
MACROECONOMIC NEWS AND THE EFFICIENCY OF INTERNATIONAL BOND FUTURES MARKETS

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INTRODUCTION

Various aspects of the relationship between home country macroeconomic announcements and home country asset returns have been investigated by Jain (1988), Hardouvelis (1988), Roley and Troll (1983), Smirlock (1986), and Urich and Wachtel (1984). These authors focus primarily on how macroeconomic news [defined as the actual announced value minus the expected release value and usually obtained from Money Market Services (MMS)] affects either U.S. bond or equity price movements. Because these studies generally utilize market-closing prices, their primary focus is not concerned with market efficiency and the speed of adjustment of asset prices to news, but rather with the

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existence of an effect, if any, on the direction and size of asset price changes. Jain (1988) is an exception, since he uses hourly S&P 500 index data to also examine the influence of U.S. releases on *subsequent* hourly stock returns. He finds that U.S. stock prices respond to consumer price inflation and money supply news; and, consistent with market efficiency, that stock prices respond within a short period after the news, and that subsequent hourly returns are unrelated to the economic news. For bond markets, a more important exception is Ederington and Lee (1993), who use minute-by-minute futures data in the T-bond, Eurodollar, and deutsche mark futures markets to determine whether price movements in one-minute and five-minute time intervals *subsequent* to the release of macroeconomic data are influenced by the releases themselves. They find (p. 1189) that "most of the price adjustment to these information releases occurs within one minute of the release and trading profits based on the initial reaction basically disappear within this period." Futures markets are, thus, efficient with respect to the releases because subsequent returns are essentially independent of the first minute's return.

This study provides an analysis of the efficiency of bond futures markets that differs from that of Ederington and Lee (1993). In their work, market expectations are never used, and price deviations are defined in terms of the difference between the current market price and its average sample value (both defined as of a specific within-day time lag relative to the release of the macroeconomic data). As a result, these deviations are not conditioned on available information and can only be used to derive estimates of the relationship between the releases and the *unconditional* volatility of returns. An investigation of market efficiency, however, should be based on conditional expectations to provide more accurate answers to questions such as: What did the market know? How did it use this information over the course of a trading day? Using a proxy for the market's unobservable interest rate expectations will, of course, create a joint hypothesis concerning both the expectations formation mechanism and market efficiency. But using only market data to draw inferences about market efficiency is not a viable alternative, because it fails to address the conditioning behavior of market participants.

Following the practice of Jain (1988) and others, this study uses MMS forecasts to derive the *news* content of the alternative macroeconomic releases. Because several days elapse between the date of the MMS survey and the dates of the various releases, it is possible that intervening events may lead to a systematic revision in forecasts, which destroys the information value of the news estimated as the

difference between the release and MMS survey values. In other words, the MMS forecasts may be biased and inefficient and thus not consistent with rational expectations. To account for this possibility, tests for the bias and inefficiency of all forecasts are constructed and forecasts that violate the principles of rationality are discarded from the analysis. The news derived from the remaining forecasts is assumed to represent information available to market participants as of the exact time of the release. The market may use this information immediately, over the course of the trading day, or not at all. The market is defined to be inefficient if the information continues to have a *systematic* impact in trading periods subsequent to the time of release.

It is important to define "systematic effect" precisely. Data from economic news releases are usually broken down into numerous components and subcomponents. For example, total durable goods orders is broken down into consumer goods and materials and capital goods, which is comprised of nondefense capital goods, nondefense capital goods less aircraft and parts, and defense capital goods. Market participants prefer to exclude extremely volatile components such as the defense and transportation sectors. In 1992, for example, defense orders accounted for approximately 5% of total durable goods orders but contributed almost 50% to the series' variability. Moreover, transportation orders, which accounted for 25% of total orders and were often dominated by high-value aircraft orders, added to the volatility of the overall orders series and thus, if not excluded by market participants, would also have led to a misleading picture of the manufacturing sector [see Niemira and Zukowski (1994) for further discussion]. Because of the large amount of data contained in a release, an 8:30 AM release could have an impact on returns throughout the course of the trading day; the impact will not necessarily be confined to the period directly surrounding the release, because the news is further analyzed and reinterpreted. The issue addressed in this study, however, is not whether markets display delayed responses to 8:30 AM releases, but whether the responses are systematic, as manifested by statistically significant regression coefficients for returns in subsequent periods. Delayed responses to news are not inconsistent with market efficiency, but *systematic* delayed responses indicate predictability in asset returns.

In contrast to Jain (1988) and Ederington and Lee (1993), where each financial instrument used in their analyses was traded in only a single market, this article imposes an additional stringent requirement in testing for market inefficiency. Eurodollar futures, since 1986, and T-bond futures, since 1988, have been traded *simultaneously* on futures

exchanges in Chicago and London. Prices for futures contracts traded on these two exchanges should, in principle, be identical. Nonetheless, differences in market liquidity, as represented by the larger trading volumes on the Chicago exchanges, and in market microstructure and transaction costs may lead to differing price movements, particularly over short time intervals. Thus, the systematic responses in the two markets may differ because of either inefficiency or one of these other factors. To reduce the likelihood of accepting an explanation of market inefficiency when it is in fact false, the procedure used in this study requires simultaneous confirmation in both the London and Chicago markets to support a finding of market inefficiency. Using the two futures markets in this way provides a more stringent test for market inefficiency.

Another important issue deals with the amount of time that the market needs to assess the informational content of the news contained in the releases. Ederington and Lee (1993) use one-minute and five-minute return periods. This study lengthens the return period and controls for the potential influence of arbitrarily defined holding periods by examining both fifteen-minute and hourly return periods.

The findings in the article indicate that both the Eurodollar and T-bond futures contracts exhibit puzzling behavior over the course of the trading day with respect to several of the macroeconomic releases. In the fifteen-minute period commencing at the time of the announcement, there is evidence of an immediate underreaction to news about the consumer price index (CPI) in the T-bond market and to news about nonfarm payrolls in the Eurodollar market. That is, the prices of both instruments systematically respond in the same direction in several of the ensuing fifteen-minute intervals. Over the entire first hour, however, the Eurodollars appear to fully assimilate the nonfarm payrolls news, while there is evidence of a reversal in the direction of movement of T-bond prices two hours after the CPI news is released. Furthermore, the response to news about the merchandise trade balance is delayed in both markets. There are, of course, no rational explanations for these findings. While it may be difficult for the market to assess quickly the long-term consequences of macroeconomic news on long-term assets such as T-bonds, there is no reason to expect that its initial price reaction would exhibit a systematic pattern with respect to an ensuing period's reaction. On the other hand, even though additional stringent conditions have been imposed on the empirical procedure, the MMS expectations data may be biased in such a way as to impart spurious responses over the course of the day. At this point, therefore, the results for the T-bonds

and Eurodollars are anomalous; they appear to indicate that the market's responses to certain macroeconomic releases are not instantaneous but rather follow a predictable pattern throughout the day.

The outline of the article is as follows. The next section discusses both the futures and expectations data and reports the bias and efficiency tests for the MMS expectations of the various macroeconomic releases. The results of the intraday efficiency tests for the Eurodollar and T-bond markets are presented in the following section. The final section contains the conclusion.

DATA AND METHODOLOGICAL ISSUES

Data

Fixed-income performance is measured using prices from futures contracts traded in the U.S. and U.K. Price quotes closest to the quarter hour of every trading day from January 2, 1986 to December 28, 1990 are obtained from Tick Data Inc.¹ for Eurodollar futures contracts, which are traded at both the Chicago Mercantile Exchange (CME) and the London International Financial Futures Exchange (LIFFE). Trading hours for the LIFFE instruments are from 8:30 AM to 4:15 PM GMT,² while trading hours for the CME Eurodollars are from 8:20 AM to 4:00 PM EST. Thus, trading in these instruments spans regular U.S. macroeconomic announcements, which are typically released at 8:30 AM EST (1:30 PM GMT). Although U.S. T-bond futures are available at both the Chicago Board of Trade (CBOT) and the LIFFE, the CBOT futures data can be used only over a subperiod of the sample because trading in these contracts did not span the 8:30 AM EST release time until November 8, 1988. Thus, in the reported empirical work, the Eurodollar results refer to the entire time period, but the T-bond results refer to only a subperiod. All of the futures contracts possess a March, June, September, and December delivery cycle.

To measure bond performance, local currency logarithmic returns are calculated: $\ln(p_t/p_{t-1})$, where p_t is the current bond futures price and p_{t-1} is the lagged price. For each of the instruments, two series of holding periods are utilized to measure bond performance. The

¹The majority of the database constructed by Tick Data Inc., consisting of intraday prices for all futures contracts traded in the U.S. and London, is compiled from official exchange time and sales records.

²From 4:25 PM to 5:55 PM, contracts are traded using the Automated Pit Trading (APT) system. APT is a computer trading system developed by the LIFFE which emulates the open outcry market.

first is a sequence of fifteen-minute return periods beginning with the initial fifteen-minute period surrounding the news (8:30–8:45 AM EST). The second is a sequence of hourly return periods beginning with the initial hourly period surrounding the news (8:30–9:30 AM EST). These alternative holding periods are used to determine the short- and long-term response patterns of market prices to the news contained in the macroeconomic releases. For all of the instruments, prices are obtained for the near delivery contract up to two trading days before a delivery month, when prices for the next maturing contract are used. The crash week of October 17–23, 1987 is deleted from the sample.³

U.S. actual and forecast announcements are obtained from MMS for the following macroeconomic series: civilian unemployment rate (UN), CPI, durable goods orders (DG), housing starts (HS), index of leading indicators (LI), merchandise trade balance (MT), nonfarm payrolls (NF), producer price index (PPI), and retail sales (RS).^{4,5} Announcements for the above series occur at 8:30 AM EST. U.S. money supply announcements are not included in the sample because they are released after U.S. trading hours, at 4:15 PM EST on Thursdays. Both positive inflation surprises and surprises indicating a strengthening economy should result in lower bond prices. The signs of the economic activity variables will differ depending on how the variables are defined; the unemployment variable should be positively signed, while nonfarm payrolls surprises are anticipated to be negatively related to bond prices. In addition, the model assumes that a particular disclosure will have the same impact regardless of the state of the economy.

Properties of the MMS Forecasts

The MMS survey is conducted in the week preceding that of the macroeconomic releases; the published value is the median forecast and

³Because of market intervention by the Federal Reserve, the Eurodollar near maturity futures price increased from 90.40 to 92.40 from October 19 to October 20, 1987.

⁴Nonfarm payrolls and the unemployment rate are released simultaneously. Nonfarm payrolls provide the total number of employed individuals (excluding the farm sector), while the unemployment rate is defined as the ratio of the number of unemployed workers to the total labor force (the labor force is defined as employed individuals and those seeking employment). The correlation between nonfarm payrolls and unemployment is equal to -0.24 , which is significant at the 6% level. The lack of perfect negative correlation is probably attributable to the varying size of the labor force, particularly the number of job seekers.

⁵Over the time period of this study, the CPI disclosure for a particular month occurs one week after the PPI announcement. The expected CPI release for that month does incorporate PPI information because the PPI release occurs before MMS conducts its survey for the CPI. Thus, the correlation between the current month's PPI and CPI surprises in this study's sample is approximately equal to zero. In 1993, however, the CPI release was changed to occur one day after the PPI disclosure.

it is made public no later than the Sunday of the release week. To satisfy the principle of rational expectations and thus to be useful in an analysis of market efficiency, the forecast should be unbiased and efficient in the sense of Modigliani and Shiller (1973). These characteristics of the MMS expectations data were previously investigated by Pearce and Roley (1985), who conducted unbiasedness and efficiency tests for the MMS forecasts of the CPI, PPI, industrial production, and unemployment rate from 1977 to 1982. In the test of unbiasedness, the actual release value is regressed on the forecasted value, and the joint hypothesis of a zero intercept and unit slope is tested. A slope estimate that is significantly greater than one indicates that the survey data are biased downward in absolute value. In the efficiency test, the surprise value (actual release value minus the MMS forecast) for each series is regressed on lagged release values of the series, and the joint hypothesis of zero lag coefficients is tested. The idea here is that if announced data are generated by an autoregressive process, the market's expectation should be generated by the same process. As a result, the current surprise should be independent of the lagged announced values. Pearce and Roley find that the MMS survey estimates are unbiased (with the exception of industrial production) and efficient over the time period of their investigation. Similar tests for unbiasedness and efficiency are conducted for the sample in this article.

The results of the unbiasedness tests are presented in Table I. The *F* tests of the joint hypothesis of a zero intercept and unit slope reveal that the MMS forecasts of five out of the nine macroeconomic releases are biased over the sample period. The biased forecasts include those of the PPI, durable goods, leading indicators, and retail sales, which show downward bias because their regressions have slope terms that are statistically greater than one; the forecast of the unemployment rate exhibits an upward bias. The results of the efficiency tests are presented in Table II. The *F* tests indicate that lagged values of the PPI, durable goods, and retail sales announcements are significantly related to the current period's surprise, which is constructed using the MMS forecast value for each variable. The MMS forecasts of these variables, therefore, do not completely process all of the available information and, thus, violate the assumption of rational expectations. Overall, the two tests leave four forecasts that can be used in the investigation of market efficiency: CPI, merchandise trade, nonfarm payrolls, and housing starts. These forecasts satisfy the unbiasedness tests for rationality. News that is derived from these forecasts, therefore, reveals information about the state of the underlying real economy.

TABLE I
Unbiasedness Tests for Money Market Services (MMS) Survey Data

	<i>Intercept</i>	<i>Slope</i>	R^2_{adj}	<i>F</i>	<i>DW</i>
Consumer price index	-0.048 (0.034)	1.117 (0.087)	0.73	1.03	1.81
Producer price index	-0.210 (0.049)	1.475 (0.108)	0.76	11.55 ^a	1.74
Unemployment	0.395 (0.199)	0.922 (0.033)	0.93	7.62 ^a	1.78
Durable goods	0.163 (0.408)	1.744 (0.272)	0.40	3.93 ^a	2.15
Leading indicators	-0.014 (0.039)	1.229 (0.068)	0.85	5.85 ^a	2.41
Nonfarm payrolls	-20.81 (36.66)	1.207 (0.180)	0.43	1.21	1.81
Housing starts	0.100 (0.098)	0.927 (0.064)	0.78	0.90	1.56
Retail sales	-0.111 (0.087)	1.264 (0.076)	0.82	6.18 ^a	2.41
Merchandise trade	0.012 (0.013)	1.021 (0.098)	0.65	0.58	2.53

^aSignificant at the 1% level.

Estimates are reported of the regression of the actual release value on the MMS forecasted value for each macroeconomic data series from 1986 to 1990. Parameter values and standard errors (in parentheses) are presented. The *F* value refers to the joint hypothesis test of a zero intercept and unit slope.

Regression Methodology

To evaluate the efficiency of the Eurodollar and T-bond futures markets, ordinary least squares (OLS) regressions of the following form are estimated,

$$R_j = a_j + \sum_i b_i d_i N_i + u_j \quad (1)$$

where *j* refers to an arbitrary 15-minute or hourly period, *R_j* is the futures rate of return over the *j*th period, *N_i* is the news associated with the *i*th macroeconomic announcement at 8:30 AM EST, and *u_j* is a random variable that contains all other unsystematic factors occurring within the *j*th period. The parameter, *a_j*, represents unspecified systematic factors and *b_i* is the sensitivity of the *j*th period's return to the *i*th news release. If the futures markets are efficient, *b_i* should equal zero in every time period that does not encompass the announcement time of 8:30 AM EST. The dummy variable, *d_i*, is set equal to unity on the day when the announcement of the *i*th macro data series is made and to zero otherwise. Only observations on those trading days on which the CME, CBOT, and LIFFE are jointly open are included in the regressions.

TABLE II
Efficiency Tests for Money Market Services Survey Data

	<i>Intercept</i>	x_{t-1}	x_{t-2}	x_{t-3}	F	R^2_{adj}	DW
Consumer price index	-0.011 (0.32)	-0.088 (1.03)	0.023 (0.27)	-0.074 (0.93)	0.61	0.00	2.24
Producer price index	-0.047 (1.06)	0.187 ^a (2.34)	-0.069 (0.85)	-0.091 (1.24)	2.73 ^a	0.084	2.21
Unemployment	0.556 ^b (3.06)	-0.048 (0.34)	-0.070 (0.44)	0.008 (0.07)	0.30	0.00	1.98
Durable goods	0.441 (0.99)	-0.334 ^a (2.64)	-0.260 ^c (1.69)	-0.132 (0.98)	2.35 ^c	0.07	2.11
Leading indicators	0.014 (0.32)	-0.053 (1.00)	0.054 (1.01)	0.037 (0.66)	0.70	0.00	2.10
Nonfarm payrolls	-32.68 (0.99)	0.159 (1.38)	-0.057 (0.46)	0.114 (0.96)	1.32	0.02	1.96
Housing starts	0.005 (0.05)	0.004 (0.03)	0.043 (0.25)	-0.062 (0.41)	0.06	0.00	1.85
Retail sales	0.066 (0.62)	-0.197 ^b (2.68)	-0.119 (1.40)	0.050 (0.68)	4.24 ^b	0.14	2.28
Merchandise trade	0.319 (0.30)	-0.201 ^c (1.68)	0.045 (0.41)	0.143 (1.22)	1.00	0.00	2.14

^aSignificant at the 5% level.

^bSignificant at the 1% level.

^cSignificant at the 10% level.

Estimates are reported of the regression of the news surprise on three lags of the actual release values for each macroeconomic data series from 1986 to 1990. Parameter values and *t* values (in parentheses) are presented. The *F* value refers to the test of the joint hypothesis that all lagged coefficients are zero.

EVIDENCE ON THE INTRADAY EFFICIENCY OF EURODOLLAR AND T-BOND FUTURES MARKETS

Eurodollar Futures Markets

The effects of U.S. news about the CPI, merchandise trade, housing starts, and nonfarm payrolls are presented in Tables III–V. Tables III and IV show regression estimates of the four news variables for six 15-minute return periods commencing with the 8:30–8:45 AM period. Table V presents regression estimates for five one-hour return periods commencing with the 8:30–9:30 AM period. Tables III and V refer to contracts traded on the CME in Chicago, Table IV to contracts traded on the LIFFE in London.

Inspection of Tables III and IV reveals that in the first 15-minute period Eurodollar futures prices decline significantly for positive news shocks about the CPI and nonfarm payrolls and increase significantly for positive news shocks about the merchandise trade balance. News

TABLE III
Impact of U.S. News on Chicago Mercantile
Exchange (CME) Eurodollar Fifteen-Minute Returns

	8:30-8:45	8:45-9:00	9:00-9:15	9:15-9:30	9:30-9:45	9:45-10:00
Intercept	0.002 ^a (1.87)	0.002 (0.42)	-0.000 (0.94)	0.000 (0.29)	-0.001 (1.44)	-0.000 (0.85)
Consumer price index	-0.192 ^b (5.25)	-0.004 (0.22)	0.007 (0.42)	-0.009 (0.50)	0.003 (0.22)	0.006 (0.38)
Nonfarm payrolls	-0.486 ^b (13.60)	-0.050 ^b (3.04)	-0.036 ^c (2.21)	-0.021 (1.21)	0.000 (0.41)	0.001 (0.37)
Housing starts	-0.008 (0.41)	-0.011 (1.25)	-0.002 (0.17)	0.004 (0.40)	-0.004 (0.55)	-0.000 (0.37)
Merchandise trade	0.006 ^c (2.40)	-0.000 (0.28)	-0.002 ^c (2.01)	-0.000 (0.06)	-0.000 (0.17)	-0.000 (0.29)
F value	54.55 ^b	2.73 ^a	2.27 ^a	0.47	0.14	0.13
R ² _{adj}	0.15	0.06	0.04	0.00	0.00	0.00

^aSignificant at the 10% level.

^bSignificant at the 1% level.

^cSignificant at the 5% level.

Ordinary least squares estimates and *t* values (in parentheses, absolute value) measuring the effect of U.S. macroeconomic surprises on CME Eurodollar 15-minute returns from 1986 to 1990 are shown. Independent variables are U.S. surprises, defined as the actual 8:30 AM EST announced figure minus the expected value. The dependent variables are returns for alternative 15-minute periods.

TABLE IV
Impact of U.S. News on London International Financial
Futures Exchange (LIFFE) Eurodollar Fifteen-Minute Returns

	8:30-8:45	8:45-9:00	9:00-9:15	9:15-9:30	9:30-9:45	9:45-10:00
Intercept	0.002 ^a (2.42)	-0.001 ^b (1.91)	0.000 (0.16)	-0.000 (0.30)	0.000 (0.35)	-0.000 (0.42)
Consumer price index	-0.171 ^c (4.56)	0.001 (0.07)	-0.001 (0.59)	-0.005 (0.29)	0.001 (0.09)	-0.001 (0.01)
Nonfarm payrolls	-0.496 ^c (13.62)	-0.070 ^c (4.07)	-0.028 ^b (1.77)	-0.036 ^a (2.16)	0.000 (0.47)	-0.025 ^b (1.83)
Housing starts	-0.012 (0.60)	0.005 (0.49)	-0.007 (0.81)	-0.001 (0.06)	0.000 (0.05)	0.001 (0.07)
Merchandise trade	0.007 ^c (3.00)	-0.003 ^a (2.42)	-0.001 (0.64)	-0.001 (0.80)	-0.002 ^a (2.18)	0.001 (1.61)
F value	53.80 ^c	5.68 ^c	1.13	1.35	1.24	1.48
R ² _{adj}	0.15	0.02	0.00	0.00	0.00	0.01

^aSignificant at the 5% level.

^bSignificant at the 10% level.

^cSignificant at the 1% level.

Ordinary least squares estimates and *t* values (in parentheses, absolute value) measuring the effect of U.S. macroeconomic surprises on LIFFE Eurodollar fifteen-minute returns from 1986 to 1990. Independent variables are U.S. surprises, defined as the actual 8:30 AM EST announced figure minus the expected value. The dependent variables are returns for alternative fifteen-minute periods.

TABLE V
Impact of U.S. News on Chicago Mercantile
Exchange (CME) Eurodollar Hourly Returns

	8:30-9:30	9:30-10:30	10:30-11:30	11:30-12:30	12:30-1:30	1:30-2:30
Intercept	0.002 (1.25)	-0.001 (1.10)	0.000 (0.12)	0.000 (0.30)	0.000 (0.08)	-0.001 ^a (2.21)
Consumer price index	-0.216 ^b (4.72)	0.018 (0.60)	0.019 (0.86)	-0.007 (0.27)	0.014 (0.67)	-0.001 (0.05)
Nonfarm payrolls	-0.589 ^b (13.02)	-0.034 (1.17)	0.022 (1.01)	-0.000 (0.07)	0.014 (0.68)	0.000 (0.33)
Housing starts	-0.017 (0.68)	0.016 (0.96)	-0.001 (0.12)	0.007 (0.48)	0.001 (0.13)	-0.012 (0.89)
Merchandise trade	0.003 (1.03)	0.000 (0.17)	-0.000 (0.19)	-0.002 (1.32)	0.002 ^c (1.72)	-0.001 (0.55)
F value	48.26 ^b	0.67	0.45	0.51	0.98	0.30
R _{adj} ²	0.13	0.00	0.00	0.00	0.00	0.00

^aSignificant at the 5% level.

^bSignificant at the 1% level.

^cSignificant at the 10% level.

Ordinary least squares coefficient estimates and *t* values (in parentheses, absolute value) measuring the effect of U.S. macroeconomic surprises on CME Eurodollar hourly bond returns from 1986 to 1990. Independent variables are U.S. surprises, defined as the actual 8:30 AM EST announced figure minus the expected value. The dependent variables are returns for alternative hourly periods.

about housing starts does not have a significant effect on Eurodollar futures prices. Viewed as evidence of the existence of arbitrage between London and Chicago, the signs of the responses of the significant news variables for the initial 8:30-8:45 AM period are in agreement in the two tables; moreover, the point estimates are quite similar. Examining the later 15-minute periods, merchandise trade is significantly negative in both the 8:45-9:00 AM and 9:30-9:45 AM periods in London but only the 9:00-9:15 AM period in Chicago. This evidence, while suggestive of an initial overreaction to news about the trade balance, violates the required simultaneity condition for the two markets. Such is not the case, however, with nonfarm payroll news. Tables III and IV show that Eurodollar futures prices decrease significantly in the 8:45-9:00 AM and 9:00-9:15 AM periods. The fact that these decreases occur simultaneously in both the Chicago and London markets strengthens the finding that Eurodollar prices *underreact* in the initial 8:30-8:45 period to nonfarm payroll news. A negative price response, occurring when, say, positive nonfarm payroll news is discovered at the beginning of the initial 15-minute period, is continued into the two ensuing 15-minute periods. The markets' initial underreaction is a sign of market inefficiency with

respect to nonfarm payroll news as evaluated with MMS expectations data.

The results of the hourly regressions for the Chicago Eurodollars are presented in Table V. News about the CPI and nonfarm payrolls leads to significantly negative estimates at the 1% level in the first hour after the announcements; but the news about the merchandise trade balance, which shows a significantly positive impact over the initial 15-minute period in both Chicago and London, is insignificant in the hourly 8:30–9:30 AM regression. Although a significantly positive effect at the 10% level for this news variable is estimated in the 12:30–1:30 PM regression, this finding may be simply a statistical artifact rather than a finding against market efficiency. At a tighter level of significance, therefore, the evidence in Table V is consistent with the hypothesis that after the first hour the Eurodollar futures markets are efficient over the remainder of the trading day with respect to news evaluated with MMS expectations.

T-Bond Futures Markets

The results for the alternative 15-minute holding period regressions are presented in Tables VI and VII for the T-bond futures markets

TABLE VI
Impact of U.S. News on London International Financial
Futures Exchange (LIFFE) T-Bond Fifteen-Minute Returns

	8:30–8:45	8:45–9:00	9:00–9:15	9:15–9:30	9:30–9:45	9:45–10:00
Intercept	0.018 (0.21)	–0.003 (0.62)	0.004 (0.92)	0.000 (0.04)	0.003 (0.93)	–0.002 (0.52)
Consumer price index	–1.802 ^a (6.43)	0.008 (0.05)	0.054 (0.38)	–0.277 ^b (2.05)	–0.454 ^a (3.50)	–0.008 (0.07)
Nonfarm payrolls	–3.250 ^a (10.06)	0.000 (0.36)	0.083 (0.51)	–0.035 (0.22)	0.000 (0.35)	0.032 (0.22)
Housing starts	0.008 (0.03)	–0.024 (0.16)	0.090 (0.64)	–0.001 (0.02)	0.031 (0.25)	0.021 (0.18)
Merchandise trade	0.007 (0.25)	–0.028 ^c (1.70)	0.009 (0.61)	–0.023 (1.62)	–0.010 (0.75)	0.007 (0.54)
F value	35.72 ^a	0.76	0.30	1.82	3.35 ^b	0.09
R ² _{adj}	0.21	0.00	0.00	0.01	0.02	0.00

^aSignificant at the 1% level.

^bSignificant at the 5% level.

^cSignificant at the 10% level.

Ordinary least squares estimates and *t* values (in parentheses, absolute value) measuring the effect of U.S. macroeconomic surprises on LIFFE T-bond 15-minute returns from November 8, 1988 to December, 1990. Independent variables are U.S. surprises, defined as the actual 8:30 AM EST announced figure minus the expected value. The dependent variables are returns for alternative 15-minute periods.

TABLE VII
Impact of U.S. News on Chicago Board of
Trade (CBOT) T-Bond Fifteen-Minute Returns

	8:30-8:45	8:45-9:00	9:00-9:15	9:15-9:30	9:30-9:45	9:45-10:00
Intercept	0.017 (0.19)	-0.002 (0.59)	0.006 (1.51)	0.001 (0.21)	0.001 (0.14)	-0.001 (0.17)
Consumer price index	-1.731 ^a (5.96)	-0.016 (0.12)	0.111 (0.82)	-0.32 ^b (2.24)	-0.353 ^a (2.73)	-0.059 (0.47)
Nonfarm payrolls	-2.857 ^a (8.53)	-0.326 ^b (2.00)	0.062 (0.39)	-0.157 (0.95)	0.069 (0.46)	0.065 (0.45)
Housing starts	0.104 (0.36)	-0.139 (1.00)	0.158 (1.18)	-0.148 (1.05)	0.219 ^c (1.73)	-0.082 (0.67)
Merchandise trade	-0.007 (0.22)	-0.036 ^b (2.46)	-0.002 (0.11)	-0.013 (0.87)	-0.008 (0.58)	0.003 (0.22)
F value	27.25 ^a	2.77 ^c	0.54	1.95 ^c	2.88 ^b	0.22
R ² _{adj}	0.17	0.01	0.00	0.01	0.01	0.00

^aSignificant at the 1% level.

^bSignificant at the 5% level.

^cSignificant at the 10% level.

Ordinary least squares estimates and *t* values (in parentheses, absolute value) measuring the effect of U.S. macroeconomic surprises on CBOT T-bond 15-minute returns from November 8, 1988 to December, 1990. Independent variables are U.S. surprises, defined as the actual 8:30 AM EST announced figure minus the expected value. The dependent variables are returns for alternative 15-minute periods.

in London and Chicago, respectively. Table VIII contains the results of the one-hour regressions for the Chicago market. Inspection of the 15-minute regressions shows that T-bond prices react significantly negatively to news shocks about the CPI and nonfarm payrolls during the announcement period of 8:30-8:45 AM and that the responses are almost identical between London and Chicago.

Tables VI and VII reveal two instances of significant effects in the T-bond markets that are inconsistent with the hypothesis of market efficiency. The first arises with news about the merchandise trade balance. In both London and Chicago, the 8:45-9:00 AM regression shows that T-bond prices respond negatively to positive trade balance news shocks. Since the same news is available in the initial 15-minute period, but does not elicit any response, the delay indicates that unexploited profits are systematically available in the first 15-minute period. The second instance of market inefficiency arises with the pattern of response to CPI news shocks. In both London and Chicago, the initial significantly negative coefficients are followed by significantly negative coefficients in both the 9:15-9:30 AM and 9:30-9:45 AM time periods. This pattern suggests that market participants underreact in the 15-minute period surrounding the release of the CPI. There are other

TABLE VIII
Impact of U.S. News on Chicago Board of Trade (CBOT) T-Bond Hourly Returns

	8:30-9:30	9:30-10:30	10:30-11:30	11:30-12:30	12:30-1:30	1:30-2:30
Intercept	0.004 (0.34)	-0.002 (0.26)	-0.005 (0.81)	0.009 (1.24)	-0.010 (1.52)	-0.000 (0.11)
Consumer price index	-1.958 ^a (5.21)	-0.220 (0.82)	0.469 ^b (2.20)	0.107 (0.47)	0.078 (0.36)	0.174 (0.66)
Nonfarm payrolls	-3.284 ^a (7.58)	-0.195 (0.63)	0.101 (0.41)	-0.497 ^c (1.88)	0.263 (1.06)	-0.027 (0.89)
Housing starts	-0.028 (0.07)	0.177 (0.67)	0.131 (0.62)	0.015 (0.07)	-0.013 (0.06)	0.039 (0.15)
Merchandise trade	-0.058 (1.48)	0.002 (0.08)	-0.047 ^b (2.13)	-0.012 (0.50)	0.001 (0.31)	0.009 (0.31)
F value	21.90 ^a	0.39	2.35 ^c	0.99	0.34	0.34
R ² _{adj}	0.13	0.00	0.01	0.00	0.00	0.00

^aSignificant at the 1% level.

^bSignificant at the 5% level.

^cSignificant at the 10% level.

Ordinary least squares estimates and *t* values (in parentheses, absolute value) measuring the effect of U.S. macroeconomic surprises on CBOT T-bond hourly bond returns from November 8, 1988 to December, 1990. Independent variables are U.S. surprises, defined as the actual 8:30 AM EST announced figure minus the expected value. The dependent variables are returns for alternative one-hour periods.

significant coefficients in the Chicago regressions, such as those for housing starts in the 9:30-9:45 AM period and nonfarm payrolls in the 8:45-9:00 AM period, but these are not corroborated by a similar finding of significant coefficients in the London regressions.

Table VIII provides even more evidence that is inconsistent with the hypothesis of market efficiency. In the 10:30-11:30 AM time period, T-bond returns respond significantly positively to the CPI news shock and significantly negatively to the merchandise trade balance news shock. The first response indicates that an initial overreaction to the CPI news occurs during the first hour following the CPI announcement; the second confirms a two-hour delayed reaction to the trade balance news. Furthermore, the significantly negative coefficient for the nonfarm payroll news shock in the 11:30-12:30 PM regression also indicates that the market initially underreacts to nonfarm payroll news shocks. From an efficiency viewpoint, the results in Table VIII appear to be anomalous regarding the information contained in news shocks as processed by MMS expectations data.

CONCLUSION

This study examines the intraday efficiency of U.S. futures prices (Eurodollars and T-bonds) to the news content of U.S. macroeconomic

releases in which the news is determined using MMS expectations data. Since the latter data are available to the market at the 8:30 AM release time for the various macroeconomic series investigated in this article, the news associated with the expectational errors should be impounded in market prices quickly, if markets are efficient. The pricing behavior of each instrument in two futures markets is examined. Only those instances when significant responses occur simultaneously in both markets are used to support a market inefficiency explanation. Furthermore, the macroeconomic releases for which the corresponding MMS expectations exhibit bias over the sample period are deleted from the regression analysis. The findings indicate that the prices of the Eurodollar and T-bond contracts behave anomalously over the course of the trading day. In the case of news about the merchandise trade balance, the market's response appears to be delayed; while in the case of CPI and nonfarm payroll news shocks, the markets tend to underreact initially. There are no logical explanations for the futures market's apparent failure to exploit quickly all of the information available to it. Perhaps the MMS expectations data are biased in some unspecified manner and thus create spurious response patterns over the course of the day. Barring this possibility, the results in this article appear to be anomalous from the viewpoint of market efficiency.

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