The Informational Role of End-of-the-Day Returns in Stock Index Futures

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INTRODUCTION

Traditionally, futures markets have been recognized as performing two main functions—price discovery and hedging. The price discovery function helps market participants ascertain information about the market's expectation regarding future cash market prices from the futures market. The hedging function facilitates the transfer of risk by allowing market participants to use the futures market as a substitute for cash transactions.

Grossman (1977) proposes "a new explanation of the role of futures markets as a place where information is exchanged, and where people who collect and analyze information about the future state of the world can earn a return on their investment in information gathering" (p. 431). In this capacity, futures markets act as a conduit for transmitting information from the informed to uninformed. Based on Grossman's model, the futures market does this imperfectly due to the presence of noise in the price system. Fortunately, for informed traders, noise prevents their views about the future from being instantly and clearly revealed. Otherwise, the gatherers of information would not be able to earn an adequate return on their investment. According to Grossman and Stiglitz (1980), the assumptions that markets are informationally efficient and always perfectly arbitraged are inconsistent when information is costly.

Grossman (1977) argues that the incentive to invest in information gathering is inversely related to the forecasting ability of the current spot price to predict the expected future spot price. For example, let $P[jt]$ represent the closing price for the S&P 500 index on the jth trading day-of-the-week and $P[j + 1, t]$ the S&P 500 index price at 11:00 AM on the subsequent trading day.[1] Regress $P[j + 1, t]$ on

[1]Throughout this article, the S&P 500 index price is referred to as the spot price. The S&P 500 futures price is referred to as the futures price. All prices are recorded at Eastern Standard Time. S&P's monthly "500 Information Bulletin" reports an opening price for the S&P 500 index. However, this price is the index price recorded one minute after the NYSE opens and contains many stale quotes.

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The Journal of Futures Markets, Vol. 12, No. 5, 595–601 (1992)
 CCC 0270-7314/92/050595-07

$P[jt]$ and calculate the sample standard deviation of the residuals:

$$P[j+1,t] = a + bP[jt] + u[t] \tag{1}$$

The magnitude of the standard deviation of the residuals in eq. (1) is positively related to the private incentive for information gathering on $P[j+1,t]$. In 1982, the Chicago Mercantile Exchange (CME) introduced a futures contract based on the S&P 500 index. Uninformed equity traders now have the S&P 500 futures price as well as the S&P 500 spot price transmitting information to them. Information gathering via index futures includes the probing for stops by floor traders (i.e., "locals") and large nonexchange member traders.

An important feature of the S&P 500 index contract is futures trading 15 minutes beyond the close of the New York Stock Exchange, 4:00 PM EST. This article investigates the informational role of end-of-the-day (4:00 to 4:15 PM EST) S&P 500 futures returns over the period May 1982 through March 1988. End-of-the-day futures return volatility for the jth trading day of the week is positively related to the incentive for information gathering on $P[j+1,t]$. End-of-the-day futures return volatility is associated with the production of information, in particular, private information.[2]

METHODOLOGY

An important theoretical distinction exists between private and public information. Public information is information to which security prices immediately react when it is revealed. In contrast, private information affects prices through trading. Over time, private information decays and becomes public information. Grossman and Stiglitz (1980) conjecture that the more informed are traders, the more informative is the price system and the lower the ratio of the expected utility of the informed to the uninformed.

French and Roll (1986) examine the observation that stock returns tend to be more volatile during exchange trading hours than during nontrading hours and conclude that private information, in contrast to public information, is the principal factor behind high trading time variances.[3] Ross (1989) demonstrates that in an arbitrage-free economy, return volatility is directly related to information production. In his model, the variance of price changes equals the rate of information flow. Under such circumstances, an increase in the rate of information flow results in higher return volatility and vice versa.

Assume that information production on $P[j+1,t]$ occurs during the trading period on the jth trading day of the week. This study argues that informed traders will trade on their information before the market closes. Otherwise, they face the distinct possibility of information decay over the nontrading period if their private information becomes public. Since informed traders only profit by trading, the bulk of information gathering on $P[j+1,t]$ takes place during the trading period.

Traders with market-wide information have two decisions to make: where to trade and when to trade. The first decision involves whether transactions should

[2]The relationship between information and volatility may be more complicated than Grossman's model suggests. As Harris (1989b) notes, "theoretical analyses of whether speculative trade destabilizes cash markets leads to conflicting conclusions, depending on what assumptions are made" (p. 1155). He characterizes both informed and uninformed trading as having two opposite effects on volatility. That is, either can lead to increased volatility or to decreased volatility, depending on whether information/noise or liquidity effects dominate.

[3]Oldfield and Rogalski (1980) find that stock returns are more volatile during trading hours than during nontrading hours.

be executed in the spot or futures market. Since futures transactions are less costly and more liquid, it is argued that informed traders will prefer to transact in the futures market. Another distinct advantage of transacting in the futures market is the relative ease and even greater cost advantage of establishing short positions using index futures.

Admati and Pfleiderer (1988) have developed a model which provides a structural link between private information, trading volume, and stock return variances. Their model contains four classes of traders: (1) informed traders who trade strategically to maximize returns from their private information; (2) random liquidity traders; (3) specialists; and (4) discretionary liquidity traders. Both discretionary liquidity and informed traders will cluster, with each group preferring to trade during periods when liquidity trading volume is highest. In general, this occurs at the end of the day. Admati and Pfleiderer argue that "prices quoted at the end of the trading day will reflect more of the information that will be released publicly during the following nontrading hours" (p. 35).

To summarize the above discussion: the bulk of information gathering on $P[j + 1, t]$ occurs during the trading period; informed traders with market-wide information prefer to transact in the futures market; end-of-the-day price changes in index futures reflect information that will be revealed publicly during the following nontrading period; and higher end-of-the-day futures return volatility corresponds to more information gathering on $P[j + 1, t]$ and vice versa.

DATA

Data are collected on the 11:00 AM and closing spot prices for the S&P 500 index over the period May 1982 through March 1988. May 1982 corresponds to the start of trading in S&P 500 futures. The closest time stamped transaction to 4:00 PM and the corresponding S&P 500 futures settlement price are extracted from data tapes obtained from the CME.[4] Observations are recorded for the nearest futures contract with observations switched to the next most distant futures contract at the beginning of the contract month. Pre- and postholidays are excluded.

EMPIRICAL RESULTS

Incentive for Information Gathering

Regressions of $P[j + 1, t]$ on $P[jt]$ over the period May 1982 through March 1988 are performed and the sample standard deviation of the residuals (a separate regression for each day of the week) are calculated. The results are reported in Table I. The maximum value for the standard error of the regression is recorded for Friday, the minimum value for Wednesday. Based on Bartlett's test of homogeneity of variance, the null hypothesis that the standard error of the regression is equal across the days of the week is rejected. Information gathering to forecast Monday's (Thursday's) 11:00 AM S&P 500 spot price offers the largest (smallest) payoff.

End-of-the-Day Futures Return Volatility

Grossman (1977) claims that the incentive for information gathering on $P[j + 1, t]$ is positively related to the sample standard deviation of the residuals in eq. (1).

[4]Due to missing data on the tapes supplied by the CME, end-of-the-day futures returns are not calculated over the period October 23, 1987 through November 12, 1987.

Table I
STANDARD DEVIATION REGRESSION RESIDUALS AND END-OF-THE-DAY FUTURES RETURNS: REGRESSION $P[j+1,t] = a + bP[jt] + U[t]$

Standard Deviation Regression Residuals				End-of-the-Day Futures Returns (Std. Dev.)
P_{jt}	U_t	Rank	Rank	
Mon.	1.488	3	2	0.1908
Tue.	1.698	2	3	0.1746
Wed.	1.186	5	5	0.1621
Thur.	1.240	4	4	0.1717
Fri.	2.104	1	1	0.2214
Chi-square statistic	36.43[a]			127.08[a]
r	0.881[b]			

[a,b]Significant at the 0.01 and 0.05 level, respectively. Independent variable = closing price of S&P 500 index on the jth trading day of the week. Dependent variable = 11:00 AM EST price of S&P 500 index on the subsequent trading day. Chi-square statistic: variance equal across the days-of-the-week. r = Sample correlation coefficient between standard deviation of regression residuals and the standard deviation of end-of-the-day futures returns. End-of-the-day futures returns are measured from 4:00 to 4:15 PM EST on the jth trading day of the week.

It is argued here that end-of-the-day futures return volatility is positively related to information production on $P[j+1,t]$. Higher return volatility indicates more information gathering and vice versa.

The standard deviations of end-of-the-day futures returns for each day of the week over the sample period are presented in Table I. The maximum value for end-of-the-day return volatility is recorded for Friday, the minimum value for Wednesday. Based on Bartlett's test of homogeneity of variance, the null hypothesis that return volatility is equal across the days of the week is rejected. Consistent with the previous results, on average, the flow of information at the end of the day is relatively "large" on Fridays and relatively "small" on Wednesdays. The sample correlation coefficient between the standard deviation of the residuals in eq. (1) and end-of-the-day futures return volatility equals 0.881 ($p < 0.05$). The potential payoff for information gathering on $P[j+1,t]$ is positively related to the production of information on the jth trading day of the week.

Futures and Spot Returns by Day of the Week

End-of-the-day futures returns are divided into two groups. The first group contains all returns while the second group contains so-called large returns. An end-of-the-day futures return is defined as large if

$$|\text{end-of-the-day futures return} - \mathrm{M}| > \mathrm{SD}, \tag{2}$$

where M and SD represent the mean and standard deviation for all days. It is argued here that the magnitude of end-of-the-day futures returns is positively related to the flow of information. On average, the flow of information is greater at the end of the day for large returns. Table II shows the mean S&P 500 futures and mean 11:00 AM S&P 500 spot returns by day of the week.

Table II
S&P 500 11:00 AM SPOT AND END-OF-THE-DAY FUTURES RETURNS BY DAY-OF-THE-WEEK: MAY 1982 THROUGH MARCH 1988

End-of-the-Day Futures Return				S&P 500 11:00 AM Spot Return			
All Returns		Large Returns		Large Returns		All Returns	
Day	Mean	Mean	Rank	Rank	Mean	Mean	Day
Mon.	0.043	0.081	1	2	0.113	0.070	Tue.
Tue.	0.014	0.063	3	3	0.106	0.112	Wed.
Wed.	0.012	−0.023	4	4	−0.047	0.022	Thur.
Thur.	0.035	0.078	2	1	0.163	0.069	Fri.
Fri.	−0.004	−0.030	5	5	−0.074	−0.187	Mon.
F	2.64[b]	1.71			1.34	8.37[a]	
r	0.273[a]	0.416[a]					

[a,b]Significant at the 0.01, and 0.05 level, respectively. Spot returns are measured from the close of trading on the jth trading day of the week to 11:00 AM EST on the subsequent trading day. End-of-the-day futures returns are measured from 4:00 to 4:15 PM EST on the jth trading day of the week. F-statistic: mean returns equal across the days of the week. r = Sample correlation coefficient between the futures return and the corresponding spot return. Large returns are based on the end-of-the-day futures return. Large returns = futures return at least one standard deviation distant from the mean.

Friday's mean futures return is negative for both groups. For other days, the mean futures return is positive except for large returns on Wednesday. A number of factors potentially could explain low futures returns at the end of the day on Friday. These factors include: futures traders closing out long positions at the end of the day; portfolio managers hedging long stock positions; and the information of informed traders made public during the following nontrading period. Futures traders and portfolio managers are aware that mean stock returns are negative over the weekend, a phenomenon known as the weekend effect. This is consistent with a systematic pattern of closing out long futures positions and hedging long equity positions at the end of the day on Fridays.

Based upon Admati and Pfleiderer's model, the return pattern observed at the end of the day (except Friday) reflects the information of informed traders that will be released during the following nontrading period and which, on average, is favorable. An alternative explanation is provided by Harris (1989b). He finds a tendency for a systematic increase in stock prices at the close and suggests that the latter is due to most closing prices being at the ask. The tendency for futures returns to rise at the end of the day (except Friday) could be related to this phenomenon. Harris notes that the spot price increase at the end of the day is not immediately reversed the next day. This observation is consistent with the evidence presented in Table II.

Results similar to the findings for end-of-the-day futures returns are reported for 11:00 AM spot returns. Monday's mean spot return is negative for both groups.[5] For other days, the mean spot return is positive except for large returns on Thursday.

[5]Stoll and Whaley (1987) report that S&P 500 returns rise at the close on "triple witching" Fridays and then reverse themselves on the following Monday. Here, Monday opening returns following Fridays on which index futures and index options expire simultaneously are calculated over the data set (March 1984 through March 1988). This occurs on 16 Mondays. Monday's mean 11:00 AM opening return for these observations equals 0.087%.

Table III
DIRECTION OF END-OF-THE-DAY FUTURES RETURNS AND THE CORRESPONDING S&P 500 11:00 AM SPOT RETURN

	S&P 500 11:00 AM Spot Return			
	Mean	**Std. Dev.**	**r**	**t-Statistic**
A. End-of-the-day futures return > 0				
	0.114	0.534	0.177[a]	
B. End-of-the-day futures return < 0				
	−0.102	0.567	0.247[a]	6.95[a]

[a]Significant at the 0.01 level. S&P 500 spot return is measured from the close of trading on the jth trading day-of-the-week to 11:00 AM EST on the subsequent trading day. End-of-the-day futures return = return on the jth trading day of the week as measured from 4:00 to 4:15 PM EST. t-Statistic: mean S&P 500 spot of panel A = mean S&P 500 spot of panel B.

The hypothesis of equal mean returns across the days of the week is rejected for the aggregate set of all returns. However, the results are not significant at a meaningful level for large returns. These results provide some support for the conjecture that the type of information production on $P[j+1, t]$ is related to the day of the week. In particular, the production and subsequent flow of information via stock index futures is relatively unfavorable on Fridays. The release of unfavorable information on Friday, particularly after the close of stock trading, has been documented in a number of studies, for example, Dyl and Maberly (1988), Patell and Wolfson (1982), and Penman (1987).

Table III reports the 11:00 AM mean spot return based on the direction (positive or negative) of the end-of-the-day futures return.[6] The 11:00 AM mean spot return is positive (0.114%) for positive end-of-the-day futures returns (panel A); and, conversely, negative (−0.102%) for negative end-of-the-day futures returns (panel B). The mean return in panel A is statistically different from the mean return in panel B ($t = 6.95$, $p < 0.01$). The sample correlation coefficient between end-of-the-day futures returns and 11:00 AM S&P 500 spot returns is significant at the 0.01 level in both instances. Therefore, positive (negative) end-of-the-day futures returns are associated with positive (negative) 11:00 AM spot returns.

CONCLUSIONS

This article investigates the informational role of end-of-the-day S&P 500 futures returns. End-of-the-day futures return volatility for the jth trading day of the week is positively related to the incentive for information gathering on the 11:00 AM spot price. End-of-the-day return volatility is associated with the production of information.

It is found that the incentive for information gathering on the 11:00 AM spot price is relatively strong on Fridays and relatively weak on Wednesdays. Likewise, the end-of-the-day flow of information is relatively large on Fridays and relatively small on Wednesdays. These results indicate that the flow of information is a function of the day of the week, with relatively more unfavorable information being produced

[6]The 11:00 AM mean spot return is based on the previous day closing and 11:00 AM spot prices, $\ln(P[j+1,t]/P[jt]) * 100$.

on Fridays. A positive correlation exists between end-of-the-day futures returns and 11:00 AM spot returns.

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