THE JOURNAL OF FINANCE • VOL. XLVII, NO. 3 • JULY 1992

The Behavior of Option Price Around Large Block Transactions in the Underlying Security

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ABSTRACT

This paper investigates the behavior of stock and option prices around block trades in stocks. The results indicate that for both uptick and downtick block trades the stock prices adjust within a fifteen minute period after the block trade. Moreover, for uptick blocks there is no evidence of any stock price reaction before the block trade. However, the adjustment of stock price for downtick blocks begins about fifteen minutes before the block trade. We also find that option price behavior differs considerably from stock price behavior. Specifically, our results suggest that options exhibit abnormal price behavior starting thirty minutes before the block and ending one hour after the block. The pattern is more pronounced for downtick blocks and for put options. We interpret this abnormal price behavior of options before the block trade as consistent with intermarket frontrunning.

THIS PAPER COMPARES THE price effect of block transactions in the stock market with the price effect in the derivative options market. The analysis is motivated by the suggestion in the literature that options provide a superior investment vehicle because of their inherent leverage and lower transaction costs and because of their ability to avoid stock market restrictions on short sales. This implies that informed investors may prefer to trade in options, thereby causing the option market to lead the stock market.

The empirical evidence on the lead-lag relationship between the options and the stock market is inconclusive. Manaster and Rendleman (1982). Bhattacharya (1987). Anthony (1988), and Varson (1989) find that the options market leads the stock market. Stephan and Whaley (1990) argue that many of the previous studies ignore the problem caused by nonsimultaneity in closing prices and/or the existence of bid-ask spreads. In contrast to previous work, their results indicate that price changes in the stock market lead the options market by fifteen minutes.

*Kumar and Sarin are from the Virginia Polytechnic Institute and State University. Shastri is from the University of Pittsburgh. We would like to thank Don Chance, David Denis, Edwin Elton, Vidhan Goyal, Narayanan Jayaraman, Michael Jensen, Martin Lally, Anil Makhija, Karen Shastri, Clifford Smith, Hans Stoll, Robert Whaley, and participants of finance workshops at Kent State University and the University of Pittsburgh for their many comments and suggestions. Earlier versions of this paper were presented at the 1991 Eastern Finance Association Meetings, the 1991 Financial Management Association Meetings, and the 1992 American Finance Association Meetings.

We find that the options market exhibits abnormal price behavior starting thirty minutes before a block trade, while the price reaction in the stock market leads the block by fifteen minutes for downtick block trades, and does not lead the block for upticks. In addition, our results also indicate that the options market takes up to an hour after the block trade to reach the new equilibrium price while the price adjustment in the stock market is complete within fifteen minutes of the block.[1]

The evidence presented here that the options markets react thirty minutes before a block trade is consistent with the existence of intermarket frontrunning. Intermarket frontrunning is defined as trading in the derivative securities market based on the knowledge of an impending stock trade that is expected to have an impact on the value of the derivative security. Intermarket frontrunning is believed to happen with some frequency and has been of concern to regulators.[2] It must, however, be pointed out that this is not direct evidence of frontrunning, since the same price reaction would result if large blocks in stocks are first transacted off the floor, and then recorded at a later time on the floor.[3]

The remainder of the paper is organized as follows. In Section I we describe the data and empirical methodology used in the analysis, the results are reported and discussed in Section II, and Section III concludes the paper.

I. Data and Empirical Methodology

A. Sample Description

Our initial sample consists of 138 firms with stocks listed on the New York Stock Exchange (NYSE) and options listed on the Chicago Board Options Exchange (CBOE) in 1983. Intra-day stock and option prices are obtained from the Francis Emory Fitch database and the Berkeley Options database, respectively. We eliminated 58 firms from our initial sample because low liquidity in their listed options prevented us from performing any meaningful analysis.[4]

For the remaining 80 firms in our sample, all stock trades which met the following criteria were identified for the year 1983:

1. The number of shares traded was at least 10,000.
2. The relative size of the trade was at least 0.1%, where relative size is

[1]Qualitatively similar results (available on request) are obtained by examining trading volume.

[2]The commission appointed by President Reagan to study the October 1987 Crash states in its report that frontrunning in advance of large orders is worth a careful look. More recently, the Intermarket Surveillance Group has been given a charge to curb frontrunning activities.

[3]It could be argued that this form of knowledgeable trading on the options market also constitutes frontrunning since it reflects the completed off floor transaction, but the stock and options markets in general are not aware of that transaction.

[4]A firm was excluded if the average daily number of transactions on all listed puts and calls was less than 50 in January 1983.

defined as the number of shares traded divided by the number of shares outstanding.
3. The trade was not the opening transaction of the day.

This resulted in 1421 uptick and 2147 downtick block trades. From this we identified our final sample of 156 uptick block trades and 211 downtick block trades by applying the following criteria sequentially.[5]

1. On a particular day, there was only one block trade on the stock. This avoids possible contamination of the price behavior by other block transactions in the same stock on the same day.
2. The block trade occurred in the time period beginning ninety minutes after opening and ending two hours before closing. This allows us sufficient time around the block trade to examine the lead-lag relationship.
3. The block trades were the largest uptick and downtick trades for each day across all stocks, where trade size was defined as the ratio of the number of shares to the number of shares outstanding.

Table I reports some descriptive statistics on the sample and population of block transactions. As the table indicates, our sample of block transactions is not qualitatively different from the population of block transactions, both in terms of relative size and dollar value of the trade. However, the downtick block transactions are, on average, larger than the uptick block transactions.

The analysis of option price behavior is based on the shortest maturity options that were listed at the time of the block trade.[6] These options were selected since they are the most sensitive to changes in stock price.

B. Empirical Methodology

The analysis of option and stock prices around block trades is based on the examination of average returns over twelve fifteen-minute intervals starting one hour before and ending two hours after the block trade using the bootstrap procedure suggested in Barclay and Litzenberger (1988).[7] The return over interval t is calculated as:

$$R_t = (P_t - P_{t-1})/P_{t-1} \tag{1}$$

[5]Uptick and downtick rules are generally used to classify blocks into buyer-initiated and seller-initiated blocks. See Holthausen, Leftwich and Mayers (1987, 1990) for more details.

[6]In the situation where the shortest maturity options had less than five days to maturity, we selected the option with the next closest maturity to eliminate any effects of option expiration.

[7]The choice of the fifteen-minute interval is based on two conflicting factors. A longer return interval would bias our results towards finding no lead-lag relationship even if one exists. On the other hand, a shorter return interval would result in a large number of missing return observations.

Table I

Descriptive Statistics

Mean, median, and range of relative size and dollar value (in millions of dollars) for the sample and the population of block trades on 80 stocks which traded on the New York Stock Exchange and had listed options on the Chicago Board Options Exchange in 1983.[a] The population of 3568 block trades met the following criteria: (1) the firm had data available on the Fitch stock transaction database and the Berkeley option database, (2) the number of shares traded was at least 10,000, (3) the relative size of the trade was at least 0.1%, and (4) the trade was not the opening transaction of the day. The sample of 367 block trades also satisfied the following criteria: (1) there was only one block trade on that stock on a particular day, (2) the block trade occurred in the time period beginning ninety minutes after opening and ending two hours before closing, (3) the block trades were the largest uptick and downtick trades for each day across all stocks.

	Uptick Blocks		Downtick Blocks	
Statistic	Sample $N = 156$	Population $N = 1421$	Sample $N = 211$	Population $N = 2147$
	Panel A: Relative Size (%)[a]			
Mean	0.23	0.21	0.28	0.23
Median	0.16	0.15	0.21	0.16
Minimum	0.10	0.10	0.10	0.10
Maximum	2.28	2.28	2.27	7.51
	Panel B: Dollar Value (Millions)			
Mean	4.10	3.79	5.37	4.31
Median	3.16	2.65	4.08	3.08
Minimum	0.35	0.27	0.45	0.22
Maximum	33.00	64.38	45.73	127.51

[a]Relative size of a block is the number of shares in the block divided by the number of shares outstanding.

where P_t is the price in the last transaction in interval t. If a security does not trade in interval t, then the returns are recorded as missing in both intervals t and $(t + 1)$.

The significance of the average return over any interval in the day of the block (the test interval) for each subsample is estimated using the following procedure:

1. For every security in a subsample, a bootstrap population of fifteen-minute interval returns is obtained from the estimation period of 132 fifteen-minute intervals in the six days surrounding the block trade (three days before and three days after the day of the block trade).[8]
2. For every security with a non-missing return in the test interval, one observation is drawn at random from the population in Step (1).

[8]We eliminate the first two fifteen-minute intervals in each day to avoid any problems with opening prices.

3. The random observations from Step (2) are averaged across all securities in the subsample that traded in the test interval to yield one observation of average return. This provides one sample point of the bootstrap distribution of returns (R^*).
4. Steps (2) and (3) are repeated 5000 times to obtain a "complete" bootstrap distribution of returns (R_i^*, $i = 1, 5000$).
5. The significance of the average return in an interval in the test period (R) is calculated as[9]:

$$p = (\text{Number of times } R_i^* \geq R)/5000 \qquad \text{if } R > 0$$
$$p = (\text{Number of times } R_i^* \leq R)/5000 \qquad \text{if } R < 0 \tag{2}$$

II. Results

A. The Behavior of Stock and Option Prices

In Table II we present the results of the price behavior of the stock and options markets in twelve fifteen-minute intervals around block trades in the stock. The block interval (0:00 to 0:14) is associated with a significant abnormal return in stocks, calls, and puts for both downtick and uptick block trades. As expected, the returns are in the direction of the block for stocks and call options and in the opposite direction for put options. This finding is consistent with previous research and indicates that block trades convey information.

The difference in the behavior of option and stock prices is in the intervals prior to and after the block interval. In the stock market, all adjustments for uptick block trades take place in the block interval, with no other intervals exhibiting significant abnormal returns. For downtick block trades, significant abnormal returns are observed for both the block interval and the interval just prior to the block. In contrast, option prices seem to react over an extended period starting approximately one-half hour before and ending approximately one hour after the block. The reaction is more pronounced for downtick block trades and for put options. In particular, call option prices increase by 9.382% (p value = 0.00) in this ninety-minute period around an uptick block trade. The block interval is responsible for 51% of this total return. The half hour before the block contributes 9%, while the forty-five minutes after the block interval contributes 40%. Similarly, for put options, the total return around an uptick block is -11.322% (p-value = 0.00), with 29, 45, and 26% of this return being realized in the pre-block, block, and post-block intervals, respectively. The total return around downtick, blocks for call options is -9.525% (p-value = 0.00), with 22, 52, and 26% being

[9] It could be argued that this method of assessing the significance of price change is inappropriate for options since they exhibit time decay. To determine whether time decay is a major factor, we use a Mann-Whitney U-test to compare the return distribution in the 66 pre-block intervals with the return distribution in the 66 post-block intervals. Our results indicate that the test statistics rejects the null hypothesis (at the 5% level) for only 3.4% of the options in the sample.

Table II

Average Stock and Option Returns Around Block Transactions

Average stock and option returns in fifteen-minute intervals starting one hour before and ending two hours after the block trade. The sample of 367 block trades is from 80 firms which traded on the New York Stock Exchange and had options listed on the Chicago Board Options Exchange which satisfied the following criteria: (1) the firm had data available on the Fitch stock transaction database and the Berkeley options database, (2) the number of shares traded was at least 10,000, (3) the relative size of the trade was at least 0.1%, (4) the trade was not the opening transaction of the day, (5) there was only one block trade on that stock on a particular day, (6) the block trade occurred in the time period beginning ninety minutes after opening and ending two hours before closing, and (7) the block trades were the largest uptick and downtick trades for each day across all stocks.

	Stocks			Call Options			Put Options		
Time Interval[a] (hours:minutes)	Average Time[b]	Mean Return[c] (%)	Bootstrap p-value[d]	Average Time[b]	Mean Return[c] (%)	Bootstrap p-value[d]	Average Time[b]	Mean Return[c] (%)	Bootstrap p-value[d]
Panel A: Uptick Blocks									
−1:00 to −0:46	−50	−0.007[b]	0.34	−51	0.757	0.43	−51	−1.508	0.07
−0:45 to −0.31	−35	0.030	0.30	−36	0.201	0.58	−36	0.570	0.35
−0:30 to −0:16	−19	0.017	0.45	−21	−0.069	0.32	−21	−2.131	0.03
−0:15 to −0:01	−4	0.024	0.38	−6	0.914	0.22	−6	−1.169	0.14
0:00 to 0:14	10	0.554	0.00	10	4.799	0.00	8	−5.046	0.00
0:15 to 0:29	25	0.010	0.48	24	1.650	0.05	25	−1.473	0.06
0:30 to 0:44	41	0.027	0.33	39	1.234	0.12	40	0.431	0.37
0:45 to 0:59	56	0.027	0.31	54	0.854	0.25	55	−1.934	0.05
1:00 to 1:14	71	0.144	0.01	69	1.665	0.05	69	0.113	0.52
1:15 to 1:29	86	−0.009	0.31	84	0.639	0.34	85	−1.240	0.10
1:30 to 1:44	101	0.029	0.31	100	−0.037	0.27	101	1.180	0.32
1:45 to 1:59	116	0.042	0.09	114	−0.313	0.15	113	0.260	0.45

Table II—*Continued*

Panel B: Downtick Blocks

−1:00 to −0:46	−49	−0.013	0.29	−51	0.906	0.12	−51	1.110	0.18
−0:45 to −0:31	−34	−0.019	0.22	−36	0.289	0.63	−37	1.445	0.12
−0:30 to −0:16	−20	−0.026	0.17	−21	−0.989	0.05	−20	3.420	0.01
−0:15 to −0:01	−5	−0.149	0.00	−6	−1.122	0.03	−5	0.866	0.35
0:00 to 0:14	10	−0.662	0.00	9	−4.935	0.00	9	6.879	0.00
0:15 to 0:29	26	−0.005	0.37	24	−2.207	0.00	25	5.474	0.00
0:30 to 0:44	40	−0.038	0.10	38	−0.951	0.03	40	1.262	0.23
0:45 to 0:59	56	0.046	0.12	54	0.679	0.31	54	2.673	0.02
1:00 to 1:14	71	−0.064	0.01	69	0.310	0.44	70	−1.318	0.03
1:15 to 1:29	85	−0.054	0.04	84	−0.332	0.24	84	1.146	0.19
1:30 to 1:44	100	0.020	0.32	99	−1.183	0.00	99	−0.332	0.21
1:45 to 1:59	115	0.050	0.06	114	0.751	0.16	114	0.480	0.36

[a]Time interval is the time relative to the block trade (0:00 is the time of the block).

[b]Average time (in minutes) between the last trade in the time interval and the block trade.

[c]The return over interval t is calculated as: $R_t = (P_t - P_{t-1})/P_{t-1}$ where P_t is the price in the last transaction in interval t. If a security does not trade in interval t, then the returns are recorded as missing in both intervals t and $(t + 1)$.

[d]Bootstrap p-value is the number of times the mean return is greater (or less) than the distribution of 5000 mean returns calculated for the same firms using randomly chosen fifteen minute returns from six days around the block. For details see section I.*B*.

realized in the three intervals. The corresponding figures for put options around downtick blocks are 19.574% (p-value = 0.00), and 17, 35, and 48%, respectively.[10,11]

The above results imply that the options market takes longer (in comparison to the stock market) to adjust to the arrival of information implicit in the block. This is consistent with the evidence in Stephan and Whaley (1990).

On the other hand, the results in table II also suggest that the period of thirty minutes prior to the block is associated with an average option return of 2.386% with a p-value of 0.00. This result is, therefore, consistent with the hypothesis that some informed traders are transacting in the options market prior to the block transaction in the stock market, causing option prices to react earlier than stock prices, i.e., traders are involved in intermarket frontrunning.[12]

B. The Relationship between Stock and Option Returns

The results in Table II indicate the existence of both a lead and a lag relationship between the stock and the options markets. In this section, we provide a more direct test of this relationship by estimating the following equation:[13]

$$AR_{ojt} = \alpha + \sum_{i=-1}^{1} \beta_i AR_{sj(t-i)} + \epsilon_{jt} \tag{3}$$

[10] The results that option prices move both before and after the block could also be due to errors in recording the time of the trades. We investigated this possibility by eliminating all trades recorded in the two minutes before and after the block. We found that the elimination of these trades does not qualitatively affect our results.

[11] The facts that returns are calculated using prices that are, on average, five minutes stale (see Table II) and that options trade less frequently than the underlying stock has the effect of transferring a part of one interval's return into the next interval. This implies that the results for the pre-block period are understated, while the reverse is true for the post-block period. This, in turn, would bias our results against (or toward) finding a lead (or lag) relationship for the options. On the other hand, the maximum impact of this mis-specification should be towards finding one lag. Our results suggest that options lag stock prices by two to three intervals. This result, therefore, is not induced by stale prices or infrequent trading. Moreover, the reported lead in the options market cannot be induced by this bias.

[12] If the block trade is caused by the announcement of a firm-specific event on the same day but before the block, the observed option price reaction could be the result of the earlier announcement and would, therefore, not be a result of intermarket frontrunning. To determine the extent to which such announcements affect our results, we checked for announcements in the Dow Jones News Service about the firms in our sample on the day of the block, but before the time of the block. We found that 43 of the blocks in our sample have firm-specific announcements on the day of the block prior to the time of the block trade. Elimination of these 43 blocks did not qualitatively affect our results.

[13] The choice of one lead and one lag term allows us to use a larger fraction of our data. Increasing the number of leads and lags would cause a substantial reduction in the number of observations that would be available on each stock.

where AR_{kjt} is the abnormal return on security j in time interval t, and k is o for options and s for stocks.[14]

If the option market lags the stock market, then we would expect $\beta_1 > 0$ (or < 0) for calls (or puts). If the option market leads the stock market, we would expect $\beta_{-1} > 0$ (or < 0) for calls (or puts).

Equation (3) is estimated separately for uptick and downtick blocks, and

Table III

Regressions of Option Abnormal Returns on the Lag, Lead, and Contemporaneous Stock Abnormal Returns

Estimates of cross-sectional regressions relating abnormal returns in the options market with the lag, lead, and contemporaneous stock abnormal returns in fifteen-minute intervals starting one hour before the block trade and ending two hours after the block trade. The equation estimated was:

$$AR_{ojt} = \alpha + \beta_{-1} AR_{sj(t+1)} + \beta_0 AR_{sjt} + \beta_1 AR_{sj(t-1)} + \epsilon_{jt},$$

where AR_{kjt} is the abnormal return on security j in time interval t, and k is o for options and s for stocks.[a] The sample of 367 block trades is from 80 firms which traded on the New York Stock Exchange and had options listed on the Chicago Board Options Exchange and which satisfied the following criteria: (1) the firm had data available on the Fitch stock transaction database and the Berkeley options database, (2) the number of shares traded was at least 10,000, (3) the relative size of the trade was at least 0.1%, (4) the trade was not the opening transaction of the day, (5) there was only one block trade on that stock on a particular day, (6) the block trade occurred in the time period beginning ninety minutes after opening and ending two hours before closing, and (7) the block trades were the largest uptick and downtick trades for each day across all stocks.

	Call Options		Put Options	
Coefficient	Estimate	t-value	Estimate	t-value
		Panel A: Uptick Blocks		
α	−0.0687	−0.32	0.1539	0.31
β_{-1}	0.4807	1.11	−2.0298	−2.02*
β_0	5.5292	13.05*	−6.0028	−5.87*
β_1	3.0660	7.86*	−5.4968	−5.79*
		Panel B: Downtick Blocks		
α	0.0707	0.28	0.3728	0.31
β_{-1}	1.3600	2.93*	0.1784	0.18
β_0	4.2553	10.04*	−6.5815	−7.11*
β_1	2.9012	7.49*	−2.7400	−3.27*

[a]The abnormal return in time interval t is the difference between the actual return in time interval t and the average return on the security in the 132 time intervals in the six days surrounding the day of the block trade.

*Denotes significance at the 0.01 level.

[14]Abnormal return in time interval t is the difference between the actual return in time interval t and the average return on the security in the 132 time intervals in the six days surrounding the day of block trade.

for calls and puts. The results are presented in Table III. For all four groups, β_1 is significant and of the sign predicted, indicating the presence of a lag relationship between options and stocks. In addition, for uptick puts and downtick calls, β_{-1} is significant and of the sign predicted, suggesting the presence of a lead relationship between options and stocks. A comparison of β_1 and β_{-1} for the two cases in which the latter coefficient is significant indicates that β_1 is greater than β_{-1}. This result suggests that the lag relationship is much stronger than the lead relationship. These results support the results in Stephan and Whaley (1990).

III. Summary and Conclusions

To summarize, our results are as follows:

1. For both uptick and downtick block trades, the stock prices adjust within approximately fifteen minutes of the block trade. In addition, there is no abnormal stock price behavior prior to the block for uptick blocks. In contrast, stock price reaction to downtick blocks starts approximately fifteen minutes before the block.
2. The behavior of option prices differs considerably from that of stock prices. Abnormal returns on options are observed starting thirty minutes prior to, and ending one hour after, the block trade in the underlying stock. The pattern is more pronounced for downtick blocks than for uptick blocks, and for put options than for call options.
3. The returns on options are related to lagged and contemporaneous returns on the underlying stock. The returns on options are also related to the lead return on the underlying stock in the cases of downtick calls and uptick puts. In these two cases, the lead relationship is weaker than the lag relationship.

Some of the above results are consistent with those reported in previous work. Specifically, the post-block abnormal behavior of option prices is consistent with the result in Stephan and Whaley (1990) that price changes in the stock market lead those in the option market. This result is further supported by the significant relationship between option return and lagged stock return.

On the other hand, we also have some evidence that even though the options market takes longer to adjust to the block transaction then does the stock market, it begins this adjustment procedure before the stock market. This conclusion is based on the result that option prices start moving in the direction of the block trade approximately thirty minutes before the block transactions, and that returns on options are significantly correlated with lead stock returns for downtick calls and uptick puts. This adjustment in the option market prior to the block trade is consistent with intermarket front-running practices.

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