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# THE LEAD-LAG RELATIONSHIP BETWEEN THE OPTION AND STOCK MARKETS PRIOR TO SUBSTANTIAL EARNINGS SURPRISES AND THE EFFECT OF SECURITIES REGULATION

C. Mitchell Conover* and David R. Peterson**

## Abstract

This study investigates the lead-lag relationship between the option and stock markets for 17 trading-days prior to substantial earnings surprises, using the Berkeley options data base, changes in put-call parity, and a control option methodology. Before the passage of the Insider Trading Sanctions Act (ITSA) in 1984, the options market leads the stock market prior to negative surprises but that the stock market leads prior to positive surprises. After the passage of ITSA there is no leading role for either market under positive or negative surprises. These results may suggest important roles for institutional factors, such as short sale constraints, and the intensity of securities regulation.

## INTRODUCTION

Several studies find informed trading in equity markets by insiders and others prior to earnings announcements. Meulbroek [16] reports run-ups in stock prices that are almost half that of announcement day abnormal returns. Elliott, Morse, and Richardson [9] find that insiders both increase their purchases and decrease their sales of stock prior to the announcement of large earnings increases. Finally, Affleck-Graves, Jennings and Mendenhall [1] find informed trading over a six-week period preceding earnings surprises.

The above studies focus on informed trading in the stock market. However, there are many reasons why informed traders would prefer the options market to the stock market. First, options may provide a greater leverage position in the underlying stock. Second, Cox and Rubinstein [7] argue that since institutional investors set prices in the options market, the interest rates implicit in option prices are more favorable than individual investors could obtain on their own. Third, transactions costs for trading in options are often lower. Fourth, for those who wish to take a short position, the options market offers further advantages. There is no uptick rule in the options market as there is for short sales in the stock market and losses in a short position can be limited with the purchase of put options, whereas the loss from shorting stocks is potentially unlimited. Additionally, many institutions are restricted from short sales but not option positions.

If informed traders prefer the options market, the value of private information should be impounded into options prices before stock prices. Evidence of option prices or volume leading stock prices or volume is found by Manaster and Rendleman [15], Bhattacharya [5], Anthony [3], and Finucane [12]. Stephan and Whaley [19] find that the stock market leads the option market, but Chan, Chung, and Johnson [6] show this result is due to wider percentage tick moves and bid-ask spreads in the options market, leading to nonsychronous trading. Generally, however, these studies do not explicitly test the lead-lag relationship in specific cases where some traders may have private information. It is in these instances when the motivations to trade first in the options market should be the strongest.

A few researchers have investigated the lead-lag relationship prior to the release of valuable information. For example, Stephan and Whaley [19] proxy for the arrival of information by examining stocks with large changes in price on a given day and conclude that the stock market leads the options market. However, their test does not determine the cause of the stock price change. Many influences on stock prices are those which few traders would have knowledge of beforehand. Thus, their methodology does not actually test for the presence of informed trading prior to informational announcements. Also, they only examine the lead-lag relationship the day of the price change.

*Northern Illinois University
**Florida State University

Amin and Lee [2] examine option trading before earnings announcements. They find abnormally high option volume up to four days before the announcement and abnormal option returns up to 30 trades prior to the announcement. However, equity returns are also abnormal preceding the announcement and, thus, it is not clear if one market is leading the other. If earnings announcements were restricted to large surprises, rather than using all announcements, then anticipatory price patterns may have been clearer. Lastly, option and stock prices are examined only immediately around the announcement (50 trades preceding the announcement). Informed traders may take positions much sooner.

Despite the inherent and legal advantages that options offer informed traders and despite the overwhelming evidence that informed trading occurs prior to informational announcements, there is a lack of evidence as to whether informed traders use the options market resulting in the options market leading the stock market prior to informational events. The purpose of this study is to determine whether the options market leads the stock market prior to earnings surprises. Rather than examining a few hours or trades before the earnings release, as in prior research, pricing relationships are analyzed over a seventeen trading-day period preceding the announcement date. Unlike previous studies of informed trading before earnings announcements, this study only examines announcements that elicit a significant stock price response. Additionally, the relationship between the options and stock market is assessed using put-call parity, which does not depend on the validity of an option pricing model or the calculation of implied volatilities.

This paper also determines if any lead relationship is asymmetric with respect to the type of the news. Initial options positions undertaken by informed traders should be larger for bad news since the options market offers unique advantages for short positions which are not available in the stock market. With the availability of options, stock prices should adjust more quickly to negative information as this information is impounded more efficiently due to the advantages of options with respect to short positions. Damodaran and Lim [8] find that the listing of put options results in a faster speed of reaction to bad news earnings announcements and greater anticipation of them. Figlewski and Webb [11] find that stocks with listed options do not experience the same degree of future underperformance as do firms without options when short sales are high. This implies that options provide unique opportunities for traders wishing to trade on negative information. Thus, the extent to which the options market leads the stock market should be heightened prior to the release of unfavorable earnings announcements. Whereas prior studies find that the presence of options improves informational efficiency with respect to bad news, none explicitly test whether it is a leading options market that causes this asymmetry.

Last, this paper examines whether changes in the regulatory environment have affected the lead-lag relationship between the options and stock market. The Insider Trading Sanctions Act of 1984 (ITSA) increased the penalties for insider trading in general and options trading in specific. Prior to the passage of ITSA there was doubt as to whether insider trading laws pertained to options and whether options traders could be prosecuted under insider trading laws since they are trading in a derivative security not held by stockholders and, thus, there is a lack of fiduciary duty to shareholders. However, Congress closed this loophole with the passage of ITSA that made option traders liable to stockholders so that inside trading in the options market was illegal. This law may have had a significant impact on informed trading prior to earnings announcements, and mitigated a potential leading role for the options market. Seyhun [18] finds that corporate insiders are more reluctant to trade in equity markets prior to earnings announcements after the passage of ITSA. However, no one has examined the impact of ITSA on informed trading in the options market. The resolution of this issue has important implications for the effectiveness of security regulation and its proper emphasis, and increases our understanding of the options market as it has developed through time.

This study is developed as follows. The next section describes the data and methodology. Empirical results are provided in the following section. The last section presents a conclusion.

## DATA AND METHODOLOGY

### Data

The resorted form of the Berkeley Options Data Base is employed to identify all firms with listings on the Chicago Board Options Exchange (CBOE) of at least three months during the period January 1983 through November 1988. It also provides call, put, and stock price quotations. Standard and Poor's Compustat database is used to obtain quarterly earnings announcement dates. The earnings announcement dates for firms not covered by Compustat are obtained from the *Wall Street Journal Index*. For each earnings announcement a three-day window surrounding the Compustat or *Wall Street Journal* announcement date is used to search for the day with the largest market-adjusted stock price response, using the University of Chicago's Center for Research in Security Prices (CRSP) data base. This day is defined as the announcement date, or day *ED=0*.

The sample of earnings announcements is then reduced to eliminate those that are not substantial enough to produce a large stock price response. Previous studies rely on earnings models to determine the informational importance of announcements. However, this study examines only those announcements that actually result in a substantial stock price movement since it is for these announcements that informed traders should have the greatest incentive to trade. Those announcements eliciting a market-adjusted return on *ED=0* greater than zero are referred to as positive news announcements and those eliciting a market-adjusted return on *ED=0* less than zero are referred to as negative news announcements. The positive and negative earnings announcements are each sorted in order of market-adjusted return. The top 25 percent of positive earnings announcements and the lower 25 percent of negative earnings announcements are selected.

The data is divided by subperiods to analyze the effect of security regulations on the lead-lag relationship in the options and stock markets. ITSA was passed on August 10, 1984. Since the tests to follow examine informed trading over almost a month before an earnings announcement, the second subsample of earning announcements begins a month after the passage of the law. Thus, the post-ITSA sample period does not begin until September 10, 1984. The ending date for the first subsample is the day that ITSA was passed. Therefore, the pre-ITSA subperiod is from February 1, 1983, through August 10, 1984, and the post-ITSA subperiod is from September 10, 1984, through November 19, 1988. These subsamples of earnings announcements are used in subsequent tests to ascertain the effectiveness of securities regulation.

In this study, day *ED=0* is defined as the probable first public release of the earnings announcement. Using a SEC database of prosecuted insider trading cases, Meulbroek [16] finds that the average insider trading incident takes place 13.2 days before the information is made public. Patell and Wolfson [17] find substantial increases in implied volatilities in the options market beginning approximately seventeen trading-days prior to quarterly earnings announcements. Using these studies as a guide for the estimation interval, the investigation of the lead-lag relationship begins at day *ED=-17*, with quotes during days *ED=-20* to *ED=-18* forming a benchmark period. The study ends at day *ED=-1*, the day before public release of the earnings announcement.

The calculation of put-call parity relationships requires concurrent prices of puts, calls, and the underlying stock. The Berkeley data base is first searched for put quotes and then these are matched with the chronologically nearest call quotes, occurring within fifteen minutes of the put quote, that have the same underlying stock price. Bid and ask quotes are used instead of transaction prices because they allow a more accurate characterization of the relationship between stock and options. Together with the accompanying stock price, the paired put and call quotes provide the security price information needed to calculate put-call parity measures. For each firm one put-call pair is chosen that has a common maturity and exercise price and this same pair is used throughout the estimation period to ensure consistency of put-call parity measurements. The analysis uses the most actively traded put-call pair for each firm.

The sample of stock and option prices are also structured to ensure that both markets are trading at the same time. Before September 30, 1985, the options market opened at 9:00 Central Standard Time (CST) while the stock market opened at 8:30 CST. Though both markets now open at 8:30 CST, options do not start trading until the underlying stock has already traded. Since the opening of the options market is delayed relative to the stock market, we eliminate the first stock price and option bid and ask quote of each trading day. Also, because the stock market closes at 3:00 CST, the sample of options prices is restricted to those before 3:00 CST, as in Stephan and Whaley [19].

In the model of Kyle and Villa [14], informed traders may wish to conceal their activity in securities markets by transacting with noise traders. In the case of options, most noise trading will take place in the most thickly traded options. Thus, in addition to choosing the most thickly traded options for each firm, the analysis is repeated for a subsample of earnings announcements with accompanying high options volume. The larger sample is partitioned to include only the top half of positive and top half of negative earnings announcements where the partition is based on the volume of options traded.

The final sample consists of 511 announcements. The number of announcements in each subperiod and for both positive and negative news is shown in Table 1. The sample is split fairly evenly between positive and negative news announcements with slightly more positive announcements. Table 1 also provides summary statistics for the announcement date market-adjusted returns of each subsample. All have a mean market-adjusted return near 0.05 in absolute value, with a standard deviation close to 0.02. These earnings announcements provide considerable incentive for an informed trader to act before the first public release and hence are of economic significance.

## TABLE 1

**Number of Quarterly Earnings Announcements and Statistics for Market-Adjusted Returns by Sub-period and Type of Announcement**

The following quarterly earnings announcements are for CBOE firms during the period February 1983 until November 1988. Announcements eliciting an announcement day market-adjusted return greater than zero are referred to as positive news while those eliciting a market-adjusted return less than zero are referred to as negative news. The pre-ITSA period is measured from February 1, 1983, to August 10, 1984. The post-ITSA period is from September 10, 1984, to November 19, 1988.

| Sub-period and Type of Announcement | Number of Earnings Announcements (Number of Firms) | Mean Market-Adjusted Return (Standard Deviation) | Maximum Market-Adjusted Return in Absolute Value | Minimum Market-Adjusted Return in Absolute Value |
|---|---|---|---|---|
| Pre-ITSA Positive News | 90 (29) | 0.0529 (0.0252) | 0.225 | 0.035 |
| Pre-ITSA Negative News | 82 (63) | -0.0545 (0.0282) | 0.200 | 0.032 |
| Post-ITSA Positive News | 181 (51) | 0.0514 0.0203 | 0.190 | 0.035 |
| Post-ITSA Negative News | 158 (94) | -0.0497 (0.0184) | 0.119 | 0.032 |
| Total Number of Earnings Announcements (Firms) | 511 (146) | | | |

## Methodology

An exact put-call parity relationship for American options cannot be derived as for European options, since, in the presence of dividends, both American puts and calls may be optimally exercised early. However, in the absence of market frictions and with known interest rates and known dividend amounts paid twice over the life of the option, upper bounds (*UB*) and lower bounds (*LB*) can be derived for the stock price, as in Jarrow and Rudd [13]:

Equation 1

$$UB_t = C_t^a - P_t^b + d_1 B(t,T_1) + d_2 B(t,T_2) + K \geq S_t$$

Equation 2

$$LB_t = C_t^b - P_t^a + L \leq S_t$$

where *L* is the minimum of:

$[KB(t,T) + d_l B(t,T_l) + d_2 B(t,T_2)]$, $[KB(t,T_2) + d_l B(t,T_l)]$, $[KB(t,T_l)]$.

In equations (1) and (2), $C_t$ and $P_t$ denote call and put option quotes and the superscripts denote the bid and ask. The current time is $t$ while $T_i$ is the time that dividends, $d_i$, are paid, and $T$ is the time of option expiration. $K$ is the exercise price, $S_t$ is the stock price, and $B(t,T_i)$ is the price at time $t$ of a default risk free, zero coupon bond paying $1 at maturity of time $i=1,2$. $B(t,T)$ is the price at time $t$ of a default risk free, zero coupon bond paying $1 at expiration of the option.

If call option prices become more underpriced (overpriced) relative to stocks then the deviation of the stock price from its lower (upper) boundary will widen and the deviation of the stock price from its upper (lower) boundary will narrow. Similarly, if put option prices become more underpriced (overpriced) relative to stocks then the deviation of the stock price from its lower (upper) boundary will narrow and the deviation of the stock price from its upper (lower) boundary will widen.

Prior to positive earnings announcements, informed traders would most likely take a long position in the stock or its call options, or they would sell put options. Thus it is expected that stock and call option prices should rise and put prices fall. In the presence of trading in the options market that precedes trading in the stock market, there should be upward pressure on call prices and downward pressure on put prices. In this case, the deviation of the stock price from its lower boundary should narrow as the lower boundary moves closer to the stock price and the deviation from the upper boundary should widen as the upper boundary moves away from the stock price. If, instead, the stock market leads the options market prior to earnings announcements, there should be upward pressure on stock prices prior to the announcements. In this case, the deviation of the stock price from its lower boundary should widen and the distance from the upper boundary should narrow.

Prior to negative earnings announcements, informed traders would most likely take a short position in the stock or write call options, or they would buy put options. Stock and call option prices should decrease and put prices should rise. In the presence of trading in the options market that precedes that in the stock market, there should be downward pressure on call prices and upward pressure on put prices. In the case of bad news, the deviation of the stock price from its lower boundary should widen as the lower boundary falls below the stock price and the distance between the stock price and upper boundary should narrow as the upper boundary drops closer to the stock price. If, instead, the stock market leads the options market prior to earnings announcements, there should be downward pressure on stock prices beforehand. In this case, the deviation of the stock price from its lower boundary should narrow and the deviation of the stock price from its upper boundary should widen.

The following statistic is defined to evaluate the relationship between option and stock prices in the period preceding earnings announcements:

Equation 3

$$D_t = \frac{S_t - LB_t}{UB_t - LB_t}$$

$D_t$ is a measure of deviation from put call parity that is scaled by the difference in upper and lower bounds for an option. Scaling by the upper and lower boundaries controls for differences in $D_t$ due to differences in option bid-ask spreads across firms. $D_t$ should decrease (increase) in the preannouncement period for positive (negative) earnings announcements if the options market leads the stock market. If, on the other hand, the stock market leads the options market, $D_t$ should increase (decrease) in the preannouncement period for positive (negative) announcements.

Although a lead-lag relationship may exist between the stock and option markets, it is not possible to hypothesize the duration of changes in put-call parity boundaries. The duration of such changes depends on the informativeness of security price movements and the presence of market frictions that would prevent market observers from acting on such movements. If capital markets are perfect, then a lead for either the stock market or options market would quickly vanish within seconds. In this case, $D_t$ would remain constant during days *ED=-20* to *ED=0*. If, however, market frictions are present, the adjustment process between the two markets might be somewhat slower. In this case, $D_t$ would change at some time during days *ED=-20* to *ED=0* with an eventual return to its previous value. The methodology does not suggest that put-call parity boundaries are violated. Rather, the goal is to determine if there has been some movement within the boundaries due to the presence of informed trading. Because of market frictions, it is expected that movements in the boundaries implied by put-call parity endure long enough to be detected such that the informativeness of boundary movements will not be immediately impounded into the lagging market's prices. Since the informativeness of potential unusual trading in the options market is likely to be eventually impounded into stock prices, changes in put-call boundaries should be measured over an interval short enough to detect the presence of such changes. However, the interval chosen must also contain at least one put and call quote to calculate put-call parity. Half-day intervals are used to satisfy both constraints.

$D_t$ is first calculated for each earnings announcement for days *ED=-20* to *ED=-18* to form a benchmark statistic. During this benchmark period, $D_t$ is calculated for each earnings announcement for all quotes on the chosen pair of options in the three trading-day period. All the $D_t$s during this three-day period are then averaged to form the benchmark statistic for each announcement, referred to as $D_b$.

Days *ED=-17* to *ED=-1* are then divided into half-day intervals and a representative $D_t$ is calculated for each half-day interval for each earning announcement using all option bid and ask quotes for the same chosen pair in the interval.

If only one put-call pair is available in an interval, then that pair is used to form the representative $D_t$ for that interval. If more than one pair is available, then all pairs are used to form an equally-weighted average $D_t$ and this average $D_t$ is used as the representative $D_t$ for an earnings announcement firm during an interval. The separation of trading days into halves uses noon as the division between the two intervals.

Because the passage of time is known to decrease the value of both put and call options, the value of $D_t$ may change over time even in the absence of informed trading. Hence, $D_t$ is also calculated for an option control firm over the benchmark period (days *ED=-20* to *ED=-18*) and for each of the intervals during the event period (days *ED=-17* to *ED=-1*). In each time period, the $D_t$ for this control firm is subtracted from the $D_t$ of the firm with an upcoming earnings announcement to arrive at statistics that should be free of passage of time effects. Four control firms are selected for use so that each of the three possible calendar trading cycles that CBOE options trade on are represented by at least one control firm. The January, April, July, and October cycle is represented by IBM options. The February, May, August, and November cycle is represented by Hewlett Packard options and the last trading cycle is represented by General Motors options in 1983-1986 and General Electric options in 1987 and 1988. These four control firms are chosen because they were very actively traded, minimizing sample attrition for any half-day interval.

The particular put and call control options selected for each earnings announcement firm must have the same maturity date as the announcement firm's options and a ratio of the exercise price to stock price as close as possible in absolute value to that of the announcement firm. As for earnings announcement firms, the same put and call pair is retained over the entire estimation period of days *ED=-20* to *ED=-1* for the control firm. Once a suitable control set of put and call options are identified, a representative $D_t$ is calculated for each control firm using an equally-weighted average of all $D_t$s on the chosen pair of options during the benchmark estimation period of days *ED=-20* to *ED=-18*. The $D_t$ for these firms' options is then calculated for each of the half-day intervals during days *ED=-17* to *ED=-1* using all option bid and ask quotes for the same chosen pair in the interval. As for the earning announcement firm options, if only one put-call pair quote is available in an interval, then this quote is used as the representative $D_t$ for a control firm during that interval. If more than one pair is available, then all pairs are used to form an equally-weighted average $D_t$ and this average $D_t$ is used as the representative $D_t$ for a control firm during an interval.

The control firm $D_t$ is then subtracted from the $D_t$ of each earnings announcement firm to arrive at the measure $DD_t$ for each half-day interval of the event period, days *ED=-17* to *ED=-1*, and $DD_b$ for the benchmark period, days *ED=-20* to *ED=-18*. These $DD_t$ and $DD_b$ should be free of all passage of time effects.

For each announcement *i* and half-day interval *t* (over days *ED=-17* to *ED=-1*), the difference between the event period and benchmark period measures of deviations from put-call parity ($Q_{i,t}$) are calculated as:

Equation 4

$$Q_{i,t} = DD_{i,t} = DD_{i,b}$$

If there is no material change in the put-call parity relationship during the preannouncement period, $Q_{i,t}$ will be insignificantly different from zero. If on the other hand, there is a material change in security prices such that the put-call parity relationship changes in the preannouncement period, $Q_{i,t}$ will be significantly different from zero. $Q_{it}$ should be negative (positive) for positive (negative) earnings announcements if the options market leads the stock market. If the stock market leads the options market $Q_{i,t}$ should be positive (negative) for positive (negative) announcements.

Any differences from zero in the $Q_{i,t}$ may persist for several intervals, depending on the benefits and costs of informed trading in the lagging market. Though it is difficult to hypothesize the duration of a significant difference, statistically significant differences from zero indicate a high probability of trading activity in one market that leads that in the other market prior to earnings announcements.

## EMPIRICAL RESULTS

In Table 2, the results for earnings announcements greater than expected (the top 25 percent of surprises) are presented for the pre-ITSA period. The first half of a trading day is denoted with the suffix .1 and the last half is denoted with the suffix .2. The maximum number of observations per half-day interval is 90 and the minimum is 66 with an average of 73.69. For each interval the average $Q_{i,t}$ across firms, denoted $\overline{Q}_t$, and the proportion of $Q_{i,t}$ greater than zero, are examined.

The results in Table 2 are supportive of a leading stock market. Thirty of the 34 intervals have $\overline{Q}_t$s that are greater than zero and a proportion of positive $Q_{it}$s of at least 50 percent. At a 5 percent significance level, 11 of the 34 intervals (*ED=-13.2*, *-12.1*, *-11.1* to *-9.1*, *-8.1*, *-6.2*, *-5.1*, and *-4.1*) have positive $\overline{Q}_t$s that are statistically different from zero. Three of the 34 intervals (*ED=-13.2*, *-11.1*, and *-8.1*) have a proportion of positive $Q_{it}$s that is significantly greater than 50 percent by a sign test. Thus, the options market lags the stock market prior to the release of positive earnings surprises in the pre-ITSA period.

However, in the case of earnings announcements less than expected (bottom 25 percent) in the same time period, Table 3 presents evidence of an options market lead. Thirty-two of the 34 intervals have positive $\bar{Q}_t$s and 33 of the 34 intervals have a proportion of positive $Q_{it}$s greater than 50 percent. Nine of the 34 intervals (*ED=-17.2*, *-16.1*, *-12.1*, *-11.1*, *-10.1*, *-10.2*, *-9.1*, *-6.1*, and *-4.2*) have $\bar{Q}_t$s that are significantly different from zero. Seven of the 34 intervals have a proportion of positive $Q_{it}$s that are significantly greater than 50 percent. For negative earnings surprises in the pre-ITSA period, the evidence supports a leading options market.

For the post-ITSA period, results in Tables 4 and 5 are presented for good and bad news announcements, respectively. Neither Tables 4 or 5 suggest any lead role for either the options market or stock market. In Table 4, half of the 34 intervals have $\bar{Q}_t$s greater than zero and none are significantly different from zero. The proportion of positive $Q_{it}$s is not statistically different from 50 percent for any interval. Similar results prevail in Table 5 as well where 12 of the 34 intervals are positive and none of the intervals has a $\bar{Q}_t$ significantly different from zero. None of the 34 intervals have a proportion of positive $Q_{it}$s that is significantly different from 50 percent.

Two subsets of our sample are also examined to determine if certain observations are causing the patterns detected. The first includes only the top and bottom ten percent of earnings surprises, as measured by market-adjusted returns. These surprises may provide the greatest incentive to trade on private information. The second examines the most actively traded halves, in terms of option volume, of the initial 25 percent favorable and unfavorable surprises. These options may provide the best opportunities for informed traders to conceal their trades. For both subsets, however, results are similar to the full sample.

Overall, the patterns provide interesting results. Given the special advantages of options with short positions and the relatively lax scrutiny of insider option trading prior to the passage of ITSA, the most likely occurrence of an options market lead is for negative news earnings announcements in the pre-ITSA period. Empirically, this is the only sample where an options market lead is found. Somewhat surprisingly, there is a stock market lead for good news in the pre-ITSA period. These results suggest that short sale constraints are an important factor influencing informed trading.

It is also hypothesized that after the passage of ITSA insiders may be more reluctant to use their private information, leading to a dampening of any lead-lag relationships. The post-ITSA results for both good and bad news are consistent with this hypothesis. The results are also consistent with Chan, Chung, and Johnson [6], who find no lead-lag relationships in the post-ITSA period.

## CONCLUSION

This study examines lead-lag relationships between the stock and option markets prior to substantial earnings surprises, when informed traders would have substantial incentives to trade. The inherent advantages of trading in the options market suggest a possible leading role, especially for negative surprises. Any leading role for the options market should be mitigated after the passage of ITSA.

This paper employs bid and ask quotes of calls and puts obtained from the Berkeley options data base, put-call parity relationships, and a control sample methodology to investigate lead and lag patterns between the stock and option markets over a 17-day period prior to earnings surprises. Results indicate that in the pre-ITSA period, the options market leads the stock market for negative surprises but for positive surprises the stock market leads. After the passage of ITSA there is no leading role for either market. These results suggest that institutional factors, such as short sale constraints, and regulatory intensity may affect relative price patterns between the stock and option markets.

## ENDNOTES

1. Arshadi and Eyssell [4] find that ITSA curbed insider trading before tender offer announcements and Eyssell and Reburn [10] find that ITSA reduced insider trading before the issuance of common stock.

2. The daily market-adjusted return is calculated for each firm by subtracting the equally-weighted CRSP index return of New York and American Stock Exchange securities from the firm's stock return on a daily basis. Firms with declarations of dividend changes from day *ED=-20* through *ED=0* are deleted since the put-call parity measure employed assumes that dividend amounts are known with certainty. Dividend information is obtained from CRSP. Treasury security yields serve as a proxy for risk free interest rates and are obtained from the *Wall Street Journal*. Due to the influences of the crash, announcements in October and November, 1987, are also eliminated.

3. They are also statistically different from zero at the 1 percent significance level.

4. The benefit of put-call parity is that it allows the calculation of an implied stock price boundary without assuming the validity of an option pricing model or constant return variances. Furthermore, though previous studies of the lead-lag relationship had used only call prices to arrive at an implied stock price, put-call parity incorporates information from put prices as well.

5. These statistics should also be serially uncorrelated if there is an underlying time series process common to both control and earnings announcement options.

6. The ratio of exercise price to stock price is examined for the earnings announcement firm and control firm for the first option quotations in the interval *ED=-12* to *ED=-8*.

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## TABLE 2
### Measures of Change in Put-Call Parity for Earnings Announcements Greater than Expected in the Pre-ITSA Sub-period

*ED* is the half-day event period relative to the disclosure of the earnings announcement where .1 refers to trading before 12 p.m. and .2 refers to trading after 12 p.m. $\bar{Q}_t$ measures average deviations from put-call parity. $\bar{Q}_t$ less than zero indicates an options market lead and $\bar{Q}_t$ greater than zero indicates a stock market lead. The t-statistic is the test statistic for evaluating whether $\bar{Q}_t = 0$. Percent > 0 is the proportion of $Q_{it}$ greater than 0. A proportion of positive $Q_{it}$ less than .5 indicates an options market lead and a proportion of positive $Q_{it}$ greater than .5 indicates a stock market lead.

| ED | $\bar{Q}_t$ | t-statistic | p-value | Percent > 0 | Sign p-value |
|---|---|---|---|---|---|
| -17.1 | 0.024 | 0.97 | 0.337 | 0.535 | 0.635 |
| -17.2 | 0.026 | 1.33 | 0.186 | 0.545 | 0.494 |
| -16.1 | -0.006 | -0.26 | 0.799 | 0.478 | 0.810 |
| -16.2 | 0.007 | 0.33 | 0.741 | 0.507 | 1.000 |
| -15.1 | 0.027 | 1.18 | 0.241 | 0.500 | 1.000 |
| -15.2 | -0.011 | -0.49 | 0.623 | 0.507 | 1.000 |
| -14.1 | 0.017 | 0.72 | 0.476 | 0.541 | 0.561 |
| -14.2 | 0.014 | 0.56 | 0.579 | 0.590 | 0.141 |
| -13.1 | 0.039 | 1.41 | 0.164 | 0.566 | 0.302 |
| -13.2 | 0.064* | 2.72 | 0.008 | 0.651* | 0.008 |
| -12.1 | 0.061* | 2.06 | 0.043 | 0.587 | 0.165 |
| -12.2 | 0.032 | 1.49 | 0.139 | 0.526 | 0.734 |
| -11.1 | 0.077* | 2.55 | 0.013 | 0.632* | 0.029 |
| -11.2 | 0.079* | 2.58 | 0.012 | 0.613 | 0.057 |
| -10.1 | 0.076* | 2.82 | 0.006 | 0.600 | 0.093 |
| -10.2 | 0.068* | 2.25 | 0.028 | 0.589 | 0.160 |
| -9.1 | 0.078* | 2.28 | 0.026 | 0.595 | 0.130 |
| -9.2 | 0.046 | 1.57 | 0.121 | 0.571 | 0.254 |
| -8.1 | 0.094* | 2.81 | 0.006 | 0.625* | 0.044 |
| -8.2 | 0.023 | 0.77 | 0.442 | 0.526 | 0.731 |
| -7.1 | 0.032 | 1.11 | 0.271 | 0.539 | 0.567 |
| -7.2 | 0.062 | 1.99 | 0.051 | 0.582 | 0.222 |
| -6.1 | 0.057 | 1.79 | 0.078 | 0.569 | 0.289 |
| -6.2 | 0.065* | 2.16 | 0.034 | 0.597 | 0.125 |
| -5.1 | 0.064* | 2.36 | 0.021 | 0.533 | 0.644 |
| -5.2 | 0.057 | 1.74 | 0.087 | 0.493 | 1.000 |
| -4.1 | 0.086* | 2.38 | 0.020 | 0.592 | 0.154 |
| -4.2 | 0.049 | 1.36 | 0.179 | 0.527 | 0.728 |
| -3.1 | -0.024 | -0.85 | 0.396 | 0.427 | 0.248 |
| -3.2 | 0.011 | 0.36 | 0.719 | 0.478 | 0.810 |
| -2.1 | 0.034 | 1.04 | 0.302 | 0.529 | 0.720 |
| -2.2 | -0.010 | -0.35 | 0.725 | 0.522 | 0.810 |
| -1.1 | 0.022 | 0.73 | 0.468 | 0.552 | 0.464 |
| -1.2 | 0.022 | 0.66 | 0.509 | 0.500 | 1.000 |

* $\bar{Q}_t$ significantly different from zero by two-tailed t-test at a 5 percent significance level or proportion of positive $Q_{it}$s significantly different from 50 percent by a two-tailed sign test at a 5 percent significance level.

## TABLE 3
### Measures of Change in Put-Call Parity for Earnings Announcements Less than Expected in the Pre-ITSA Sub-period

*ED* is the half-day event period relative to the disclosure of the earnings announcement where .1 refers to trading before 12 p.m. and .2 refers to trading after 12 p.m. $\bar{Q}_t$ measures average deviations from put-call parity. $\bar{Q}_t$ greater than zero indicates an options market lead and $\bar{Q}_t$ less than zero indicates a stock market lead. The t-statistic is the test statistic for evaluating whether $\bar{Q}_t = 0$. Percent > 0 is the percentage of $Q_{it}$ greater than 0. A proportion of positive $Q_{it}$ greater than .5 indicates an options market lead and a proportion of positive $Q_{it}$ less than .5 indicates a stock market lead.

| *ED* | $\bar{Q}_t$ | t-statistic | p-value | Percent > 0 | Sign p-value |
|---|---|---|---|---|---|
| -17.1 | 0.034 | 1.64 | 0.107 | 0.597 | 0.142 |
| -17.2 | 0.037* | 2.01 | 0.049 | 0.615 | 0.082 |
| -16.1 | 0.052* | 2.33 | 0.023 | 0.614 | 0.072 |
| -16.2 | -0.000 | -0.00 | 0.998 | 0.485 | 0.902 |
| -15.1 | 0.048 | 1.76 | 0.083 | 0.603 | 0.114 |
| -15.2 | 0.040 | 1.40 | 0.166 | 0.547 | 0.532 |
| -14.1 | 0.043 | 1.62 | 0.110 | 0.563 | 0.342 |
| -14.2 | 0.042 | 1.57 | 0.121 | 0.625 | 0.060 |
| -13.1 | 0.032 | 1.21 | 0.231 | 0.597 | 0.142 |
| -13.2 | 0.023 | 0.79 | 0.434 | 0.545 | 0.539 |
| -12.1 | 0.065* | 2.17 | 0.034 | 0.603 | 0.114 |
| -12.2 | 0.053 | 1.87 | 0.065 | 0.575 | 0.242 |
| -11.1 | 0.060* | 2.01 | 0.048 | 0.629* | 0.041 |
| -11.2 | 0.050 | 1.60 | 0.116 | 0.627* | 0.050 |
| -10.1 | 0.092* | 3.10 | 0.003 | 0.642* | 0.027 |
| -10.2 | 0.065* | 2.13 | 0.037 | 0.657* | 0.014 |
| -9.1 | 0.081* | 2.90 | 0.005 | 0.657* | 0.012 |
| -9.2 | 0.048 | 1.63 | 0.108 | 0.603 | 0.114 |
| -8.1 | 0.040 | 1.44 | 0.155 | 0.627* | 0.050 |
| -8.2 | 0.041 | 1.54 | 0.128 | 0.529 | 0.720 |
| -7.1 | 0.049 | 1.44 | 0.155 | 0.551 | 0.470 |
| -7.2 | 0.052 | 1.54 | 0.129 | 0.629* | 0.041 |
| -6.1 | 0.059* | 2.07 | 0.043 | 0.576 | 0.268 |
| -6.2 | 0.045 | 1.58 | 0.120 | 0.580 | 0.228 |
| -5.1 | 0.054 | 1.66 | 0.101 | 0.543 | 0.550 |
| -5.2 | 0.045 | 1.38 | 0.172 | 0.538 | 0.620 |
| -4.1 | 0.041 | 1.46 | 0.150 | 0.562 | 0.382 |
| -4.2 | 0.091* | 2.48 | 0.016 | 0.591 | 0.175 |
| -3.1 | 0.050 | 1.48 | 0.143 | 0.576 | 0.268 |
| -3.2 | 0.022 | 0.59 | 0.557 | 0.525 | 0.795 |
| -2.1 | 0.025 | 0.78 | 0.436 | 0.557 | 0.443 |
| -2.2 | 0.034 | 1.13 | 0.265 | 0.550 | 0.519 |
| -1.1 | 0.037 | 1.04 | 0.305 | 0.607 | 0.141 |
| -1.2 | -0.011 | -0.36 | 0.718 | 0.518 | 0.894 |

*$\bar{Q}_t$ significantly different from zero by two-tailed t-test at a 5 percent significance level or proportion of positive $Q_{it}$s significantly different from 50 percent by a two-tailed sign test at a 5 percent significance level.

# TABLE 4
## Measures of Change in Put-Call Parity for Earnings Announcements Greater than Expected in the Pre-ITSA Sub-period

*ED* is the half-day event period relative to the disclosure of the earnings announcement where .1 refers to trading before 12 p.m. and .2 refers to trading after 12 p.m. $\bar{Q}_t$ measures average deviations from put-call parity. $\bar{Q}_t$ less than zero indicates an options market lead and $\bar{Q}_t$ greater than zero indicates a stock market lead. The t-statistic is the test statistic for evaluating whether $\bar{Q}_t = 0$. Percent > 0 is the proportion of $Q_{it}$ greater than 0. A proportion of positive $Q_{it}$ less than .5 indicates an options market lead and a proportion of positive $Q_{it}$ greater than .5 indicates a stock market lead.

| *ED* | $\bar{Q}_t$ | t-statistic | p-value | Percent > 0 | Sign p-value |
|---|---|---|---|---|---|
| -17.1 | -0.017 | -0.81 | 0.418 | 0.435 | 0.178 |
| -17.2 | 0.021 | 0.94 | 0.348 | 0.510 | 0.920 |
| -16.1 | -0.004 | -0.21 | 0.835 | 0.424 | 0.089 |
| -16.2 | 0.005 | 0.21 | 0.832 | 0.486 | 0.847 |
| -15.1 | -0.024 | -1.17 | 0.245 | 0.458 | 0.407 |
| -15.2 | 0.006 | 0.22 | 0.824 | 0.423 | 0.155 |
| -14.1 | -0.009 | -0.41 | 0.680 | 0.459 | 0.415 |
| -14.2 | -0.040 | -1.64 | 0.105 | 0.438 | 0.261 |
| -13.1 | -0.012 | -0.51 | 0.614 | 0.504 | 1.000 |
| -13.2 | -0.036 | -1.40 | 0.164 | 0.420 | 0.133 |
| -12.1 | -0.013 | -0.55 | 0.581 | 0.450 | 0.294 |
| -12.2 | -0.013 | -0.49 | 0.623 | 0.476 | 0.696 |
| -11.1 | 0.044 | 1.83 | 0.069 | 0.538 | 0.430 |
| -11.2 | 0.006 | 0.27 | 0.789 | 0.517 | 0.783 |
| -10.1 | 0.007 | 0.29 | 0.776 | 0.488 | 0.860 |
| -10.2 | 0.002 | 0.09 | 0.926 | 0.491 | 0.924 |
| -9.1 | 0.042 | 1.72 | 0.088 | 0.565 | 0.162 |
| -9.2 | 0.030 | 0.93 | 0.353 | 0.490 | 0.921 |
| -8.1 | 0.036 | 1.29 | 0.198 | 0.586 | 0.063 |
| -8.2 | 0.047 | 1.63 | 0.106 | 0.546 | 0.387 |
| -7.1 | 0.004 | 0.16 | 0.877 | 0.469 | 0.539 |
| -7.2 | -0.005 | -0.18 | 0.857 | 0.485 | 0.844 |
| -6.1 | -0.028 | -1.14 | 0.258 | 0.439 | 0.191 |
| -6.2 | -0.002 | -0.07 | 0.948 | 0.519 | 0.769 |
| -5.1 | 0.040 | 1.73 | 0.087 | 0.566 | 0.145 |
| -5.2 | 0.031 | 1.20 | 0.234 | 0.577 | 0.141 |
| -4.1 | -0.010 | -0.41 | 0.685 | 0.257 | 0.597 |
| -4.2 | 0.013 | 0.47 | 0.637 | 0.514 | 0.845 |
| -3.1 | 0.023 | 0.84 | 0.402 | 0.512 | 0.857 |
| -3.2 | 0.014 | 0.49 | 0.623 | 0.510 | 0.920 |
| -2.1 | -0.006 | -0.21 | 0.837 | 0.520 | 0.721 |
| -2.2 | -0.036 | -1.25 | 0.215 | 0.505 | 1.000 |
| -1.1 | -0.013 | -0.39 | 0.696 | 0.508 | 0.927 |
| -1.2 | -0.043 | -1.41 | 0.161 | 0.477 | 0.699 |

*$\bar{Q}_t$ significantly different from zero by two-tailed t-test at a 5 percent significance level or proportion of positive $Q_{it}$s significantly different from 50 percent by a two-tailed sign test at a 5 percent significance level.

## TABLE 5
### Measures of Change in Put-Call Parity for Earnings Announcements Less than Expected in the Post-ITSA Sub-period

*ED* is the half-day event period relative to the disclosure of the earnings announcement where .1 refers to trading before 12 p.m. and .2 refers to trading after 12 p.m. $\bar{Q}_t$ measures average deviations from put-call parity. $\bar{Q}_t$ greater than zero indicates an options market lead and $\bar{Q}_t$ less than zero indicates a stock market lead. The t-statistic is the test statistic for evaluating whether $\bar{Q}_t = 0$. Percent > 0 is the percentage of $Q_{it}$ greater than 0. A proportion of positive $Q_{it}$ greater than .5 indicates an options market lead and a proportion of positive $Q_{it}$ less than .5 indicates a stock market lead.

| ***ED*** | $\bar{Q}_t$ | **t-statistic** | **p-value** | **Percent > 0** | **Sign p-value** |
|---|---|---|---|---|---|
| -17.1 | -0.017 | -0.77 | 0.442 | 0.490 | 0.922 |
| -17.2 | -0.039 | -1.69 | 0.094 | 0.439 | 0.218 |
| -16.1 | -0.022 | -0.93 | -0.355 | 0.468 | 0.566 |
| -16.2 | -0.015 | -0.59 | 0.554 | 0.447 | 0.353 |
| -15.1 | -0.025 | -1.02 | 0.312 | 0.466 | 0.555 |
| -15.2 | -0.017 | -0.58 | 0.561 | 0.506 | 1.000 |
| -14.1 | -0.047 | -1.96 | 0.053 | 0.447 | 0.324 |
| -14.2 | -0.010 | -0.40 | 0.693 | 0.530 | 0.661 |
| -13.1 | 0.020 | 0.70 | 0.483 | 0.509 | 0.923 |
| -13.2 | 0.022 | 0.75 | 0.457 | 0.522 | 0.752 |
| -12.1 | 0.019 | 0.79 | 0.430 | 0.495 | 1.000 |
| -12.2 | -0.018 | -0.58 | 0.565 | 0.488 | 0.914 |
| -11.1 | -0.009 | -0.35 | 0.727 | 0.470 | 0.617 |
| -11.2 | -0.001 | -0.03 | 0.977 | 0.473 | 0.679 |
| -10.1 | 0.000 | 0.01 | 0.996 | 0.476 | 0.696 |
| -10.2 | -0.052 | -1.57 | 0.121 | 0.435 | 0.251 |
| -9.1 | 0.010 | 0.46 | 0.647 | 0.504 | 1.000 |
| -9.2 | 0.008 | 0.29 | 0.773 | 0.495 | 1.000 |
| -8.1 | 0.036 | 1.36 | 0.178 | 0.530 | 0.579 |
| -8.2 | 0.047 | 1.44 | 0.155 | 0.596 | 0.089 |
| -7.1 | 0.038 | 1.15 | 0.253 | 0.556 | 0.290 |
| -7.2 | 0.013 | 0.41 | 0.686 | 0.562 | 0.289 |
| -6.1 | -0.007 | -0.26 | 0.799 | 0.519 | 0.769 |
| -6.2 | -0.006 | -0.19 | 0.849 | 0.505 | 1.000 |
| -5.1 | 0.022 | 0.73 | 0.470 | 0.495 | 1.000 |
| -5.2 | -0.036 | -0.96 | 0.341 | 0.467 | 0.598 |
| -4.1 | 0.004 | 0.16 | 0.875 | 0.485 | 0.842 |
| -4.2 | -0.013 | -0.45 | 0.654 | 0.511 | 0.917 |
| -3.1 | -0.011 | -0.39 | 0.700 | 0.455 | 0.426 |
| -3.2 | -0.026 | -0.81 | 0.419 | 0.433 | 0.246 |
| -2.1 | 0.002 | 0.06 | 0.950 | 0.495 | 1.000 |
| -2.2 | -0.022 | -0.81 | 0.420 | 0.517 | 0.830 |
| -1.1 | -0.035 | -1.20 | 0.234 | 0.455 | 0.391 |
| -1.2 | -0.001 | -0.03 | 0.977 | 0.470 | 0.617 |

*$\bar{Q}_t$ significantly different from zero by two-tailed t-test at a 5 percent significance level or proportion of positive $Q_{it}$s significantly different from 50 percent by a two-tailed sign test at a 5 percent significance level.