiday. In contrast, none of the 16 futures contracts show different trading volume around the exchange-open holidays. Interpreting the holiday pattern of futures trading volume is complicated because the trading volume of each contract often follows a predictable pattern over its life, e.g., the trading volume increases when the time to maturity approaches. Furthermore, the data used start from the introduc-

[12] We classify unleaded gas and heating oil as international futures contracts because their prices are highly correlated with crude oil prices.

[13] Positive preholiday returns should not come as a total surprise for gold and Eurodollar futures since both prices are mainly affected by U.S. economic factors (Sherman, 1983). As for sugar, the significantly higher preholiday returns disappear after other seasonalities are taken out.

[14] The holiday psychology is shown by the positive returns even for international contracts.

[15] The results comparing trading volume for individual contracts can be obtained from the authors.

tion of the contract to the most recent period, usually a span of more than 15 years. The structure of trading volume has changed significantly over such a long period. While the bias from the long-term cyclical trend of the market activity may not have a significant and predictable pattern on the trading volume for the few days around a holiday, we seek to eliminate the biases from both the changing time to maturity and the cyclical trend in volume by estimating the following volume equation:

$$\text{Log}(V_{it}) = \alpha + \beta_1 CT_{it} + \beta_2 \text{Log}(T_{it}) + \beta_3 PE(PH) + \beta_4 OE(PO) + e_{it} \quad (1)$$

where V_{it} is the trading volume for the ith contract at time t, CT_{it} is the calendar time from the introduction of the contract, T_{it} is the time to maturity, $PE(PH)$ is the dummy variable for the day preceding an exchange-open (or closed) holiday, and $OE(PO)$ is the dummy variable for the day following the holiday, and e_{it} is the error term. Equation (1) assumes that trading volume contains a trend of exponential increases over the years and a constant change (decrease) of base volume on holidays. Thus, the parameter estimates for β_3 and β_4 measure the differential volume associated with holidays after controlling for the systematic structure in trading volume. Since equation (1) is estimated over the time series of cross-sectional contracts, the residual volume can be heteroskedastic. In Panels A and B of Table III, White's heteroskedastic-consistent estimators of equation (1) for both exchange-open and exchange-closed holidays and for both domestic and international futures contracts are presented. For the sake of brevity, only the parameter estimates for the holiday dummies, β_3 and β_4, are reported. For the domestic futures contracts, 13 of 16 domestic futures contracts exhibit significantly lower (negative) excess trading volume in the day preceding the exchange-closed holidays, while 12 futures contracts show no difference in trading volume for exchange-open holidays. Eight contracts show higher excess volume for the day following the holiday which can be interpreted as trading for the postholiday inventory adjustment.

It appears that changes in trading volume prior to holidays are consistent across the different international futures contracts. For eight out of the 12 contracts, the excess trading volume drops before exchange-closed holidays, while trading is normal when the exchange is open for the holidays. This would suggest that there is a component in asset trading that is uniquely associated with holidays, even though the same asset may still be traded in other locations. Our evidence indicates that traders in the futures markets appear to avoid trading in the periods immediately before holiday closings. Furthermore, the activity of speculators who are less inclined to take short positions, or are more eager to cover a previous short position immediately prior to nontrading periods, may produce a higher preholiday return. The lower trading activity prior to the holidays further suggests that the higher preholiday return is inconsistent with a theory of buying because of a positive holiday psychology. In short, the evidence reported here is more consistent with the prediction of the inventory adjustment hypothesis.

Table III

Estimates of Excess Trading Volume Associated with Exchange-open and Exchange-closed Holidays

$$\text{Log}(V_{it}) = \alpha_1 + \beta_1 CT_{it} = \beta_2 \text{Log}(T_{it}) + \beta_3 PE(PH) + \beta_4 OE(PO) + e_{it}$$

The model specified above tests the significance of factors determining daily volume. V_t is the one-day contract-trading volume, CT is calendar time from the day of the contract introduction, representing trend in contract volume, T is days to maturity, $PE(PH)$ and $OE(PO)$ are dummy variables for pre- and postholiday volume associated with exchange open (or closed) holidays. To save space, we only report the estimates of β_3 and β_4 that measure the incremental volumes uniquely associated with the day prior to and the day following a holiday.

	Domestically Traded Contracts							Internationally Traded Contracts						
	Exchange-open Holidays			Exchange-closed Holidays				Exchange-open Holidays			Exchange-closed Holidays			
Commodity	β_3	β_4	F	β_3	β_4	F	Commodity	β_3	β_4	F	β_3	β_4	F	
Corn	−0.05	−0.07	8560**	−0.17**	0.06	8,568**	Coffee	0.04	0.04	12,536**	−0.10*	−0.14**	12,542**	
	(−0.90)	(−1.28)		(−4.08)	(1.45)			(0.85)	(0.78)		(−02.36)	(−3.25)		
Soybeans	0.08	0.02	9867**	−0.19**	0.12**	9,880**	Sugar	−0.02	0.03	7,081**	−0.15**	0.06	7,087**	
	(1.38)	(0.35)		(−4.40)	(2.82)			(−0.41)	(0.51)		(−3.44)	(1.36)		
Soybean oil	0.04	0.04	17,229**	−0.15**	0.04	17,244**	Crude oil	−0.07	−0.14	7,699**	−0.18*	0.02	7,701**	
	(0.87)	(0.92)		(−4.73)	(1.33)			(−0.86)	(−1.80)		(−2.33)	(0.36)		
Soy meal	0.04	0.06	13,067**	−0.12**	0.07*	13,075**	Heating oil	−0.00	0.07	6,810**	−0.17*	0.02	6,814**	
	(0.79)	(1.34)		(−3.46)	(1.97)			(−0.01)	(0.98)		(−2.63)	(0.29)		
Oats	−0.01	−0.10	3,677*	−0.10*	0.05	3,678**	Unleaded gas	−0.14	−0.01	2,484**	−0.41**	−0.09	2,493**	
	(−0.25)	(−1.61)		(−1.95)	(0.95)			(−1.16)	(−0.07)		(−3.21)	(−0.82)		
Wheat	−0.06	−0.12*	7032**	−0.08*	0.12**	7,034**	British pound	−0.07	0.05	4,387**	−0.26**	0.07	4,392**	
	(−1.04)	(−2.02)		(−1.91)	(2.82)			(−0.66)	(0.52)		(−2.94)	(0.77)		
Live cattle	−0.05	−0.09	16,782**	−0.12**	0.06	16,787**	Japanese yen	−0.00	0.06	5,898**	−0.10	0.13	5,900**	
	(−1.07)	(−1.69)		(−3.10)	(1.59)			(−0.01)	(0.57)		(−1.24)	(1.49)		
Feeder cattle	0.02	0.00	4,972**	−0.13**	0.06	4,976**	German mark	−0.02	−0.03	5,888**	−0.12	0.16	5,892**	
	(0.31)	(0.00)		(−2.57)	(1.22)			(−1.2)	(−9.58)		(−1.39)	(1.84)		
Live hogs	−0.10*	−0.15	24,612**	−0.14**	0.06*	24,616**	Swiss franc	−0.02	−0.05	5,503**	−0.12	0.18*	5,507**	
	(−2.34)	(−3.43)		(−4.21)	(1.93)			(−0.15)	(−0.43)		(−1.38)	(2.17)		
Pork bellies	−0.12	−0.16**	10,345**	−0.25**	−0.01	10,355**	Eurodollar	−0.47**	−0.14	3,980**	−0.23**	−0.00	1,858**	
	(−1.91)	(−2.57)		(−5.32)	(−0.12)			(−5.30)	(−1.86)		(−3.40)	(−0.14)		
Orange juice	0.08	0.18**	4,735**	−0.10*	0.05	4,732**	Gold	−0.08	0.00	4,583**	−0.08	0.23**	1,796**	
	(1.37)	(3.46)		(−2.31)	(1.35)			(−1.08)	(0.01)		(−1.31)	(4.28)		
Lumber	−0.07	−0.08	11,204**	−0.16**	−0.05	4,732**	Platinum	0.14	0.05	4,042**	−0.19**	0.11*	4,048**	
	(−1.24)	(−1.52)		(−3.92)	(−1.31)			(1.60)	(0.67)		(−3.17)	(2.05)		
Silver	0.04	−0.00	5,671**	−0.02	0.29**	5,684**								
	(0.58)	(−0.03)		(−0.45)	(5.79)									
Copper	0.09	0.09	6,898**	−0.11*	0.13**	6,902**								
	(1.37)	(1.45)		(−2.46)	(2.87)									
Treasury bills	−.30**	−0.19*	5,639**	−0.06	0.13*	5,631**								
	(−3.49)	(−2.24)		(−0.84)	(1.96)									
Treasury bonds	−0.33**	−0.27**	5,706**	0.05	0.28**	5,702**								
	(−3.82)	(−3.01)		(0.68)	(3.99)									

*Significant at the 5 percent level.
**Significant at the 1 percent level.

II. Testing Independent Holiday Effects

The evidence from the previous section suggests a return and trading regularity associated with holidays. Holiday return regularities are less interesting if induced by other known return regularities in the series. For example, the predictability in the holiday returns can be caused by a similar pattern in the expected component of the return.[16] To examine if the excess return also follows the same seasonality, a pricing model is required. While it is difficult to identify a universal model for all the futures contracts investigated, following Black (1976), we estimate the unexpected return for all futures contracts based on a variation of the capital asset pricing model

$$UR_{it} = R_{it} - E(R_{it})$$
$$\text{and} \quad E(R_{it}) = \alpha + \beta_{it} R_{mt} \tag{2}$$

where R_{it} is the raw return for the ith contract on day t and R_{mt} is the S & P 500 market index return. Since zero-capital futures contracts should not earn the risk-free rate of the expected return, α and β_{it} are the estimates from the market model. For each futures contract, the parameter β_{it} at time t is estimated by using the same model with the daily time series in the preceding three months relative to the time point t. Therefore, daily observations in the first three months of each contract are not used. Furthermore, due to the nonsynchronicity and heteroskadasticity in both futures and market returns, beta is estimated using the Dimson procedure. Therefore, UR_{it} in equation (2) is the excess (unexpected) return for the ith futures contract on day t.[17]

The holiday return regularity may reflect several other calendar time regularities documented by Pettengill (1989), since calendar turning points are not independent of each other.[18] More importantly, while holidays often fall on certain weekdays by design (see Panel C of Table I), the identification of other calendar time points in the testing go beyond the need to control for other confounding seasonalities. The calendar time hypothesis predicts that the preholiday return should be no different from other one-day nonholiday returns, and the postholiday return should be higher because it consists of a

[16] Current findings carry additional significance. Most expected returns in futures markets have a long-term component reflecting some annual cycle and a short-term component that may be determined by the cost of carry. The long-term cycle is too long to have any systematic impact on the several days around holidays. As the cost of carry component would lead to expected declines in prices as time passes, this would imply a larger decline in returns over a multiday period, and the preholiday return should have been significantly negative, or lower than the regular returns.

[17] To show the significance of using the market model, the beta estimated ranges from −0.79 to 0.51 for corn, from −1.01 to 1.30 for soybeans, from −0.47 to 0.60 for silver, from −0.18 to 0.23 for crude oil, from −0.17 to 0.27 for the Swiss franc, from −0.11 to 0.19 for Treasury bonds, etc.

[18] Because the frequency that the first trading day of the month is Friday is three times that of other weekdays, the turn-of-the-month return may be a manifestation of the daily effect. It is also possible that the January effect may be a significant example of the turn-of-the-month effect.

two-day time period. The findings in Panel A of Table II of a higher preholiday and a less-significant postholiday return are inconsistent with the calendar time hypothesis. On the other hand, if it is the day-of-the-week effect observed, the implication is that the postholiday return on Tuesday should be negative because it also covers the negative Monday return (Pettengill (1989)). In contrast, the postholiday return on Friday should be positive because it includes one positive Friday return. Furthermore, a two-day, postholiday return measured over the holiday and the day after should be no different from any other two-day nonholiday return on the same weekday.

To test these implications, we also compute the mean one-day, preholiday return and the mean two-day, postholiday return for different weekdays. The preholiday and postholiday returns are also compared with other nonholiday returns of the same weekday. While not reported here (results may be obtained from the authors), the evidence shows that both pre- and postholiday returns are significantly different from the regular returns on each weekday. Specifically, most postholiday returns are still too high on Monday and Friday, and too low on Tuesday, Wednesday, and Thursday, compared with the regular (nonholiday) return for the respective weekday. Note the fact that significant differences exist between two-day, postholiday returns and regular returns, suggesting that the abnormal returns associated with holidays cannot be explained by a simple time diffusion process. One more implication from such evidence suggests that it is necessary to explicitly deal with the daily effect or other seasonalities when testing for the holiday effect. Summarizing the previous discussion, the holiday effect is estimated by the following model:

$$UR_{it} = \alpha_1 + \beta_1 D2 + \beta_2 D3 + \beta_3 D4 + \beta_4 D5 + \beta_5 JJ + \beta_6 PH + \beta_7 PO + \beta_8 MD1 + \beta_9 MD2 + e_t \quad (3)$$

where UR_{it} is the excess return for the ith contract at time t; $D2$ through $D5$ are dummy variables for non-Monday weekdays; JJ is the January dummy variable (1 for daily return in January, and 0 for other months); PH and PO are preholiday and postholiday dummy variables, PO (PH) equals 1 if the return is for the day following (prior to) holidays; $MD1$ is the dummy variable for days in the last trading day of the previous month and the first four days of the month; and $MD2$ is the dummy variable for the sixth to the last to second to last trading day of the month.[19] Separation of the daily effect from the holiday effect is accomplished with multiple dummy variables. Therefore, the estimates of the holiday effects, β_6 and β_7, are independent of the confounding daily effect. As there are greater frequencies of holidays on Monday and Friday, the significance of independent holidays would also imply the inadequacy of the market-closing hypothesis to explain both the daily effect and the holiday effect. $MD1$ and $MD2$ measure the turn-of-the-

[19] The test results are not sensitive to other reasonable classifications of the month ends and beginnings.

month effect—as a result of portfolio window-dressing behavior, which generates a lower than average and a higher than average return at the end and the beginning of a month (Ariel (1987)). *JJ* represents the turn-of-the-year effect, i.e., the January return is higher than the average return for the rest of the year, which is commonly attributed to tax loss selling behavior. In short, if there are independent and individual seasonalities as hypothesized, these estimates should be statistically significant for the noted direction of the sign: $\alpha_1 < 0$, $\beta_4 > 0$, $\beta_5 > 0$, $\beta_6 > 0$, $\beta_8 > 0$, and $\beta_9 < 0$. Note that the estimate of α_1 measures the mean return for a Monday and the middle of the month, and such a day is not preceding or following a holiday. The estimates of β_1 through β_5 and β_8 through β_9 measure the incremental return associated with each seasonal.

The estimates of each parameter call for the recognition of another statistical complication associated with futures returns. As mentioned in the previous section, futures returns are often heteroskedastic due to changing time to maturity and dependence of successive observations.[20] For the first-order serial correlation in residuals from equation (3), the *DW* and the first-order autocorrelation are reported in Table IV. All of them exhibit reasonably insignificant levels. However, for the heteroskedasticity in the weighted excess returns, we further conduct a diagnostic White test (1980).[21] All White test statistics are still significant at the 1 percent level, indicating the existence of heteroscedasticity in the weighted excess return series. Therefore, Panel A of Table IV presents the heteroskedastic-consistent estimates of the equation for each of the 16 futures contracts for the exchange-closed holidays. We estimate equation (3) using both the raw returns and the excess returns as dependent variables. While both the signs and the significance levels of the parameter estimates are almost identical for two cases, for the sake of simplicity, we only report the results for the excess return regressions. Although there is no uniform evidence for all types of the documented seasonalities, most of the significant ones are consistent with the general predictions. More importantly, the general findings suggest a strong and independent holiday effect. The estimates of the coefficient β_6 indicate that all 16 futures contracts exhibit a significant preholiday (positive) effect. This is generally consistent with our holiday findings from the raw return data. It is also interesting to note that eight of 16 even exhibit significant positive excess postholiday returns. That is, there is some evidence that the generally positive returns surrounding holidays would imply some favorable holiday sentiments beyond simple mechanical inventory adjustments.

[20] To correct for the inconsistent parameter estimates for equation (3) associated with these problems, we first divide the sample into three equal subsamples with short, medium, and long time to maturity. The Goldfeld-Quandt tests indicate that the return variances are heteroskedastic with respect to time to maturity. Equation (3) is then estimated over the entire sample by the weighted least squares method.

[21] While *DW* and first-order autocorrelations for the residual returns are all insignificant, we still adjust for the higher-order dependence using the estimated asymptotic covariance matrix of the estimates assuming heteroscedasticity.

While not reported here, the estimates for exchange-open holidays using excess return measures show almost no different patterns from those for exchange-open holidays using raw return measures. Panel B of Table IV also reports the same estimates for the international futures contracts. Except for Eurodollar and gold futures contracts, the other 10 contracts do not show unusual preholiday returns. This is particularly interesting for sugar where the preholiday raw return was higher (see Panel A of Table II). In sum, the holiday effect is both robust and more pronounced than other types of calendar time seasonalities in terms of magnitude, strongly suggesting that the seasonal regularities identified in the literature are independently and individually evident. From the magnitude of the estimated coefficients, the holiday effect is in general the strongest of all other seasonals.

III. Discussion and Summary

In the futures market, there is a significantly higher return for the day prior to a holiday. Since the positive holiday effect is associated more with the domestic exchange-closed holidays, this would imply that the return effect may be related to the inventory adjustment process associated with market closings. It appears that investors are more reluctant to take positions, especially short positions, immediately before holidays. Also predicted by the same argument, we find evidence for lower volume in the day preceding the holiday and for higher volume in the days following holidays, as traders rebalance their portfolios.

Since there is still some evidence of a much less uniformly higher preholiday return for exchange-open holidays and for internationally traded futures contracts, the holiday effect may be more than just a result of market closing. It is obvious that the inventory adjustment hypothesis is less relevant in both cases. The evidence of a higher trading volume around exchange-open holidays, accompanied by some cases of higher returns for holidays, suggests the possibility that there may be a generally favorable mood around holidays. While the holiday effect is indeed weaker for world-traded futures contracts, the trading volume around exchange-open holidays nevertheless is still lower. As the lower trading volume for exchange-closed holidays indicates the component in the holiday effect consistent with the inventory adjustment process, the higher trading volume for exchange-open holidays may suggest the existence of favorable holiday moods, neither of which is area specific. Although the unusual holiday returns are more associated with individual holidays, the significance varies with the weekday of each holiday. Both the calendar time and trading time hypotheses are rejected because holiday returns are too low for holidays on Tuesday, Wednesday, and Thursday, and too high for holidays on Monday and Friday. In summary, our results give evidence of a holiday effect in futures markets. While the abnormal return is not fully explained by any of the popular hypotheses, the evidence suggests that there are several components in the holiday effect. The impact from the

Table IV

Joint Test of the Calendar Time Regularities for Exchange-closed Holidays

$$UR_t = \alpha_1 + \beta_1 D_2 + \beta_2 D_3 + \beta_3 D_4 + \beta_4 D_5 + \beta_5 JJ$$
$$= \beta_6 PH = \beta_7 OH + \beta_8 MD1 + \beta_9 MD2 + e_t$$

The model specified above tests the significance of each documented calendar time point seasonality on the excess returns. UR_t is the daily excess futures return for day t. JJ is the dummy variable for days in January, measuring the impact of the January effect; D_2 to D_5 are dummy variables for Tuesday through Friday, controlling for the daily effect; PH and OH are dummy variables for the pre- and postholiday one-day periods, measuring the holiday effect; and $MD1$ and $MD2$ are dummy variables for days at the beginning and end of the month, which measure the monthly effect.

Commodity	α_1	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9	F	R^2	White Test	DW	ρ
Panel A: Domestically Traded Contracts															
Corn	−0.012	0.011	0.065*	−0.041	−0.055	0.001	0.151*	0.092	−0.196*	0.034	10.41*	0.003	493.48*	1.96	0.022
	(−0.47)	(0.34)	(2.06)	(−1.21)	(−1.80)	(0.04)	(4.13)	(1.68)	(−7.72)	(1.39)					
Soybeans	−0.103**	0.102**	0.230**	0.121**	0.160**	−0.006	0.164*	0.085	−0.212*	−0.004	14.37**	0.004	611.66*	1.95	0.025
	(−3.90)	(3.29)	(7.08)	(3.58)	(4.91)	(−0.20)	(2.11)	(1.48)	(−8.39)	(−0.50)					
Soybean oil	−0.074*	0.022	0.197**	0.087*	0.169**	0.075*	0.193**	−0.002	−0.205**	0.026	11.85**	0.003	1722.92**	1.95	0.023
	(−2.56)	(0.60)	(5.10)	(2.37)	(4.73)	(2.04)	(3.54)	(−0.04)	(−6.95)	(0.89)					
Soymeal	−0.086**	0.053	0.208*	0.137*	0.174**	−0.021	0.215**	0.195**	−0.254**	−0.015	15.85**	0.004	379.58**	1.96	0.018
	(−3.15)	(1.56)	(6.08)	(3.78)	(5.10)	(−0.65)	(4.52)	(3.25)	(−8.22)	(−0.53)					
Oats	−0.185**	0.159**	0.291**	0.176**	0.218**	−0.023	0.258*	0.034	−0.221*	0.115**	11.38**	0.007	302.63**	1.95	0.028
	(−4.60)	(3.40)	(5.79)	(3.61)	(4.70)	(−0.54)	(2.52)	(0.40)	(−5.84)	(3.17)					
Wheat	−0.037	0.034	0.159**	−0.019	0.075	−0.079	0.289**	0.189**	−.219**	0.028	12.64**	0.005	468.70**	2.00	−0.001
	(−1.16)	(0.81)	(4.01)	(−0.48)	(1.94)	(−1.76)	(7.09)	(3.03)	(−7.38)	(0.76)					
Live cattle	−0.029	−0.072**	0.062**	0.049*	0.054*	0.098**	0.187**	0.067	−0.104**	0.015	11.35**	0.004	346.64**	1.98	0.010
	(−1.54)	(−2.82)	(2.65)	(2.04)	(2.19)	(3.67)	(4.68)	(1.79)	(−5.02)	(0.075)*					
Feeder cattle	−0.074**	−0.027	0.077**	0.086**	0.114**	0.143**	0.206**	0.114*	−0.035	0.004	8.86**	0.005	425.44**	1.97	0.017
	(−2.95)	(−0.90)	(2.68)	(3.00)	(3.68)	(6.01)	(4.91)	(2.28)	(−1.66)	(0.16)					
Live hogs	0.022	−0.077**	0.031	0.019	−0.091**	0.166**	0.234*	0.086	−0.119**	0.067**	10.81**	0.003	470.19**	1.95	0.027
	(.99)	(−2.76)	(1.05)	(0.62)	(−3.25)	(4.32)	(5.13)	(1.90)	(−4.88)	(2.97)					
Pork bellies	−0.053	−0.139**	0.046	0.083	−0.068	0.039	0.386**	0.117	−0.047	0.161**	9.20**	0.003	396.49**	1.91	0.046
	(−1.43)	(−2.88)	(1.02)	(1.79)	(−1.50)	(0.90)	(3.67)	(1.59)	(−1.40)	(3.73)					
Orange juice	−0.042	0.051	−0.001	−0.024	0.071*	0.200**	0.123**	−0.370**	0.044	0.117**	10.12**	0.004	412.52**	1.91	0.044
	(−1.60)	(1.52)	(−0.02)	(−0.66)	(2.12)	(3.77)	(2.80)	(−6.29)	(0.54)	(4.44)					
Lumber	−0.113**	−0.126**	0.105**	0.323**	0.149**	0.112*	0.153**	0.111	−0.140**	0.011	16.41**	0.007	646.54**	1.95	0.025
	(−3.71)	(−3.21)	(2.58)	(8.26)	(3.14)	(2.47)	(2.62)	(1.61)	(−4.53)	(0.33)					
Silver	−0.114**	0.084	0.259**	0.136**	0.177**	0.119*	0.206*	0.067	−3.18**	−0.80*	11.79*	0.003	376.70**	1.91	0.046
	(−2.61)	(1.56)	(5.25)	(2.65)	(3.24)	(2.51)	(2.24)	(0.85)	(−7.44)	(−1.96)					
Copper	−0.226**	0.229**	0.343**	0.270**	0.259**	0.123**	0.255**	0.224**	−0.074*	−0.067	14.67**	0.003	211.53**	1.95	0.027
	(−6.92)	(5.49)	(8.56)	(6.73)	(6.39)	(3.04)	(4.23)	(1.98)	(−1.71)	(−1.12)					
Treasury bills	−0.031**	0.021**	0.010**	0.008	0.013*	−0.007	0.055**	−0.005	−0.005	−0.000	27.54*	0.012	323.65**	1.90	0.049
	(−8.56)	(4.53)	(2.44)	(1.59)	(2.68)	(−1.46)	(6.50)	(−0.55)	(−1.54)	(−0.08)					
Treasury bonds	−0.105**	0.169**	0.032	0.093**	0.145**	−0.023	0.381*	0.008	−0.064**	−0.002	24.64**	0.009	448.13**	1.98	0.021
	(−6.78)	(8.13)	(1.71)	(4.82)	(6.38)	(−1.29)	(5.90)	(.019)	(−3.76)	(−0.11)					

Table IV—*Continued*

Commodity	α_1	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9	F	R^2	White Test	DW	ρ
Panel B: Internationally Traded Contracts															
Coffee	−0.032*	0.018	0.049**	0.094**	0.052**	−0.072**	−0.022**	0.000	−0.031*	−0.044*	6.57**	0.001	776.08*	2.00	−0.001
	(−2.31)	(1.01)	(2.72)	(5.26)	(2.85)	(−3.95)	(−2.78)	(0.00)	(−2.14)	(−2.80)					
Sugar	−0.165**	−2.40**	0.093	0.270**	0.447**	0.162*	0.098	0.207	0.039	−0.049	12.12**	0.004	401.70**	1.99	0.006
	(−2.88)	(−3.16)	(1.33)	(3.81)	(6.00)	(2.23)	(1.15)	(1.88)	(0.74)	(−0.71)					
Crude oil	−0.135**	0.071	0.235**	0.232**	0.142*	−0.123*	−0.199**	−0.304*	−0.120**	−0.050	7.43*	0.005	287.42**	1.99	0.006
	(−2.78)	(1.16)	(4.05)	(3.92)	(2.32)	(−2.24)	(−2.65)	(−2.36)	(−3.14)	(−0.99)					
Heating oil	−0.124**	0.128**	0.223**	0.192**	0.133**	−0.269**	−0.031	−0.766**	−0.117**	−0.059	17.32**	0.012	213.71**	1.94	0.029
	(−3.22)	(2.63)	(4.66)	(4.05)	(2.83)	(−5.09)	(−0.39)	(−7.79)	(−3.60)	(−1.35)					
Unleaded gas	−0.164*	0.201*	0.384*	0.346**	0.250**	−0.103	0.052	0.009	−0.020	−0.153*	3.65**	0.005	230.50**	1.93	0.034
	(−2.26)	(2.26)	(4.17)	(4.10)	(2.94)	(−1.31)	(0.27)	(0.05)	(−0.31)	(−2.03)					
British pound	−0.021	0.033	0.058	0.033	−0.009	−0.063*	0.115	−0.003	.044	−0.075	3.51**	0.002	87.36**	2.00	0.001
	(−0.75)	(1.04)	(2.00)	(1.04)	(−0.29)	(−2.11)	(1.60)	(−0.07)	(2.10)	(−3.62)					
Japanese yen	0.037	−0.024	0.020	−0.046	−0.078**	−0.075	−0.024	−0.056	−0.058*	0.003	2.98**	0.004	98.13**	2.01	−0.003
	(1.60)	(−0.83)	(0.67)	(−1.57)	(−2.71)	(−1.88)	(−0.45)	(−1.02)	(−2.34)	(0.14)					
German mark	−0.047*	0.022	0.116**	0.035	0.036	−0.128*	−0.004	0.024	−0.012	−0.067**	7.33**	0.006	131.27**	2.02	−0.008
	(−2.29)	(0.88)	(4.67)	(1.38)	(1.35)	(−5.00)	(−0.13)	(0.49)	(−0.57)	(−3.15)					
Swiss franc	−0.048*	0.043	0.109**	0.039	0.035	−0.120**	0.022	−0.005	−0.036	−0.056*	4.68**	0.004	118.70**	2.00	−0.001
	(−2.26)	(1.58)	(4.07)	(1.37)	(1.19)	(−3.44)	(0.48)	(−0.09)	(−1.52)	(−2.30)					
Eurodollar	−0.017**	0.013**	−0.007	−0.005	−0.002	−0.008*	0.014**	−0.030**	0.002	0.014**	14.93**	0.010	287.45**	1.94	0.029
	(−4.97)	(2.64)	(−1.52)	(−1.22)	(−0.41)	(−2.41)	(2.58)	(−3.80)	(0.48)	(3.91)					
Gold	−0.130**	0.177**	0.216**	0.055	0.115**	0.012	0.409**	0.035	−0.155**	−0.025	13.29**	0.004	436.14**	1.99	0.004
	(−4.63)	(4.72)	(5.74)	(1.61)	(3.20)	(0.30)	(7.37)	(0.52)	(−5.71)	(−0.73)					
Platinum	−0.242*	0.312**	0.283**	0.137	0.243**	0.040	−0.067	0.452**	−0.017	0.076	3.80**	0.003	211.41**	1.91	0.044
	(−4.00)	(3.88)	(3.77)	(1.77)	(3.06)	(0.56)	(−0.55)	(4.07)	(−0.26)	(1.14)					

*Significant at the 5 percent level.
**Significant at the 1 percent level.

inventory adjustment process dominates around holidays when markets are closed, and the favorable holiday moods when markets are open.

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