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Day-of-the-Week Effects in Financial Futures: An Analysis of GNMA, T-Bond, T-Note, and T-Bill Contracts

Elizabeth Tashijan Johnston, William A. Kracaw, and John J. McConnell*

Abstract

This paper provides a comprehensive study of weekly seasonal effects in GNMA, T-bond, T-note, and T-bill futures returns. Two distinct patterns are found in returns on GNMA, T-bond, and T-note contracts, while no seasonals are noted for T-bill futures. A negative Monday seasonal—similar to the well-known Monday effect in stock returns—is found for GNMA and T-bond contracts. A positive Tuesday seasonal is found on GNMA, T-bond, and T-note contracts. Our evidence indicates that the significance of weekly seasonals depends in an important way on the time period studied. The negative Monday phenomenon occurs only in the data before 1982, while the positive Tuesday effect is present only after 1984. In addition, we find that both seasonal phenomena occur only during months prior to a delivery month. This effect appears to be related to the calendar month. More specifically, the Monday effect is apparently concentrated during February, while the Tuesday effect is concentrated during May.

I. Introduction

A substantial volume of research recently establishes the existence of weekly seasonals in asset returns. Most of this work has been concerned with the pattern in stock market data that has come to be known as the day-of-the-week effect. Detailed studies have been carried out by French (1980), Gibbons and Hess (1981), Lakonishok and Levi (1982), and Keim and Stambaugh (1984), which show that, on average, stock returns are negative on Monday and lower on Monday than on other days of the week. Subsequently, Rogalski (1984) reports evidence that suggests that the negative returns on Monday occur between Friday's close and Monday's open and, therefore, should more properly be called a "weekend" effect in stock returns. Weekend phenomena also have been documented in foreign stock returns by Jaffee and Westerfield (1985). Using intraday stock returns, Smirlock and Starks (1986) show that, over time, the seasonal

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associated with Monday "moves" from trading hours on Monday to nontrading hours during the weekend. Also, Harris (1986) demonstrates that the weekend effect documented by Rogalski is related to firm size. Finally, Connolly (1989) provides evidence that casts doubt on the existence of any weekend effect in stock returns during the post-1975 period.

In addition to the extensive research into the weekly seasonal in stock returns, there is a smaller, growing literature that investigates seasonal patterns in other financial markets. For example, Gibbons and Hess (1981) report that returns on an index of T-bills with constant maturity are lower on Monday than on other days of the week. Flannery and Protopapadakis (1988) document, from 1977 to 1984, a Monday seasonal in a variety of U.S. Treasury securities that is more negative for securities with longer maturities. Significant day-of-the-week effects also are documented in the federal funds market by Cornell (1983) and Eisemann and Timme (1984) and in markets for foreign exchange by McFarland, Pettit, and Sung (1982). Additionally, there are other studies that investigate the daily patterns in returns on financial futures contracts. Chiang and Tapley (1983) find weekly seasonals—including a Monday effect—in daily returns on a variety of futures contracts. Two other papers, one by Cornell (1985) and a subsequent correction by Dyl and Maberly (1986), find that returns on the S&P 500 stock index future exhibit a closed-market weekend effect similar to that previously found in stock (cash) returns. More recently, Gay and Kim (1987) find a negative Monday seasonal in the Commodity Research Bureau (CRB) futures price index. In addition, Chang and Kim (1988) find evidence of a negative Monday in both the Dow Jones Commodity Price cash *and* futures indices. For both of these latter studies, however, all indications of a Monday effect had disappeared in the futures data by 1982.

The purpose of this paper is to further the investigation of seasonal effects in financial futures markets. In the analysis that follows, daily returns on GNMA, Treasury bond, Treasury note, and Treasury bill futures are examined from the time contracts began trading in each market through December 1988. The study clarifies and expands upon previous research documenting seasonal patterns in returns on GNMA and T-bond contracts and provides, to the best of our knowledge, the first analysis of returns on T-note and T-bill futures. The data used in this study are more extensive and complete than in other studies of financial futures contracts. This enables us to provide a more thorough investigation of observed seasonal patterns in futures returns than has been documented previously. In particular, because our data include daily opening and closing prices, we distinguish between seasonal effects that occur during trading hours and those that occur while the market is closed. Also, our data cover a longer time period than has been used in previous studies of futures returns. This enables us to examine, as has been done previously for stock returns, the persistence and stability of observed seasonal effects over time. Finally, the size of the sample used here allows us to examine rigorously the effect of contract maturity on seasonal phenomena, without introducing contemporaneous correlation in returns—a problem encountered in previous research on futures contracts.

Our analysis identifies two significant seasonal patterns in the data. First, for GNMA and T-bond contracts, average returns on Mondays are found to be negative and statistically different from zero. This pattern is similar to the Monday effect evidenced in studies of stock returns and returns on stock index futures. Additionally, the negative Monday return observed for T-bond futures closely parallels that found by Flannery and Protopapadakis (1988) in the cash market for "long-term" Treasuries. As with stock market returns, the negative Monday seasonal in GNMA and T-bond contracts is associated with the weekend and not with holidays or other market closings. At the same time, however, we find that this pattern occurs only in the earlier returns in the data—the period before January 1980. Moreover, we find that the Monday phenomena are confined in two other important ways. First, the effect occurs during trading hours on Monday, as opposed to over the weekend for stocks and stock index futures. Second, the effect occurs only in contracts traded during months immediately prior to a delivery month, and is more pronounced in returns during February.

The other significant pattern we observe is a positive Tuesday effect on GNMA, T-bond, and T-note contracts. For these contracts, average returns on Tuesday are positive and significantly different from zero. In contrast to the Monday effect, the Tuesday phenomenon is confined to the more recent returns in the sample—occurring after December 1984. In addition, the Tuesday effect also appears during nontrading hours and only on contracts traded prior to a delivery month. In this case, the effect is more pronounced in returns during May.

Finally, we find no significant seasonal patterns in returns on T-bill contracts. Average returns on T-bill contracts are not significantly different from zero for any of the samples tested. This contrasts with the finding of Gibbons and Hess (1981) of a Monday effect in the cash market for T-bills. Another implication is that, over all of the contracts studied, significant seasonal patterns are found only for those traded over the Chicago Board of Trade (GNMA, T-bond, and T-note contracts) and not those traded over the International Money Market of the Chicago Mercantile Exchange (T-bill contracts).

The remainder of the paper is organized as follows. Section II provides a description of the data employed. Section III contains the main body of our empirical analysis and the results. The major findings of our analysis are discussed and concluding remarks are made in Section IV.

II. Data

The data consist of daily observations of the opening and closing prices for futures contracts on GNMAs, U.S. Treasury bonds, U.S. Treasury notes, and U.S. Treasury bills.[1] Each of these contracts matures during one of four months in the delivery cycle: March, June, September, or December. Because the contracts have been traded for different periods of time, the sample periods and number of contracts vary as shown on p. 26.

The GNMA futures contract used in this study is the GNMA CDR, which was the most actively traded among GNMA futures contracts. In the fall of 1985, the daily volume on the GNMA CDR futures contract fell to the point where com-

[1] The data were provided by Dunn and Hargitt, Inc., and consist of daily high, low, open, and settlement prices. By using the highest volume contracts in most of the subsequent tests, it is reasonable to interpret the settlement price as the actual closing price.

Futures Contract	Sample Period	Number of Contracts
GNMA	Oct. 1975–Aug. 1985	40
T-Bond	Aug. 1977–Dec. 1988	45
T-Note	May 1982–Dec. 1988	27
T-Bill	Jan. 1976–Dec. 1988	52

plete daily price quotations were no longer given in the financial press. Consequently, we terminate the sample in August 1985. Prices for GNMA, T-bonds, and T-note contracts involve transactions on the Chicago Board of Trade (CBT). Prices on T-bill futures reflect trades on the International Money Market (IMM) of the Chicago Mercantile Exchange.

Unless otherwise noted, samples are constructed using the nearby contract (nearest to delivery) except during a delivery month when the contract next nearest to delivery is used. This process yields a non-overlapping price series for each type of contract, involving a different number of contract maturities for each distinct futures contract. This procedure provides several advantages over more general sampling procedures. First, it confines the sample to the most actively traded contracts. Up until the delivery month, trading volume in a particular contract generally increases. Once the delivery month is reached, volume quickly shifts to the contract next nearest to delivery. Using the highest volume contracts should result in more accurate measurement of "equilibrium" prices. Second, this procedure avoids the potential problem of contemporaneous correlation among data that do include more distant contracts. That is, under the procedure used here, the price of only one contract—that with the highest daily volume—is used for each trading day in the sample. When more distant contracts are included, the prices of more than one contract are used for each trading day. Correlation among prices recorded on the same days would seriously compromise the validity of the statistical tests used in the study. And finally, by using contracts that are close to delivery, we minimize the susceptibility of the contract price to confounding effects caused by shifts in the term structure of interest rates and/or shifts in market risk premia.[2]

Continuously compounded returns are calculated from each price series as,

$$ {}_t r_{t+1} = \mathrm{Ln}\left[\frac{P_{t+1}}{P_t}\right], $$

where P_t represents the contract price at time t. Since no real investment takes place when a contract is bought or sold, ${}_t r_{t+1}$ represents a "return" in the sense that it measures the continuously compounded change in the contract price from t to $t+1$. Unless otherwise noted, returns that occur over a holiday, and the day following a holiday, are deleted. Thus, the resulting series represent "normal" one-day and weekend returns.

For each type of contract, daily returns are computed from closing price to closing price, closing price to opening price, and opening price to closing price.

[2] Evidence of the existence of risk premia in the prices of commodity futures contracts has been noted recently by Chang (1985) and by Fama and French (1987). To the extent that premia exist in our data, the size of such premia should generally be smallest for those contracts closest to delivery.

This procedure allows us to distinguish between seasonalities that occur during nontrading hours and those that occur during trading hours.

III. Analysis and Results

A. The Daily Returns Sample

General characteristics of the daily returns data are presented in Table 1. Average returns are calculated for each contract type, using the entire sample. In these and all subsequent tabulations, average returns are multiplied by 100 to reflect percent equivalents. Two-tailed *t*-tests are performed to determine if sample means are significantly different from zero.[3] On the close-to-close basis, Panel A shows that mean daily returns for GNMA, T-bond, and T-bill contracts are negative, while the mean return for the T-note contract is positive. Looking at the intraday returns (Panels B and C), the negative average close-to-close return observed on GNMA and T-bond contracts appears to be driven by trading time returns. For T-notes and T-bills, the most dominant intraday returns occur during nontrading hours.

TABLE 1

Statistical Summary of Daily Returns (%) by Type of Futures Contract for the Entire Sample Period[a,b]

	GNMA Contracts	T-Bond Contracts	T-Note Contracts	T-Bill Contracts
Panel A. Returns (%) Computed from Closing Price to Closing Price				
Mean Return	−0.0036	−0.0083	0.0285	−0.0013
t-Statistic	−0.25	−0.48	1.97	−0.11
Sample Size	2319	2635	1555	3046
Panel B. Returns (%) Computed from Opening Price to Closing Price (Trading Time)				
Mean Return	−0.0171	−0.0192	0.0100	0.0003
t-Statistic	−1.28	−1.26	0.81	0.03
Sample Size	2319	2635	1555	3046
Panel C. Returns (%) Computed from Closing Price to Opening Price (Nontrading Time)				
Mean Return	0.0134	0.0109	0.0185	−0.0017
t-Statistic	1.57	1.11	1.94	−0.18
Sample Size	2319	2635	1555	3046

[a] *t*-statistic tests the null hypothesis that the mean return is zero.
[b] Sample size is the number of daily returns included in the computation of the mean return.

On closer examination, separate *t*-tests indicate that the close-to-close and intra-day returns for each contract are not significantly different from zero. In addition, when intra-day returns are compared with each other via a two-sided *t*-test, no significant difference in means is detected for any of the contract types.

[3] Because futures contracts involve no investment, the reasonable null hypothesis is that the return (continuously compounded percentage change in price) on the contract is zero. Consequently, we use a two-sided *t*-test to test the null hypothesis that the return is zero against the two-sided alternative that the return is not zero.

Thus, there are no permanent positive or negative components in the aggregate futures returns—either on a close to close basis, or using intraday returns.

B. Day-of-the-Week Patterns

To examine the data for daily seasonals, returns are classified by day of the week for each contract type. Mean returns are computed for each day of the week, and t-tests are performed to determine if sample means are significantly nonzero. Since this procedure divides the returns data for each contract into multiple (5) subsamples, some care must be taken when interpreting two-sided t-tests on isolated subsamples. "Significant" t-statistics may appear merely because the data are split into a sufficient number of samples. Therefore, for samples where significant average returns are detected for a particular day of the week, a multiple F-test is performed to determine if the average returns on all days of the week in the sample are jointly equal. This test is made by performing a regression of the form[4]

$$r_t = a_0 + a_M X_{M,t} + a_W X_{W,t} + a_T X_{T,t} + a_F X_{F,t} + e_t , \quad (1)$$

where r_t = futures return for day t;

$X_{i,t}$ = 1 if day t is the ith day of the week, 0 otherwise;

a_i = regression coefficient for each day of the week i, Mon ($i = M$), Wed ($i = W$), Thur ($i = T$), Fri ($i = F$); and

e_t = random error term for day t.

An F-statistic is then calculated to test the null hypothesis,

$$H_0 \;:\; a_M = a_W = a_T = a_F . \quad (2)$$

Failure to reject the null suggests that any apparent patterns in daily returns that are observed when performing significance tests in isolation are not robust and are probably due to the effect of multiple subsamples. Under these circumstances, such results cannot be viewed as evidence of a daily seasonal.

Results from the day-of-the-week tests are presented in Table 2. Average returns computed from close to close, open to close, and close to open are presented by day of the week for each contract type.[5] Some interesting and familiar patterns are revealed. First, a negative Monday effect, associated in many other

[4] The intercept for the regression in Equation (1) contains the effect of the "return" generated on Tuesday. Thus, the coefficients on dummy variables for the remaining days of the week measure the marginal effect of each day relative to Tuesday. An alternative specification would be to suppress the intercept and include dummies for each of the 5 trading days of the week; however, this specification will introduce bias into the coefficient estimates if the true mean return is nonzero.

[5] Both the close to close and the close to open returns actually occur over two calendar days. For any particular day, close to close returns are computed from the previous day's close to the close of that trading day. Close to open returns for that day are computed from the previous day's close to the open of trading on that day. Each day's close to close return is the sum of the same day's nontrading (close to open) return and the same day's trading (open to close) return. For example, Monday's close to close return covers the period from the market's close on Friday to the market's close on Monday; the "Monday" nontrading period is from the market's close on Friday to the market's open on Monday; and the Monday trading time return is simply the return from Monday's opening to Monday's closing.

studies with stock returns, is also apparent in GNMA and T-bond futures returns. Using close to close returns (Panel A), average returns are negative on Monday and statistically nonzero at the 0.01 level of significance for the GNMA contract and at the 0.05 level for the T-bond contract. Additionally, average returns on GNMA, T-bond, and T-note contracts are positive on Tuesday and are statistically different from zero for T-bonds at the 0.05 level, and for T-notes at the 0.01 level. The positive Tuesday return on GNMA futures, however, is significant only at the 0.15 level. The negative Monday effect is similar to that found by Chiang and Tapley (1983). (However, using close to close returns, they find an additional negative effect on Wednesday, and no positive Tuesday effect.)

TABLE 2

Statistical Summary of Daily Returns (%) by Type of Futures Contract for the Entire Sample Period Classified by Day of the Week[a,b,c]

	Mon.	Tues.	Wed.	Thurs.	Fri.	F_5
Panel A. Returns (%) Computed from Closing Price to Closing Price						
GNMA Futures Contract						
Mean Return	−0.113	0.046	−0.022	0.031	0.039	4.133*
t-Statistic	−2.71*	1.52	−0.84	1.03	1.15	
Sample Size	450	462	488	478	441	
T-Bond Futures Contract						
Mean Return	−0.114	0.081	−0.052	−0.001	0.046	4.035*
t-Statistic	−2.47**	2.21**	−1.61	−0.03	1.11	
Sample Size	512	526	554	541	502	
T-Note Futures Contract						
Mean Return	0.004	0.119	−0.016	0.020	0.015	2.695**
t-Statistic	0.11	3.86*	−0.56	0.69	0.40	
Sample Size	302	312	327	318	296	
T-Bill Futures Contract						
Mean Return	0.004	−0.020	−0.010	−0.004	0.026	0.404
t-Statistic	0.12	−0.76	−0.44	−0.16	0.89	
Sample Size	589	610	642	625	580	
Panel B. Returns (%) Computed from Opening Price to Closing Price (Trading Time)						
GNMA Futures Contract						
Mean Return	−0.109	0.050	−0.054	0.040	−0.016	4.948*
t-Statistic	−3.17*	1.77	−2.04**	1.37	−0.51	
Sample Size	450	462	488	478	441	
T-Bond Futures Contract						
Mean Return	−0.073	0.075	−0.090	−0.003	−0.003	3.761*
t-Statistic	−2.00**	2.23**	−2.98*	−0.08	−0.07	
Sample Size	512	526	554	541	502	
T-Note Futures Contract						
Mean Return	0.028	0.083	−0.042	0.007	−0.024	3.104**
t-Statistic	0.97	3.07*	−1.63	0.26	−0.76	
Sample Size	302	312	327	318	296	
T-Bill Futures Contract						
Mean Return	0.021	0.013	−0.029	−0.016	0.016	0.767
t-Statistic	0.81	0.50	−1.22	−0.63	0.60	
Sample Size	589	610	642	625	580	

(continued on next page)

TABLE 2 (continued)

Statistical Summary of Daily Returns (%) by Type of Futures Contract for the Entire Sample Period Classified by Day of the Week[a,b,c]

	Mon.	Tues.	Wed.	Thurs.	Fri.	F_5
Panel C. Returns (%) Computed from Closing Price to Opening Price (Nontrading Time)						
GNMA Futures Contract						
Mean Return	−0.004	−0.005	0.032	−0.009	0.054	2.131
t-Statistic	−0.17	−0.30	2.03**	−0.57	2.56**	
Sample Size	450	462	488	478	441	
T-Bond Futures Contract						
Mean Return	−0.041	0.007	0.037	0.002	0.049	2.488**
t-Statistic	−1.41	0.36	1.97**	0.09	1.99**	
Sample Size	512	526	554	541	502	
T-Note Futures Contract						
Mean Return	−0.024	0.037	0.026	0.013	0.039	1.425
t-Statistic	−0.99	1.62	1.28	0.84	1.75	
Sample Size	302	312	327	318	296	
T-Bill Futures Contract						
Mean Return	−0.017	−0.033	0.019	0.012	0.011	1.211
t-Statistic	−0.69	−1.69	1.01	0.69	0.51	
Sample Size	589	610	642	625	580	

[a] *t*-statistic tests the null hypothesis that the mean return equals zero using a two-tailed test; *, and **, indicate significance at the 0.01 and 0.05 levels, respectively.

[b] F_5 is the *F*-statistic testing the null hypothesis that mean returns are equal across all five days of the week; * and **, indicate significance at the 0.01 and 0.05 levels, respectively.

[c] Sample size indicates the number of daily returns included in the computation of each mean by day of the week.

Next, an *F*-test is performed to determine if the patterns observed above are an artifact of subdividing the original sample. The *F*-statistic tests whether the marginal difference between Tuesday and the remaining days of the week are jointly zero, as stated in (1) and (2). The relevant *F*-statistic is reported in Table 2 as F_5. Using close to close returns, F_5 indicates that the null can be rejected at the 0.01-significance level for both the GNMA and the T-bond contracts, and at the 0.05 level for the T-note contract. This indicates that close to close returns are significantly different across days of the week. The F_5 statistic is insignificant for the *T*-bill contract. Therefore, the negative average return observed from the close of the market on Friday to the close of the market on Monday in the GNMA and T-bond contracts, and the positive average return from the close of the market on Monday to the close of the market on Tuesday in the T-bond and T-note contracts appear to be robust.

Comparing results using intraday returns, it is clear that the significant seasonals observed using close to close data are concentrated during trading hours. Using open to close returns, average returns from GNMA and T-bond contracts are negative on Monday and significant at the 0.05 level. Moreover, the *F*-tests indicate that trading time returns are not equal across days of the week for GNMA or T-bond contracts. At the same time, using open to close returns, no significant Monday effect is observed in either contract. Similarly, the average Tuesday returns for the T-bond and T-note contracts are significantly positive during trading time, and not significantly different from zero during nontrading time. An additional seasonal (also observed by Chiang and Tapley (1983) using close to close returns) also appears in our trading time data. The average trading time return is significantly negative on Wednesday for GNMA and T-bond contracts.

A weaker pattern of seasonals occurs during nontrading hours. For GNMA and T-bond contracts, there are positive average returns observed from the close of the market on Tuesday to the open on Wednesday, and from the close of the market on Thursday until the open of the market on Friday. Compared to the effects on Monday, however, the magnitude of these effects is much smaller and their statistical significance is more tenuous. In fact, for the GNMA contract, the F-statistic cannot reject (at the 0.05 level) the hypothesis that the returns are equal across days of the week.

Regarding T-bill futures, the numbers reported in Table 2 indicate no evidence of significant seasonal patterns. Using close to close, open to close, and close to open returns, average T-bill contract returns are not significantly different from zero at the 0.05 level. The multivariate F-tests also support the absence of significant differences in the mean returns across days of the week.

It is perhaps not surprising that a similar pattern—the negative Monday—is observed for both GNMA and T-bond futures. Both contracts are based on long-term, fixed income securities with similar default risk, and both are traded over the CBT. The T-note contract, which is based on an intermediate term security, exhibits a different pattern, a positive return on Tuesday. The T-bill contract, for which no significant seasonals are found, is based on the 90-day instrument and is traded on the IMM.[6] These observations suggest that the seasonal phenomena documented in futures markets, and possibly other markets, are related to characteristics of the underlying security (e.g., term to maturity), or to the exchange involved.

Placed in perspective with previous studies of daily seasonals in other markets, the results above offer some additional interesting comparisons. In particular, the negative Monday effect observed on GNMA and T-bond contracts is similar to the Monday effect observed previously by Cornell (1985) and Dyl and Maberly (1986) in the market for stock index futures. This adds support to the possibility that negative Monday effects are relatively frequent phenomena in financial markets—especially futures markets. On the other hand, the Monday effects in GNMA and T-bond futures are different in at least one important respect from Monday seasonals observed in other markets, including the market for S&P 500 futures. The Monday effect in S&P 500 futures returns has been shown to occur during the weekend—from Friday's close to Monday's open. For T-bond and GNMA contracts, the negative seasonal occurs during trading hours on Monday. Additionally, no Monday effect is found for either T-note or T-bill contracts.

[6] Aside from the obvious differences in the cash instruments involved, there are more subtle differences among GNMA, T-bond, T-note, and T-bill futures contracts that could contribute to the contrasting behavior of contract returns. One such difference concerns the so-called delivery options. There are a variety of securities that may be delivered against GNMA, T-bond, and T-note contracts. Only 90-, 91-, or 92-day securities may be delivered against the T-bill contract. The importance of delivery options to the valuation of futures contracts has been discussed in a number of papers. Basically, a delivery option involves the delivery of bonds of differing quality—e.g., coupon rate—and the timing of such deliveries. See Garbade and Silber (1983), Gay and Manaster (1984), (1986), Johnston (1986), and Kane and Marcus (1986a), (1986b) for a more complete discussion.

The results above provide mixed evidence on the question of whether seasonal patterns observed in futures returns are merely reflections (especially for nearby contracts) of seasonals in the underlying cash returns. For example, the negative Monday evidenced in S&P 500 futures closely parallels the well-known negative Monday effect in cash stock returns. Indeed, a similar phenomenon is evidenced above. The negative Monday observed above in T-bond futures returns also resembles the Monday phenomenon observed by Flannery and Protopapadakis (1988) in the cash market for long-term Treasuries. At the same time, however, while Gibbons and Hess find a Monday seasonal in (cash) T-bill returns, we find no evidence of a parallel pattern in T-bill futures returns. Thus, the question remains as to whether seasonal patterns in futures returns generally reflect more fundamental patterns in cash market returns.

C. Holiday Returns

In this section, contract returns occurring over holidays and days following holidays are examined. These data were excluded from our previous tests to avoid any peculiar effects associated with holiday closings. Similar investigations of holidays have been carried out in studies of stock returns to show that the negative average return observed from Friday's close to Monday's open is associated with the weekend, per se, and not generally with market closings. We are interested here in whether the Monday effect associated with GNMA and T-bond futures returns is also a peculiarity of the weekend or a phenomenon associated with market closings in general.

To examine this prospect, returns over each holiday for GNMA and T-bond contracts are calculated as follows: (1) from market close on the day preceding the holiday to market close on the day following the holiday (close to close), (2) from the market close on the day preceding the holiday to the market open on the day following the holiday (close to open), and (3) from the market open to the market close on the day following the holiday (open to close). Average returns are computed for each of the contracts in the sample, and t-tests are performed to determine if average returns are significantly nonzero. Results are presented below.

	Close to Close Returns (%)	Close to Open Returns (%)	Open to Close Returns (%)
GNMA			
Mean	0.0698	0.0327	0.0371
t-Statistic	1.10	0.76	0.66
Sample Size	161	161	161
T-Bonds			
Mean	0.1294	0.0554	0.0740
t-Statistic	1.64	1.30	1.04
Sample Size	179	179	179

There is no indication that the Monday (or weekend) effects previously observed for GNMA and T-bond futures also occur as a result of holiday closings. Returns over holidays are not significantly different from zero.

These results are similar to previous evidence on stock returns. The negative

Monday seasonal apparently does not occur merely because the market is closed during the previous day. There is something peculiar about the (regular) weekend that produces the Monday seasonal observed in GNMA and T-bond futures returns. And, even though the effect concerning stock returns is generated during the weekend, whereas that involving GNMA and T-bond futures appears during Monday trading hours, it is interesting that both phenomena—involving different instruments and different markets—are generally linked to the weekend period.[7]

D. Influence of the Sample Period on Day-of-the-Week Seasonals

In this section, the data are divided into three subsamples, each covering a different period of time. The purpose of this procedure is to determine whether the observed seasonal patterns in the data are persistent over time. Concern over this issue is motivated, in part, by previous research on stock returns. Smirlock and Starks (1986) have recently reported that the negative Monday (or weekend) effect in stock returns has been "moving up" in time. That is, over a period from 1963 to 1983, they find evidence of a negative seasonal during earlier years in the data that is concentrated during trading hours on Monday. During later years, they find the negative effect "moves" to become concentrated during nontrading hours over the weekend. Additionally, Gay and Kim (1987) and Chang and Kim (1988) have reported negative Monday seasonals in the CRB futures index and the Dow Jones Commodity Price Index that disappear during the most recent months of their samples. This suggests the possibility that the Monday effect in GNMA and T-bond futures revealed in our previous tests may not be a permanent characteristic of the data or may be changing over the time period studied.

Returns are grouped as occurring in the period prior to January 1981, from January 1981 through December 1984, and from January 1985 through December 1988 (or, in the case of the GNMA CDR contract, through August 1985). These sample periods are labeled 1, 2, and 3, respectively. The number of months included in each sample involved for each type of contract is as follows

	Number of Months in the Sample		
Type of Contract	Period 1	Period 2	Period 3
GNMA	63	48	8
T-Bond	41	48	48
T-Note	0	32	48
T-Bill	60	48	48

Because each type of futures contract began trading on a different date, the number of months covered in the first sample period varies across the different types of contracts. The second and third periods cover equal 48-month intervals. The T-note contract did not begin trading until May 1982, so the contract did not trade in the first period, and only traded for 32 months in the second period. The

[7] Holiday returns were analyzed for T-note and T-bill contracts also. Similar results were obtained. No seasonal effects were found in returns to either contract around holiday closings.

GNMA contract was deleted from the data set in August 1985 because of thin trading.

Using the nearby (with 1 or 2 months to maturity) and "next nearest" (with 3 months to maturity) contract, the average close-to-close returns are computed for each type of contract over each time period. Results are presented in Table 3. It appears that neither the negative Monday effect nor the positive Tuesday effect observed over the entire time period are stable through time. The negative seasonal on Monday is clearly evident in the data for both the GNMA and T-bond contracts before January 1981. This is consistent with the findings of Chiang and Tapley (1983) who use data prior to 1981. After January 1981, however, there is no evidence that Monday's average return is significantly nonzero. Thus, the prevalent seasonal pattern noted earlier is not present in the most recent months. This pattern is similar to the results of Gay and Kim (1987) and Chang and Kim (1988), which document the disappearance of Monday effects in the CRB futures index and the Dow Jones Commodity Price Futures Index, respectively, at approximately the same time. Additionally, it is during the later periods that the positive average return on Tuesday is observed for GNMA, T-bond, and T-note contracts. To the extent that this effect is regarded as a statistically significant seasonal pattern in returns, it is clearly confined to the more recent months of the data.

Finally, the results concerning T-bill contracts are consistent with our previous findings. Using close to close returns, no significant seasonal pattern is apparent. The average return for each day of the week is not statistically different from zero in any of the subsamples.

E. Influence of the Delivery Cycle on Day-of-the-Week Effects

In the previous tests, returns data are based upon the nearby contract or, where appropriate, the contracts next nearest to delivery. The reason for this procedure was to produce samples of high-volume contracts with noncontemporaneous returns. As a result, however, the samples include contracts with varying, but relatively short, terms to delivery. This raises an additional question that should be addressed. That is, to what extent are observed seasonal phenomena due to time to delivery or position in the delivery cycle? Our previous tests were based on samples composed of different "commodities" (i.e., contracts with 1, 2, and 3 months to delivery). At a minimum, it is important to distinguish by term to delivery among the contracts in our previous samples. It is equally important to include more distant contracts in the analysis as well. In so doing, we can provide additional insight as to whether the seasonals in futures contracts originate in the futures market, per se, or are derived from seasonals in the cash market. The property of convergence between cash and futures implies that, as a futures contract approaches maturity, the futures price will more closely mimic the behavior of the cash price. As a result, observed seasonals on short-term futures contracts could result merely from the approach of delivery as the futures price more closely reflects "fundamental" seasonal patterns in the cash price. On the other hand, contracts with longer terms to delivery should be more independent of the cash price. Evidence that seasonal effects in futures are confined to contracts closer to delivery would support this explanation.

TABLE 3
Statistical Summary of Daily Returns (%) by Type of Futures Contract Classified by Day of the Week and Time Period[a,b,c]
(Returns (%) Computed from Closing Price to Closing Price)

	Mon.	Tues.	Wed.	Thurs.	Fri.
Panel A. Period 1 (from the Beginning of Trading through December 1980)					
GNMA Futures Contract					
Mean Return	−0.136	0.051	−0.005	−0.024	0.028
t-Statistic	−3.07*	1.35	−0.16	−0.64	0.65
Sample Size	235	242	253	250	232
T-Bond Futures Contract					
Mean Return	−0.251	0.053	−0.044	−0.087	0.068
t-Statistic	−3.39*	0.77	−0.89	−1.41	0.89
Sample Size	146	149	158	160	147
T-Bill Futures Contract					
Mean Return	−0.035	0.054	0.000	−0.072	0.035
t-Statistic	−0.77	1.32	0.00	−1.95	0.77
Sample Size	225	232	246	245	224
Panel B. Period 2 (January 1981 through December 1984)					
GNMA Futures Contract					
Mean Return	−0.118	0.017	−0.042	0.090	0.061
t-Statistic	−1.42	0.31	−0.88	1.66	1.06
Sample Size	184	188	202	195	179
T-Bond Futures Contract					
Mean Return	−0.127	0.022	−0.092	0.081	0.064
t-Statistic	−1.34	0.36	−1.66	1.31	0.93
Sample Size	183	188	201	195	179
T-Note Futures Contract					
Mean Return	−0.003	0.109	−0.019	0.063	0.014
t-Statistic	−0.05	2.45**	−0.45	1.29	0.23
Sample Size	120	124	132	131	121
T-Bill Futures Contract					
Mean Return	0.025	−0.080	−0.004	0.015	0.097
t-Statistic	0.036	−1.43	−0.07	0.26	1.54
Sample Size	182	190	202	194	180

(continued on next page)

To examine the possibility that term to delivery is a factor in explaining the seasonal patterns in returns, the data are classified by month to delivery. Since this procedure permits us to differentiate among contracts that were traded at the same time, we also are able to expand our samples to include more distant contracts without introducing the problem of contemporaneous correlation in the data.[8] The inclusion of more distant contracts is relevant to our analysis in two respects. First, including these data allows us to determine whether the seasonal effects noted earlier in returns on short-term contracts also are present in returns on longer term contracts. And second, to examine the influence of term to deliv-

[8] For example, during months immediately preceding a delivery month, our previous sampling procedure includes only contracts that had one month remaining to delivery—i.e., the nearby contract. At the same time, however, longer term contracts are traded with 4, 7, 10, etc., months to delivery. Returns on those contracts will be contemporaneously correlated with those on the 1-month contract, so they were excluded from our previous samples. In this section, we include returns on more distant contracts in the analysis, but not in the same samples. Each sample is classified by number of months to delivery, so introduction of correlation in sample returns is again avoided.

TABLE 3 (continued)

Statistical Summary of Daily Returns (%) by Type of Futures Contract Classified by Day of the Week and Time Period[a,b,c]
(Returns (%) Computed from Closing Price to Closing Price)

	Mon.	Tues.	Wed.	Thurs.	Fri.
Panel C. Period 3 (January 1985 through December 1988)					
GNMA Futures Contract					
Mean Return	0.089	0.174	−0.027	0.099	−0.015
t-Statistic	0.85	3.29*	−0.33	1.16	−0.14
Sample Size	31	32	33	33	30
T-Bond Futures Contract					
Mean Return	0.009	0.163	−0.018	−0.014	0.009
t-Statistic	0.15	2.64*	−0.30	−0.25	0.13
Sample Size	183	189	195	186	176
T-Note Futures Contract					
Mean Return	0.008	0.126	−0.014	−0.009	0.016
t-Statistic	0.20	2.99*	−0.36	−0.25	0.33
Sample Size	182	188	195	187	175
T-Bill Futures Contract					
Mean Return	0.031	−0.051	−0.031	0.065	−0.057
t-Statistic	0.65	−1.32	−0.83	1.66	−1.26
Sample Size	182	188	194	186	176

[a] *t*-statistic tests the null hypothesis that the mean return equals zero using a two-tailed test; * and **, indicate significance at the 0.01 and 0.05 levels, respectively.

[b] Sample size indicates the number of daily returns included in the computation of each mean by day of the week.

[c] T-note contracts began trading in May 1982. Therefore, there are no observations in Period 1 for T-notes, and the sample period for T-notes in Period 2 begins in May 1982. Observations on the GNMA contract end in August 1985 in Period 3 because infrequent trading led to incomplete price information beginning in the fall of 1985.

ery on contract returns generally, it is necessary to consider a more representative (by maturity) sample of those contracts that actually are traded.

By expanding the sample, we include contracts that were traded as long as 11 months prior to the delivery month. This procedure confines our expanded samples to relatively high-volume contracts and simultaneously generates a reasonable spectrum of maturities. Using close to close prices, average returns are calculated by day of the week for each contract, at each maturity. Results for GNMA, T-bond, and T-note contracts are reported in Tables 4, 5, and 6. Consistent with our previous findings, significant day-of-the-week seasonals again appear in returns on GNMA, T-bond, and T-note contracts, but not in returns on T-bill contracts.[9] The most interesting aspects of these results are summarized below.

The results in Tables 4 and 5 indicate that the seasonal patterns observed on GNMA and T-bond contracts are not related to the term to delivery on the contract, per se, but are apparently related to particular months during the delivery cycle.[10] For instance, the negative Monday return associated with GNMA and

[9] Tests concerning T-bill contracts found no significant patterns in the data. Tabulated results are omitted here, but are available from the authors on request.

[10] Because the futures contracts mature quarterly, returns on contracts with 3, 6, and 9 months remaining until the delivery month are realized during a delivery month. Returns on contracts with 1, 4, 7, and 10 months remaining until the delivery month are realized in months preceding a delivery

TABLE 4

Statistical Summary of Daily Returns (%) Computed from Closing Price to Closing Price on GNMA Futures Contracts Classified by Month to Delivery and Day of the Week[a,b]

Number of Months to Delivery		Mon.	Tues.	Wed.	Thurs.	Fri.
0	Mean Return	0.030	0.121	−0.066	−0.026	0.119
	t-Statistic	0.41	2.27**	−1.10	−0.45	1.75
	Sample Size	109	105	110	109	103
1	Mean Return	−0.178	0.112	−0.008	0.066	0.032
	t-Statistic	−2.30**	2.06**	−0.19	1.12	0.57
	Sample Size	152	153	162	160	136
2	Mean Return	−0.137	−0.019	−0.028	0.062	0.056
	t-Statistic	−2.03**	−0.38	−0.50	1.19	0.99
	Sample Size	154	158	162	154	154
3	Mean Return	−0.025	0.047	−0.029	−0.033	0.027
	t-Statistic	−0.35	0.94	−0.08	−0.72	0.45
	Sample Size	146	151	164	164	151
4	Mean Return	−0.186	0.108	0.003	0.043	0.035
	t-Statistic	−2.33**	1.91	0.08	0.72	0.60
	Sample Size	148	149	158	155	132
5	Mean Return	−0.131	−0.030	−0.038	0.071	0.055
	t-Statistic	−1.89	−0.56	−0.70	1.37	0.95
	Sample Size	148	157	157	152	151
6	Mean Return	−0.030	0.047	−0.046	−0.029	0.020
	t-Statistic	−0.40	0.89	−1.05	−0.64	0.34
	Sample Size	142	146	161	160	147
7	Mean Return	−0.216	0.099	0.012	0.024	0.020
	t-Statistic	−2.70*	1.75	0.27	0.39	0.35
	Sample Size	142	145	151	148	128
8	Mean Return	−0.139	−0.059	−0.021	0.074	0.065
	t-Statistic	−1.92	−1.08	−0.40	1.39	1.11
	Sample Size	138	140	153	152	137
9	Mean Return	−0.048	0.032	−0.048	−0.021	0.017
	t-Statistic	−0.65	0.61	−1.06	−0.46	0.27
	Sample Size	136	140	153	152	137
10	Mean Return	−0.209	0.087	0.023	0.024	0.028
	t-Statistic	−2.49**	1.41	0.49	0.39	0.44
	Sample Size	134	135	144	140	120
11	Mean Return	−0.150	−0.081	−0.051	0.133	0.050
	t-Statistic	−1.92	−1.41	−0.90	1.99**	0.88
	Sample Size	126	134	138	138	137

[a] Using a two-tailed test, *t*-statistic tests the null hypothesis that the mean daily return equals zero; *, **, and *** indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

[b] Sample size is the number of daily returns included in the computation of the mean return.

T-bond contracts occurs only during nondelivery months. Moreover, the most dominant pattern in these two contracts involves months immediately *prior* to a delivery month. Average returns on GNMA and T-bond contracts with 1, 4, 7, and 10 months remaining until delivery each exhibit a similar, significant negative average return on Monday.

month; those with 2, 5, 8, and 11 months remaining until the delivery month are realized in months immediately following a delivery month.

TABLE 5

Statistical Summary of Daily Returns (%) Computed from Closing Price to Closing Price on T-Bond Futures Contracts Classified by Month to Delivery and Day of the Week[a,b]

Number of Months to Delivery		Mon.	Tues.	Wed.	Thurs.	Fri.
0	Mean Return	0.035	0.158	−0.051	−0.112	0.266
	t-Statistic	0.41	2.23**	−0.73	−1.54	2.54**
	Sample Size	124	124	128	124	119
1	Mean Return	−0.167	0.139	−0.047	0.056	0.010
	t-Statistic	−1.99**	2.18**	−0.95	0.87	0.14
	Sample Size	170	170	186	180	162
2	Mean Return	−0.139	0.026	−0.096	0.049	0.050
	t-Statistic	−1.87	0.41	−1.62	0.82	0.78
	Sample Size	174	183	190	184	178
3	Mean Return	−0.032	0.085	−0.014	−0.079	0.103
	t-Statistic	−0.40	1.36	−0.25	−1.41	1.28
	Sample Size	169	175	184	184	172
4	Mean Return	−0.170	0.153	−0.047	0.054	0.018
	t-Statistic	−2.06**	2.36**	−0.93	0.83	0.26
	Sample Size	166	175	181	177	160
5	Mean Return	−0.151	0.041	−0.097	0.053	0.007
	t-Statistic	−2.00**	0.62	−1.61	0.87	0.10
	Sample Size	164	179	187	178	174
6	Mean Return	−0.021	0.070	−0.039	−0.073	0.089
	t-Statistic	−0.27	1.11	−0.66	−1.27	1.07
	Sample Size	166	172	181	179	167
7	Mean Return	−0.177	0.142	−0.032	0.051	0.022
	t-Statistic	−2.12**	2.14**	−0.63	0.75	0.31
	Sample Size	161	160	174	172	157
8	Mean Return	−0.148	0.013	−0.063	0.056	0.008
	t-Statistic	−1.96***	0.18	−0.98	0.90	0.31
	Sample Size	166	174	182	175	168
9	Mean Return	−0.023	0.058	−0.055	−0.076	0.084
	t-Statistic	−0.28	0.93	−0.96	−1.31	1.01
	Sample Size	160	168	176	174	162
10	Mean Return	−0.174	0.158	−0.028	0.023	0.049
	t-Statistic	−2.06**	2.35**	−0.55	0.33	0.67
	Sample Size	156	154	172	169	153
11	Mean Return	−0.139	0.042	−0.108	0.065	0.005
	t-Statistic	−1.81	0.61	−1.76	1.06	0.08
	Sample Size	160	171	178	170	161

[a] Using a two-tailed test, *t*-statistic tests the null hypothesis that the mean daily return equals zero; *, **, and *** indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

[b] Sample size is the number of daily returns included in the computation of the mean return.

The other significant seasonal in the data—the positive Tuesday seasonal in GNMA, T-bond, and T-note contracts—is evident in Tables 4, 5, and 6. For GNMA, T-bond, and T-note futures, average Tuesday returns are generally positive for contracts of all maturities. For GNMA and T-bond futures, however, statistical significance of the Tuesday effect is confined to contracts traded immediately prior to, or during a delivery month. For T-note futures, statistical significance of the Tuesday effect is confined to contracts with shorter maturities—especially those with 1, 2, and 3 months remaining to delivery.[11]

TABLE 6

Statistical Summary of Daily Returns (%) Computed from Closing Price to Closing Price on T-Note Futures Contracts Classified by Month to Delivery and Day of the Week[a,b]

Number of Months to Delivery		Mon.	Tues.	Wed.	Thurs.	Fri.
0	Mean Return	0.054	0.084	−0.059	−0.073	0.137
	t-Statistic	0.72	1.37	−0.91	−1.39	1.44
	Sample Size	65	65	71	67	66
1	Mean Return	0.008	0.120	−0.070	0.005	−0.046
	t-Statistic	0.14	2.56**	−1.65	0.09	−0.72
	Sample Size	95	94	101	94	96
2	Mean Return	0.008	0.147	0.022	0.085	0.007
	t-Statistic	0.11	2.11**	0.40	1.36	0.11
	Sample Size	89	95	99	98	95
3	Mean Return	0.031	0.114	0.021	−0.038	0.080
	t-Statistic	0.48	2.03**	0.35	−0.82	1.01
	Sample Size	88	89	98	101	94
4	Mean Return	0.014	0.102	−0.056	0.049	−0.007
	t-Statistic	0.20	1.97***	−1.40	0.84	−0.11
	Sample Size	88	89	97	93	93
5	Mean Return	−0.024	0.117	0.016	0.046	−0.032
	t-Statistic	−0.32	1.71	0.28	0.68	−0.54
	Sample Size	82	91	92	89	88
6	Mean Return	0.20	0.111	−0.007	0.025	0.031
	t-Statistic	0.28	1.96***	−0.11	0.52	0.39
	Sample Size	77	83	86	89	83
7	Mean Return	0.42	0.102	−0.113	0.049	0.102
	t-Statistic	0.49	1.44	−2.13**	0.72	0.97
	Sample Size	65	61	74	73	71
8	Mean Return	0.006	0.120	0.084	−0.064	−0.041
	t-Statistic	0.05	0.96	1.01	−0.64	−0.36
	Sample Size	42	45	54	53	41
9	Mean Return	−0.148	0.196	0.281	−0.096	0.040
	t-Statistic	−0.91	1.21	1.67	−1.09	0.22
	Sample Size	30	26	28	32	32
10	Mean Return	0.187	0.402	0.270	−0.306	−0.216
	t-Statistic	1.08	1.77	1.32	−1.23	−1.02
	Sample Size	26	24	27	28	25
11	Mean Return	−0.261	0.480	−0.074	0.007	−0.082
	t-Statistic	−1.47	1.90	−0.54	0.04	−0.30
	Sample Size	16	23	20	13	17

[a] Using a two-tailed test, *t*-statistic tests the null hypothesis that the mean daily return equals zero; *, **, and *** indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

[b] Sample size is the number of daily returns included in the computation of the mean return.

[11] It should be pointed out that, while Monday and Tuesday seasonals indicated in Tables 4 through 6 both occur during months prior to delivery months, they are not contemporaneous phenomena. As was demonstrated in our earlier tests, the Monday effect is indicative of GNMA and T-bond returns in the period before January 1981. The Tuesday phenomena observed in GNMA, T-bond, and T-note returns appears in the data during the period after December 1984.

The results above suggest that the delivery cycle may be an important determinant of the observed seasonal patterns in GNMA, T-bond, and T-note contracts. To further verify this prospect, additional tests are performed to determine if the seasonal effects during months prior to a delivery month are, in fact, significantly different from other months of the delivery cycle. Regressions of the form, $r_t = b_0 + b_1 X_{1,t} + b_2 X_{2,t} + e_t$, are estimated for GNMA, T-bond, and T-note futures, where r_t represents the close to close return for day t; $x_{1,t}$ and $X_{2,t}$ are dummy variables to indicate if returns occur during a month immediately prior to a delivery month, or during a month immediately after a delivery month; b_1 and b_2 are coefficients; and e_t is an error term. In this specification, b_0 captures any effect due to returns in a delivery month. To avoid the problem of contemporaneous correlation in returns, the data are grouped by contract maturity into 4 noncontemporaneous subsamples as follows: 0, 1, and 2 months; 3, 4, and 5 months; 6, 7, and 8 months; and 9, 10, and 11 months.[12] Separate regressions are performed on each group to yield F-statistics to test the null, $b_1 = b_2$. This procedure is performed on Monday close to close returns for GNMA and T-bond contracts, and on Tuesday close to close returns for GNMAs, T-bonds, and T-notes. In all cases, the test statistic fails to reject the null at a level of significance lower than 0.05. These results provide evidence that the negative Monday and positive Tuesday seasonals observed on GNMA, T-bond, and T-note contracts are not generally associated with the delivery cycle itself. However, given the relationship between delivery and calendar months, the significance may be associated instead with a particular month (or months) of the year.

To examine this result more carefully, close to close returns on nearby GNMA, T-note, and T-bond contracts are classified once more by calendar month.[13] Average returns are recalculated by day of the week for each month of the year. By confining our analysis to the nearby contracts, sample sizes are necessarily quite small. Because of the relatively fewer number of T-note returns in the data, sample sizes for T-notes, classified by month, were not sufficient to make statistical inference. In addition, tests are further compromised by the multiple subsampling (by month) problem. Nevertheless, the results of these tests clarify earlier indications that the predominant seasonal in the data—the negative average return on Monday—occurs during months immediately preceding a delivery month.

First, the negative Monday effect for GNMA and T-bond contracts is most pronounced in the month of February. For GNMA futures, average Monday returns on the nearby contract during February are −0.506 percent, and are significantly different from zero at the 0.05 level. For T-bond contracts, average Monday returns during February are −0.517 percent, also significant at the 0.05

[12] This procedure produces sample sizes that are still quite large. For T-bond and GNMA contracts, the smallest sample is 396. As the data on T-note contracts was less extensive, the smallest sample was 73 observations (on the most distant maturities). In all cases, samples are sufficiently large for statistical inference.

[13] The sample includes returns on the nearby contract during nondelivery months and returns on the next nearest contract during delivery months. As in some of our previous tests, inclusion of more distant contracts introduces serious contemporaneous correlation in returns and undermines the significance of test statistics. We performed a similar analysis using contracts with 4, 5, and 6 months to maturity and obtained similar results. These results are not reported in the paper.

level. Average Monday returns during all other months are not significantly different from zero for either GNMA or T-bond contracts. Additionally, the positive Tuesday seasonal previously observed on GNMA and T-bond futures during months prior to a delivery month is confined to the month of May for both contracts. For GNMA contracts, the average Tuesday return during May is 0.210 percent, and is significantly different from zero at the 0.05 level. For T-bond contracts, the average Tuesday return during May is 0.274 percent, and is significantly different from zero at the 0.05 level. For both types of contracts, average Tuesday returns during all other months of the year are not significantly different from zero.[14]

F. Nonparametric Tests

In some previous studies using daily price data in other markets, it has been established that the distributional properties of the data are significantly nonnormal (see, e.g., McFarland, Pettit, and Sung (1982)). In order to assure that our previous results are robust, nonparametric tests are performed to augment our earlier tests. Daily returns on the nearby contract (or next nearest contract during delivery months) are reexamined for each contract type, and for each time period studied, using a binomial sign test. For each day of the week, the number of positive and negative returns is computed. A z-statistic is computed to test the null hypothesis that positive and negative returns are equally likely events.

The results of the nonparametric procedures generally support our previous conclusions. In particular, indication of a negative Monday effect in GNMA and T-bond contracts is found again. Using close to close prices, negative Monday returns are significantly more frequent (at the 0.01 level) for both GNMA and T-bond contracts, but only during the sample period prior to January 1981. Thus, our previous conclusion holds up: a negative Monday seasonal is present in returns on GNMA and T-bond contracts, which is confined to the earlier period of the data.[15] At the same time, there is additional evidence of a positive, Tuesday effect in returns on GNMA and T-bond contracts during the period after December 1984. Positive Tuesday returns are significantly more frequent (at the 5-percent level) for both GNMA and T-bond futures during the latter sample period. The results concerning T-note contracts are less conclusive. While the positive Tuesday returns are observed more frequently on T-note contracts during the post-December 1984 period, the z-statistic is not significant at the 0.05 level.[16]

IV. Summary and Conclusions

The results of this study provide a more comprehensive investigation of

[14] Complete tabulation of month by month results for each contract is quite lengthy and, therefore, is not included here, however, complete results are available on request.

[15] We also should note that our nonparametric procedures show a significant negative effect on Wednesday for both GNMA and T-bond contracts. For GNMAs, this effect occurs during the latter sample period (after December 1984). For T-bonds, the negative Wednesday occurs during the earliest sample period (before January 1981). Thus, they are not contemporaneous phenomena. Moreover, while our parametric tests also showed some indication of negative Wednesday seasonals, they were not robust to more rigorous multivariate techniques.

[16] Again, while complete tabulations of our nonparametric results are too lengthy to include here, they are available on request.

weekly seasonals in GNMA, T-bond, T-note, and T-bill futures returns than has been done previously. Evidence is presented that, during the time period studied, two distinct and significant seasonal patterns are present in returns on GNMA, T-bond, and T-note futures returns. At the same time, no significant seasonals are found in T-bill futures returns. We find this result to be significant in two respects. First, it shows the seasonal patterns detected in GNMA, T-bond, and T-note futures are not descriptive of financial futures contracts in general. Moreover, this result provides some direction as to factors of the contracts—e.g., in the cash instrument involved or the exchange on which contracts are traded—which may help identify the source of seasonality in asset returns. Second, we note that seasonal patterns have already been established in the cash markets for both T-bonds and for T-bills and, while we do find similar patterns in T-bond futures, there is no corresponding seasonal pattern in T-bill futures. This evidence contradicts the notion that seasonal patterns in futures contracts are generally reflections of seasonal patterns in the underlying cash market.

Our results concerning GNMA and T-bond futures contracts are generally consistent with, but different from, the findings of previous studies. Using the complete sample of close to close returns, we find negative seasonals are present on Monday. This result is similar to that previously documented by Chiang and Tapley (1983). On closer examination of the data, however, several additional findings are obtained that provide a clearer and more complete explanation of the patterns in returns on GNMA and T-bond contracts.

Our evidence shows that the significance of seasonal phenomena in GNMA and T-bond futures depends, in an important way, on the time period studied. The negative Monday effect that has been reported for the variety of futures returns studied by Chiang and Tapley (1983), Gay and Kim (1987), and Chang and Kim (1988), generally pertain to the time period before 1982. Our results are similar in that the negative Monday observed in GNMA and T-bond futures returns occurs in the time period before January 1980. Since that time, however, no evidence is found of a negative Monday seasonal in returns on either contract. We do find, however, evidence of a positive seasonal on Tuesday in returns on GNMA, T-bond, as well as T-note contracts. The positive Tuesday effect is observed only during the latter sample period, after December 1984.

As in recent studies of stocks and stock index returns, we find the negative Monday seasonal in GNMA and T-bond futures returns to be associated with the weekend and *not* with other closings such as holidays. These remarkably similar results suggest that the negative Monday effects observed in both stock and futures markets might be due to some common characteristics of market organization. However, two additional findings are at odds with such a simple conclusion. First, previous research has demonstrated that (in recent years) the negative Monday seasonal associated with stock returns and with index futures actually occurs during nontrading hours over the weekend. An analysis of intraday returns in this study shows that the negative seasonal in GNMA and T-bond futures actually occurs during trading hours on Monday. Additionally, we find no negative Monday effect to exist in returns on T-note or T-bill contracts.

Finally, the study reveals that the observed seasonal patterns in GNMA, T-bond, and T-note contracts are more complex than previously believed. We find that the observed seasonal effects occur only during months prior to a delivery month. Moreover, the negative Monday effect observed on GNMA and T-bond contracts is concentrated in the month of February. The positive Tuesday effect observed on GNMA, T-bond, and T-note contracts is concentrated in the month of May. These results pertain not only to nearby contracts, but also to contracts with more distant settlements. Thus, seasonal patterns in these contracts are not due to approaching settlement. Rather, these phenomena appear to be related in some way to the delivery cycle itself, or to particular months of the year.

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