The Profitability of Volatility Spreads around Information Releases

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INTRODUCTION

Since the introduction of options on interest rate futures, traders have frequently bought and sold pairs of puts and calls on these options in anticipation of an economic announcement. These strategies are undertaken to profit from a change in the volatility of the futures contract resulting from a major economic announcement. Implicit in such actions are beliefs that: (1) certain economic series contain an unanticipated component large enough to meaningfully affect prices; and (2) the price change is large enough to affect the volatility of the underlying asset. Other series may be viewed as "nonevents" in that the observed value rarely deviates meaningfully from that anticipated by the market.

There is evidence that some economic series do have a substantial element of surprise. Urich and Wachtel (1984) find that the unanticipated component of the money supply announcement has a significant effect on Treasury bill futures rates. Bhattacharya (1986) finds an effect from both unexpected levels in housing start and inflation announcements on GNMA futures prices. Jain (1988) documents a stock market price reaction to surprises in money supply and consumer price index announcements. These studies regress price changes against the unanticipated component of an announcement. Since they employ unexpected volatility, they make no statement about market efficiency in terms of profit potential from trading in anticipation of these observed price changes. Even if the mean of the price change cannot be predicted, systematically biased estimates of the magnitude of price changes can generate profit opportunities. Thus, using options to trade on anticipated volatility effects would be one way to profit from market inefficiencies.

The purpose of this study is to determine the extent to which option prices correctly reflect volatility spikes related to the announcement of major economic series. The efficiency of the market is further examined by evaluating the profit opportunities from specific options trading strategies that capitalize on volatility changes. Knowing that T-bond futures may display some reaction to these announcements, options on T-bond futures are used to answer the following ques-

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tions: (1) does the volatility of the futures contract, as implied by the options price, show a significant change on the announcement dates of major economic series?; and (2) does the announcement reflect an excess profit opportunity for options traders?

The contribution of this study is two-fold. First, it examines the impact of economic announcements in terms of market efficiency. Even if a particular series of announcements is consistently associated with significant changes in implied volatility, this does not always translate into an excess profit opportunity. Second, the study encompasses a much larger set of economic announcements than has been used to date, thereby providing a more comprehensive view of the possible market effects that these series might have.

EFFECTS OF UNANTICIPATED COMPONENTS OF ECONOMIC ANNOUNCEMENTS

Surprises in some economic series have been shown to result in price changes in futures contracts. If traders know that T-bond futures are affected by the unanticipated component in some economic announcements, then the distribution of possible price changes should be reflected in the implied volatility of the options prior to the announcement date. However, if a price change is far enough away from predictions, it could cause a one-time change in implied volatility after an announcement.

Evidence of a statistical difference in average volatility following an economic announcement would indicate that the market exhibits a predisposition to consistently under- or overestimate the price effect of a given economic series on T-bond futures. Essentially, such a statistical change in volatility would indicate that *forecasted* price volatility for T-bond futures is consistently under- or overestimated prior to the announcement, and that this is not a transitory phenomenon, but rather persists for somewhat lengthy time periods.

The direction of change in implied volatility depends on the actual price effect of an announcement relative to the prior expectation of the price effect. For example, if the price effect is expected to be large, and the actual price change consistently falls well within the range of the anticipated change, then the implied volatility could fall subsequent to the announcement. On the other hand, the price effect may be larger than anticipated, so that the actual price change causes an increase in the implied volatility on the day of announcement.[1] In either case, volatility spreads might be profitable if, on average, implied volatility prior to the announcement does not adequately reflect these price changes.

DATA AND METHODOLOGY

The set of economic series chosen for this study are listed in Table I. The series are chosen either because their price effects have been examined in previous studies, or

[1]Patell and Wolfson (1981) measure the effect of earnings announcements by measuring the change in implied volatility in stock options over time, assuming that this measure is always changing to reflect the average volatility in the underlying process until the expiration date. They illustrate ways in which the average volatility could change on the date of an announcement if there is a spike in the volatility of the underlying asset. Of course, if the possibility of such a spike is already anticipated, the average volatility should also reflect it. In such a case, volatility spreads should not be consistently profitable.

Table I
ECONOMIC SERIES STUDIED

Series	n	Agency
1. Advance Durable Goods Order	24	Bureau of the Census
2. Business Inventory Report	24	Bureau of the Census
3. Capacity Utilization	24	Federal Reserve Board
4. Civilian Unemployment Rate	21	Bureau of Labor Statistics
5. Consumer Installment Credit	25	Bureau of Economic Analysis
6. Consumer Price Index	20	Bureau of Labor Statistics
7. Domestic Car Sales	69	Bureau of the Census
8. GNP Deflator	8	Bureau of Economic Analysis
9. GNP Flash Report	24	Bureau of Economic Analysis
10. Housing Starts	23	Bureau of the Census
11. Industrial Production	24	Federal Reserve Board
12. Money Supply	24	Federal Reserve Board
13. Personal Consumption	24	Bureau of Economic Analysis
14. Producer Price Index	25	Bureau of Labor Statistics
15. Treasury Statement	24	Department of the Treasury

because of their likely effects on interest rates.[2] Futures and options prices are collected for the market close before the announcement and the open after the announcement for the years 1984 and 1985.[3] The settlement prices and the high and low of the open for the nearby T-bond futures and T-bond futures options closest to expiration are used. Options include those closest to the money, and those at the next two highest and next two lowest strikes.

Implied Volatility Changes

Two implied volatility calculations are performed: one for the settlement price and one for the following open. Since there is no single price for the opening, the mean of the high and low of the opening range are used. This paired volatility calculation is repeated for each announcement event date of the particular economic time series. The average volatility change for each series is then calculated.

The implied volatility is calculated as the value of the parameter, σ, that minimizes the sum of squared deviations of the observed options prices from the theoretical values for those options. That is,

$$\min_{\sigma} \sum_{i=1}^{n} \left\{ O_{io} - O_{ir} \right\}^2$$

where O_{io} and O_{it} represent, respectively, the observed and theoretical values of the ith option (a put or a call) in the data set of the n options gathered. The analytic approximations are those suggested by MacMillan, and subsequently improved

[2]The Money Supply, Consumer Price Index, Housing Starts, Producer Price Index, Industrial Production, and Civilian Unemployment Rate were studied by Urich and Wachtel (1984), Bhattacharya (1986), and Jain (1988). All other series had at least monthly observations and were announced at times that were predictable, enabling traders to take volatility spreads at the correct times.

[3]Since futures options and futures markets in T-bonds open and close at the same time, the prices are essentially simultaneous.

upon by Barone-Adesi and Whaley (1987). The theoretical model is that of Black (1976) for an American put or call on a futures contract. While the model is not perfect for the distribution of T-bond futures prices, there is no model that dominates it. Based on a control group test described below, the model provides stable estimations of volatility when there are no announcements. Furthermore, it is the model most widely used by exchange traders.

A control group of 51 dates over the 1984–1985 period that had no announcements is also formed, and the change in volatility from close to open is calculated also for this group. The control group of nonannouncement dates shows no significant change in implied volatility. This result is important in light of the following arguments. First, it could be argued that a different composition, or set of motivations of the trading group at the open and close, could lead to a systematic difference in implied volatilities measured at these two times. Second, it is possible that changes in volatility in the sample are due not to the domestic announcements studied, but to events overseas that would be impacted in the following morning's volatility. Third, the limitations of the options pricing model chosen may result in observed changes in volatility when none are present. The results of the control do not support the foregoing arguments. The fact that the control group exhibits no change in volatility lends credence to the choice of the model in estimating volatility, and to the interpretation that observed changes in volatility are due to the unanticipated component of the announcements studied rather than to the other possible causes listed above.

Trading Profits

The next step is to simulate the options positions that traders commonly take to profit from an expected change in volatility. Five positions are simulated:

1. A long straddle, where the trader buys one put and one call with the same strike price and expiration date. If implied volatility increases, the long straddle makes money.
2. A long outstrangle where the trader buys one out-of-the money put and one out-of-the money call with the same expiration date. If implied volatility increases, the long outstrangle makes money, with a lower potential loss than the long straddle.
3. A long instrangle, where the trader buys one in-the-money put and one in-the-money call with the same expiration date. The profit profile is similar to that of a long outstrangle.
4. A long call back spread, where the trader buys at-the-money calls equal to the ratio of 1/delta, and sell one futures contract. The net effect is that of a long straddle.
5. A long put back spread, where the trader buys at-the-money puts equal to the ratio of 1/delta, and buys one futures contract. The net effect is that of a long straddle.

The five basic strategies all display similar profit/loss profiles, with slight differences. While some exhibit a larger dollar change in value for a given volatility change, they are also more expensive to initiate. If the market is efficient, the expected profit and risk of a given strategy are commensurate with its cost, and no particular strategy would dominate others ex ante. All five strategies result in prof-

its when volatility increases. Profit occurs in one of two ways. First, an increase in volatility causes an increase in the value of the put and call options at any given futures price. This is graphically represented by an upward shift in the profit/loss curve. Second, a futures price movement in the right direction results in a gain.[4]

All transactions are assumed to occur at the settlement or the mean of the high and the low of the opening range. The average rate of return from each type of strategy for each announcement is found. First, the ending dollar value on the position is divided by the initial investment. (The initial investment is the value of the margin on the combined options and futures positions as set by the Chicago Board Options Exchange during the 1984–1985 period. Any collateral is assumed to earn interest, which is added during the ending dollar value calculation.) This figure is divided by the days since the close (to account for weekends or holidays from the close to the open). The rate of return is calculated as the log of this figure.

DISCUSSION OF RESULTS

Table II lists the average change in volatility in the options of T-bond futures following announcements in the 1984–1985 period studied, as well as for the control

Table II
CHANGES IN IMPLIED VOLATILITY
FOLLOWING AN ECONOMIC ANNOUNCEMENT

Series[a]	Sample Size	Vol. Change	*t*	*T*+	Johnson *t*
1	24	0.0026	2.0741[d]	2.7385[d]	0.8817
2	24	0.0044	2.5945[d]	2.7006[d]	1.4959
3	24	0.0034	1.7663[c]	0.9288[c]	1.1621
4	21	0.0028	1.6343	1.1811	1.0726
5	26	0.0030	2.3815[d]	2.4132[d]	1.2840
6	24	0.0024	1.8569[c]	2.2510[c]	0.9480
7	69	0.0021	2.4268[d]	2.2066[d]	1.6305
8	8	−0.0004	−0.4188	−0.9802	−0.5314
9	24	−0.0027	−1.5241	−0.9126	−1.9887[c]
10	23	0.0004	0.1626	−0.0456	0.0620
11	24	−0.0020	−1.0435	−0.1825	−1.3102
12	101	0.0005	0.6387	1.3178	0.5373
13	24	0.0015	2.1113[d]	2.3155[d]	1.4207
14	25	−0.0014	−0.8925	−0.2018	−1.1225
15	24	0.0008	0.9698	1.7003	0.7737
C[b]	51	0.0005	0.6713	2.2703	0.4726

[a]The series are described by number in Table I. Since all series appear to deviate from the normal distribution, both the *T*+ and Johnson statistic are reported, although the *T*+ is the appropriate one if there is no asymmetry in the distribution.

[b]C is a control group of 51 dates for which there is no economic announcement during the 1984–1985 period.

[c]Significant at the 10% level.

[d]Significant at the 5% level.

[4]While the payoff function from a long volatility spread is convex, this does not imply that all price movements will be profitable; only those which move away from the minimum point of the function.

group. Based on a visual examination of histograms of the distributions of the changes in volatility, none of the series appears to be asymmetric. Each distribution of results is then tested for asymmetry and deviations from the normal distribution.[5] Again, not one of the series shows evidence of asymmetry. Since all series appear to deviate from the normal distribution, both the $T+$ (signed rank Wilcoxon) and the Johnson t-statistic are presented with the regular t-statistic.[6]

Based on the t-statistic appropriate for each series, seven of the economic series appear to result in a significant change in volatility in the options on T-bond futures: Advance Durable Goods Orders, Business Inventory Report, Capacity Utilization, Consumer Installment Credit, Consumer Price Index, Domestic Car Sales, and Personal Consumption. An eighth series, the GNP flash report, has a significant Johnson t-statistic, but does not have a significant t- or $T+$-statistic. Of these, all but the GNP flash report exhibit an average increase in volatility. Such an increase may indicate that the market is consistently underestimating the magnitude of the price effect in response to unanticipated components of the relevant announcement. The fact that the GNP flash report is accompanied by an average decline in volatility may indicate that any accompanying price effects fall consistently short of those expected.

While the studies cited previously show that some of the Money Supply, Housing Starts, inflation, and the Consumer Price Index series have an effect on futures and stock prices, only the Consumer Price Index series is associated with an increase in options volatility. The magnitude (not the direction) of the price effect from any unanticipated component of these announcements may have already been correctly assessed by the market.

Table III lists the profits that would have been realized from the trading strategies. These profits are calculated assuming trades on the close at the settlement price and trades on the open at an average of the bid–ask prices. The statistical procedures used for the changes in volatility are also applied to the distributions of profits. Of all the simulated positions, there are 12 that result in a significantly positive profit, and three that result in a significantly negative profit. These 15 strategies are spread over nine different series. The six series that have no significant returns associated with them are Civilian Unemployment Rate, Consumer Installment Credit, Consumer Price Index, Housing Starts, Money Supply, and Producer Prime Index.

Initially, these profit results appear to be somewhat surprising. Significant changes in volatility do not appear to lead the way to profitable trading strategies. Even a casual analysis of the results reveals no relationship between volatility and profits. In fact, one of the series showing a significant change in volatility, Consumer Installment Credit, has not a single profitable strategy associated with it. These results are not as surprising as they might first seem. While an increase in volatility shifts the profit/loss curve upward graphically, there is usually an accompanying price shift, which may work against the trader.[7] Conversely, price shifts may occur that do not affect volatility, but are large enough to provide significant profits.

[5]The tests for symmetry used are the symmetry t- and j-statistics described in Hollander and Wolfe (1973). If the distribution is found to be asymmetric, then the appropriate test would be the Johnson t (1978). The Shapiro–Wilk (1965) test for normality is applied to those series which showed no evidence of asymmetry. Since the distributions appear to be symmetric but nonnormal, the $T+$ (signed rank Wilcoxon) nonparametric test is reported.

[6]The Johnson t-statistic is presented in spite of the lack of evidence of asymmetry. It is possible that the power of the tests is not great enough to correctly identify the asymmetric distributions.

Table 3
STRATEGIES AND PAYOFFS FOR SERIES USING AVERAGE OR SETTLEMENT PRICES FOR ORDERS

Series[a]	Strategy[b] 1	2	3	4	5
1	0.0253[c]	0.0318[c]	0.0067	0.0169	0.0125[c]
2	0.0291	0.0420[c]	0.0529	0.0422[c]	−0.0051
3	0.0208	0.0364[d]	0.0083	0.0225	0.0002
4	0.0210	0.0336	0.0269	0.0403	0.0028
5	0.0202	0.0330	0.0148	0.0220	0.0005
6	0.0146	0.0270	0.0115	0.0133	−0.0002
7	0.0090	0.0194[d]	0.0103	0.0164	−0.0056
8	−0.0073	−0.0178	0.0052	−0.0155[d]	0.0161[d]
9	−0.0171	−0.0313[c]	−0.0131	−0.0232	−0.0065
10	0.0002	−0.0026	−0.0079	−0.0147	0.0053
11	−0.0063	0.0104	−0.0051	−0.0439[c]	0.0061
12	0.0049	0.0074	0.0053	0.0056	−0.0026
13	0.0119[c]	0.0134	0.0003	0.0082[c]	0.0073
14	−0.0017	0.0126	−0.0022	−0.0255	0.0045
15	0.0131[d]	0.0147[d]	−0.0045	0.0042	0.0030

[a]The series are described by number in Table I.

[b]The strategies are—1:A long straddle, where the trader buys one put and one call with the same strike price and expiration date. 2: A long outstrangle where the trader buys one out-of-the money put and one out-of-the money call with the same expiration date. 3: A long instrangle, where the trader buys one in-the-money put and one in-the-money call with the same expiration date. 4: A long call back spread, where the trader buys at-the-money calls equal to the ratio of 1/delta, and sells one futures contract. 5: A long put back spread, where the trader buys at-the-money puts equal to the ratio of 1/delta, and buys one futures contract.

[c]Significant at the 10% level.

[d]Significant at the 5% level.

One might conclude from these figures that the market is inefficient with respect to some economic series. There appears to be a profit potential from undertaking volatility spreads in advance of certain economic announcements. Of the significantly profitable positions, the average rate of return ranges from 0.0051 to 0.0422.

However, while an average rate of return of 4.22% for an overnight position is very large, one must remember that these positions are not without risk, and the calculations do not adjust for risk. Furthermore, the profit potential reported in this table is not easily exploited. It is important to understand that, on the opening or closing, the public (as opposed to members) will almost certainly be buying at the high and selling at the low of that range. With this in mind, the trading profits are recalculated using the offer and bid prices for the purchases and sales, respectively. Table IV lists the profits under this new assumption. The results are strikingly different. Not one of the 75 total positions has a significantly positive profit, and 26

[7]While not reported here, short positions of the spreads are simulated also. Not one series yields significantly positive profits in the short spreads.

Table IV
STRATEGIES AND PAYOFFS FOR DIFFERENT SERIES USING HIGH AND LOW PRICES FOR THE BUY AND SELL ORDERS

	Strategy[b]				
Series[a]	1	2	3	4	5
1	0.0120	0.0090	0.0039	−0.0159	−0.0168[d]
2	0.0203	0.0234	0.0238	0.0208	−0.0260[d]
3	0.0131	0.0205	0.0066	0.0042	−0.0150[d]
4	0.0090	0.0121	0.0226	0.0076	−0.0227[d]
5	0.0118	0.0196	0.0132	0.0004	−0.0170[d]
6	0.0011	0.0052	0.0081	−0.0170	−0.0284[d]
7	0.0006	0.0027	0.0079	−0.0077	−0.0255[d]
8	−0.0211[d]	−0.0450[d]	0.0000	−0.0461[d]	−0.0123[c]
9	−0.0297[d]	−0.0567[d]	−0.0170	−0.0550[d]	−0.0321[d]
10	−0.0127	−0.0237	−0.0101	−0.0450[d]	−0.0177[d]
11	−0.0176	−0.0103	−0.0086	−0.0725[d]	−0.0183[d]
12	0.0049	0.0074	0.0053	0.0056	−0.0026
13	−0.0020	−0.0172	−0.0035	−0.0217[d]	−0.0180[d]
14	−0.0161	−0.0114	−0.0070	−0.0610[d]	−0.0239[d]
15	0.0010	−0.0051	−0.0063[c]	−0.0257[d]	−0.0209[d]

[a]The series are described by number in Table I.

[b]The strategies are— 1: A long straddle, where the trader buys one put and one call with the same strike price and expiration date. 2: A long outstrangle where the trader buys one out-of-the money put and one out-of-the money call with the same expiration date. 3: A long instrangle, where the trader buys one in-the-money put and one in-the-money call with the same expiration date. 4: A long call back spread, where the trader buys at-the-money calls equal to the ratio of 1/delta, and sells one futures contract. 5: A long put back spread, where the trader buys at-the-money puts equal to the ratio of 1/delta, and buys one futures contract.

[c]Significant at the 10% level.

[d]Significant at the 5% level.

have significantly negative profits. This is an indication that, for the average trader, the market holds no consistent profit opportunities.

This apparent turnabout in the profitability figures should serve as a caution to those who use settlement or average prices in testing for market efficiency. It is clear that, once transaction costs are taken into account, the apparent market inefficiencies disappear. In fact, any attempt to capitalize on a perceived volatility effect from an economic announcement appears to be an impressive way to lose money to transaction costs.

SUMMARY AND CONCLUSIONS

This study extends previous work on the effects of economic announcements on interest rates. It does so by: (1) examining the change in implied volatility in T-bond futures options following the announcement dates of 15 different series; and (2) investigating excess profit opportunities using positions in these options surrounding the announcement date. Only eight of the series coincide with a significant change in volatility. However, some of the series found in previous studies to have a price effect associated with an unanticipated component are not those associated with

significant volatility changes. It appears that, for many of the economic series studied (including most of those examined in previous studies), the market is fairly accurate in its estimation of volatility.

On the other hand, simulated strategies undertaken to benefit from changes in volatility sometimes prove to be significantly profitable, even in the absence of significant volatility changes. The strategies are successful, but not for the reasons initially stated: profits may come from price changes, even if the underlying volatility has not changed. These trading profits totally disappear with the inclusion of transaction costs in the profit calculations. Thus, while the market appears to be inefficient with respect to the effects of some economic announcements, these inefficiencies disappear after accounting for transaction costs.

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