INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA
313/761-4700 800/521-0600

An Empirical Investigation of the Impact of Related Markets on Trading Characteristics

Theivanai Palaniappan

Submitted in partial fulfillment of the
requirements for the degree
of Doctor of Philosophy
in the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

1996

ABSTRACT

An Empirical Investigation of the Impact of Related Markets
on Trading Characteristics

Theivanai Palaniappan

This paper begins with a refinement on the methodology of classification of trades. In contrast to other papers, which use only trade information or only quote price information to categorize transactions, this paper uses quote price and depth information to better classify trades. The methodology described allows over 90% of the trades that occur at the midpoint to be categorized. It also suggests that the generally used methodology of classifying trades that occur between the ask and the quote midpoint as buys and those that occur between the bid and the quote midpoint as sales may be incorrect in some cases.

The second section deals with the interaction of the market for when-issued securities created as a result of a stock split and the market for the pre-split stock. The premium observed in the when-issued market is explained by the fact that trades in this market are more likely to be above the quote midpoint. The difference in spreads in the two markets and the occurrence of trade on the when-issued market, in spite of the larger costs incurred, are also investigated. A number of trading strategies are used to ascertain if the difference in trading structures can be exploited to make a profit.

The last section deals with the effect of the listing of an equity option on the underlying security. Volume increases immediately around the option listing date. Spread and volatility are observed to decrease for the stock, and the depth of the market increases up to the listing date. Option listing is determined to have little negative affect on the trading characteristics of the stock.

TABLE OF CONTENTS

Acknowledgments

I wish to thank all the members of my committee for their help and advice during the various stages of research for this thesis. I am particularly indebted to Dr. Lawrence Glosten, without whose motivation, this thesis would not have been possible. His encouragement and advice were very important.

I would like to thank my friends at Columbia University and the facility and staff at the Business School for creating a pleasant environment for learning and research. I would also like to thank my husband for all his support and encouragement.

1. CLASSIFICATION OF TRADES

1-1 Currently Used Methods of Classification

Any transaction on the exchange involves a buyer and a seller. However, trades are required to be classified as buys or sells in many situations. For example, in Hasbrouck (1991) and Glosten and Harris (1988) trades are categorized as purchases or sales in order to determine the information revealed by a transaction, and in papers on the price impact of trades buys and sells are considered separately[1] because the impact of both types of trades on the market are not necessarily the same for numerous reasons[2]. Any information that leads to a more accurate trade classification is valuable.

A trade is classified as a purchase if the order is initiated by a buyer and as a sale if initiated by a seller. The identity of the originating trader is not obvious from transaction information. In cases where market buy and sell orders are crossed it is not possible to categorize trades (as they are the result of an order originating from a buyer and an order originating from a seller). However, any other observed trade is classified as either a purchase or a sale depending on the order that initiated it.

In cases where only trade information is available, the tick test and the reverse tick test are used. The tick test classifies a trade based on the trade price and that of the previous trade. A higher price indicates a purchase transaction and a lower trade price a sale. In situations where both prices are equal, the trade price of the transaction before the previous one is used. The reverse tick test classifies a trade based on the trade price and that of the next trade. If the current trade price is below that of the next trade it is a sale, a price above indicates a purchase.

The two test lead to the same trade categorizations only for cases of price reversal.

---

[1]For example, Holthausen, Leftwich & Mayers (1990) and Chan and Lakonishok (1993)

[2]For example, restrictions limiting situations when short sales are possible and the fact that large buys reveal more information than large sales.

a. Price Reversal b. Price Continuation

Figure 1-1: Classification of trade using preceding and following trade prices.

In Figure 1-1a the trade at time t is classified using the tick test as a purchase since the price is above the previous trade price at t-1, and using the reverse tick test as a purchase since the price at t is above the price at t+1[1]. Figure 1-1b is the case of price continuation. Here the tick test categorizes the trade as a purchase and the reverse tick test categorizes it as a sale. It is not obvious which test is correct in this case.

If information on prevailing quotes is available it may allow the above situation to be avoided. The trade price can be compared to the ask and the bid prices. A price equal to the ask indicates a purchase and a price equal to the bid indicates a sale. Prices above the ask may occur for large trades where the market maker is not willing to trade the large quantity at the quoted price or when a limit sell order is filled. Therefore, a trade price above the ask indicates that the transaction is a purchase. Similarly, prices below the bid categorize a trade as a sale.

For prices within the quotes the classification is not as apparent. In general, trades that occur closer to the ask are classified as purchases and those that occur closer to the bid as sales. This is not necessarily correct. A trade may occur within the quotes for different reasons. It maybe the result of market buy and sell orders crossing, or the result of limit orders being filled. Standing orders in the crowd may also cause trade prices within the quotes. The order being filled maybe either a purchase or a sale and unambiguous

[1] A simplistic rationale behind the tick test is that purchases cause price to rise and sales cause price to fall. The reverse tick test is based on the assumption that a decrease in trade price implies that the previous trade is at the ask, and therefore a purchase. Correspondingly, an increase in price implies that the previous trade is at the bid, and therefore a sale.

classification is no longer possible. Trades that occur at the midpoint can not be categorized for the same reasons.

Lee and Ready (1991) investigate another problem that may arise when quotes are used to classify trades. As quotes are entered electronically and trades manually, it is possible that a quote revision that was triggered by a trade is recorded before the trade. To use this quote to categorize the trade is incorrect. For the period considered by Lee and Ready, they find that quote revisions are clustered in the 20 second interval around the trade, with over 55% of the quotes occurring before the trade. They conjecture that these quote revisions are caused by the trade and therefore should be resequenced after the trade. When trades are categorized ignoring quotes that occur within 5 seconds previous to a trade, the percentage of trades classified increases. Based on this, Lee and Ready conclude that the procedure of resequencing quotes improves the classification of trades. To determine if the methodology proposed below allows even further classification of trades, the sample of trades that have a quote occurring in the previous 5 seconds will be considered separately.

This paper uses data on the both the price and depth of the quotes provided by the market maker to address the above situations. It determines if this information allows a more accurate classification of trades and if the information distinguishes purchases from sales for transactions that could not be categorized earlier. Section 1-2 describes the data that will be used. Section 1-3 explains the methodology used to classify trades and the usefulness of depth and price information. Section 1-4 concludes.

1-2 Data Source

The data set provided by the Institute for the Study of Securities Markets contains trade and quote information for securities listed on the exchanges. Trade information consists of date and time of the trade, price and volume of the transaction and a condition code that indicates if the trade is normal. Quote information consists of date and time of quote, price and depth on the ask and bid sides of the market and a code that indicates if the quote is best bid-offer eligible.

To form the sample that is used in this paper, the companies are first ranked in order of the number of shares outstanding at the beginning of 1988. The entire sample is divided into quartiles, and the first 10 companies from each quartile are selected. As the amount of data

is large, the period of interest in this paper is limited to one month in 1988. As not all the selected companies are traded actively, those firms with less than 15 days of trading are replaced by others from the same quartile. Information about the companies in each quartile is summarized in Table 1-1.

Table 1-1 : Average shares outstanding, daily average share volume and daily average price for the sample of firms, divided into quartiles.

Quartile	Average Shares outstanding ('000)	Daily average share volume ('00)	Daily average price ($)
1	1267083.80	7401.97	35.03
2	31194.30	1779.03	32.47
3	10516.20	155.49	29.26
4	4683.80	82.32	10.35

In general, firms with more shares outstanding have a higher average daily trading volume and a larger price.

In contrast to earlier research which focuses primarily on price information, this paper uses both quote price and depth information. A quote revision can involve changes in price only, changes in depth only or changes in both price and depth. Table 1-2 below provides a summary of the relative occurrence of the three possible types of quote revisions for each of the quartiles and the overall sample.

Table 1-2: Frequency of occurrence of types of quote revisions.

Quartile	Price & Depth Change (%)	Price change (%)	Depth change (%)
1	36.55	6.21	57.24
2	43.80	13.90	42.30
3	44.35	13.89	41.76
4	40.29	2.90	56.80
Overall	41.25	9.23	49.52

It can be seen that the market maker chooses to change only depth most often and both price and depth in most other cases. For both the smallest and the largest quartiles, over

50% of the quote revisions involve changes in only depth. Revisions where only quote prices change are infrequent. This suggests that information is lost if only prices are used. As depth changes in almost all cases where quote revisions occur, it may provide valuable information for the classification of trades.

Lee and Ready (1991) find that a large fraction of all quote revisions occur immediately around a trade. As trades are entered manually and most quote revisions electronically, they assume that quotes recorded in the 5 seconds preceding a trade have been sequenced incorrectly. Lee and Ready resequence these quotes after the trade, and use the immediately preceding quote to classify the trade as a purchase or a sale. Table 1-3 contains the average fraction of all quotes that occur in the 1, 2, 5 and 10 seconds preceding a trade for each quartile and the overall sample of 40 firms.

Table 1-3: Time between occurrence of trade and preceding quote.

Sample	Within 1s (%)	Within 2s (%)	Within 5s (%)	Within 10s (%)
Quartile 1	10.55	12.42	16.67	22.42
Quartile 2	14.73	15.91	17.60	19.49
Quartile 3	16.86	17.52	18.17	19.19
Quartile 4	25.66	26.97	27.63	28.42
Overall	16.95	18.20	20.02	22.38

It is observed that over 20% if all quote revisions occur in the 5 seconds before a trade. For companies with fewer shares outstanding, quote revisions are more likely to occur immediately preceding a trade. This may be because market makers post less quotes for smaller companies.

1-3 Trade Classification Methodology and Results

Trades that occur at the ask are purchases. A trade occurs above the ask when the market maker adjusts quotes in response to a particular order (for example, a large quantity order) or when a large market order causes a limit sell order to be filled. Therefore, trades that occur at or above the ask are classified as buys. Similarly, trades that occur at or below the bid are categorized as sells. For transactions within the quotes the classification is no

longer as apparent. Prices within the ask and the bid maybe observed when market buy and sell orders are crossed or when either limit purchase or sale orders are filled. In general, trades that occur at prices between the ask and the quote midpoint are classified as purchases and those that occur between the quote midpoint and the bid as sales.

In the procedure described below, information on price and depth contained in the quotes provided by the market maker is used to verify if classification of trades that occur between the ask and the bid is possible. The accuracy of the methodology of classifying trades that occur between the ask and the quote midpoint as buys and trades that occur between the quote midpoint and the bid as sells is also verified.

Trade Classification Methodology:

After a purchase transaction the market maker may increase the ask or the bid or both to encourage sales. If the quote revision that occurs following a trade involves an increase in the ask or the bid or both (with neither decreasing) the trade can be classified as a purchase. If no change occurs in price then the quoted depth is considered. (In order to maintain a desired inventory level, the market maker may change the quoted depth.) To discourage purchases and encourage sales, depth on the ask side of the market may be decreased or depth on the bid side maybe increased. Therefore, if a decrease in ask depth or an increase in bid depth occurs after the trade, it can be classified as a purchase. Similarly, a transaction followed by an decrease in the ask or the bid or both, or no change in prices but an increase in ask depth or a decrease in bid depth, is classified as a sale. Any change in the quote price or depth other than as described above leaves the trade unclassified.

(i) Application of methodology to trades that do not require resequencing

All trades that have a quote occurring in the 5 seconds preceding the trade are omitted to avoid problems that may be caused by an incorrect sequencing of trades and quotes. Table 1-4 below shows the distribution of trades for each quartile and over the entire sample.

Table 1-4: Distribution of trades.

Trade Price	Quartile 1 (%)	Quartile 2 (%)	Quartile 3 (%)	Quartile 4 (%)	Overall (%)
Above ask	0.47	0.21	0.37	1.09	0.54
At ask	31.70	28.34	29.96	28.45	29.61

Between Ask & Qt. Mid.	2.82	8.46	6.44	3.53	5.31
At Qt. Mid.	19.99	17.64	23.05	34.67	23.84
Between Bid & Qt. Mid.	4.29	9.86	9.77	2.14	6.51
At Bid	40.27	35.17	30.01	29.36	33.70
Below Bid	0.45	0.32	0.39	0.75	0.48

It can be seen that over 35% of the trades occur within the quotes for the overall sample, with the problem of unclassified trades being most severe for firms with a smaller number of shares outstanding. A resolution of this problem would be very valuable to any study that requires categorization of trades.

For each of the 40 companies in the period under consideration, the trades that occur within the quotes are investigated. Three separate cases are considered - where the trade price is between the ask and the quote midpoint, where the trade occurs at the quote midpoint and where the trade occurs between the quote midpoint and the bid. Trades occurring within each category are classified using the above methodology.

For each case, Table 1-5 provides the average percentage of trades, over firms that have transactions in the category, that can now be classified.

Table 1-5: Trade classification.

Trade Price	Buy (%)	Sell (%)	Unclassified (%)
Between Ask & Qt. Mid.	48.91	43.72	7.37
At Qt. Mid.	47.11	44.67	8.23
Between Bid & Qt. Mid.	34.76	57.89	7.37

It is observed that of all trades that occur between the ask and the quote midpoint only 49% can be classified as purchases. 44% are actually categorized as sales and 7% can not be classified as buys or sells. Studies that consider all trades that occur between the ask and the quote midpoint as buys may be misclassifying a large fraction of the transactions. Research that omits these trades may be losing valuable information. Of all trades that occur at the quote midpoint, only 8% remain unclassified. For trades that occur between

the quote midpoint and the bid, approximately 58% are sales and 35% are purchases. It is seen that even though all trades that occur within the quotes cannot be categorized, using price and depth information does allow more than 90% of them to be classified.

(ii) Application of methodology to trades that require resequencing

For trades that have a quote occurring in the previous 5 seconds, the quote is resequenced after the trade. The quote which is resequenced is assumed to be directly caused by the trade being investigated, and therefore should convey information about its direction. (For the sample used in section (i), the quote occurring after the trade does not necessarily occur immediately after it. It is possible that other information may also be incorporated in the quote revision.) Since the quote revision can be directly linked to the trade, the percentage of unclassified trades should be small.

Trades are classified by comparing the transaction price to the prevailing quotes. An incorrect sequencing of trades and quotes may lead to misclassification of trades and erroneous conclusions. Table 1-6 shows the distribution of trades that have a quote recorded in the 5 seconds before it. The first column uses the previous quote in determining trade distribution. The second column contains the distribution using the quote preceding the previous quote.

Table 1-6: Distribution of trades with and without resequencing.

Trade Price	Without Resequencing (%)	With Resequencing (%)
Above ask	0.41	1.54
At ask	27.35	40.00
Between Ask & Qt. Mid.	7.46	2.95
At Qt. Mid.	23.45	7.45
Between Bid & Qt. Mid.	8.08	3.08
At Bid	32.63	42.67
Below Bid	0.62	2.33

Both methods of categorization yield identical results for 55% of the trades. However, as in Lee and Ready (1991), it is observed that a larger percentage of all trades can be classified when quotes that occur in the 5 seconds preceding a trade are resequenced after the trade. The percentage of trades remaining uncategorized is now under 20%.

Using the methodology proposed in this paper, trades that occur within the quotes are investigated. Table 1-7 provides the average percentage of trades, over firms that have transactions in the category, that can now be classified.

Table 1-7: Classification of trades that occur between quote prices.

Trade Price	Buy (%)	Sell (%)	Unclassified (%)
Between Ask & Qt. Mid.	72.26	17.37	10.36
At Qt. Mid.	46.91	35.63	17.46
Between Bid & Qt. Mid.	24.00	56.51	19.49

A large fraction of uncategorized trades can now be classified. Trades occurring between the ask and quote midpoint are likely to be purchases 72% of the time, and sales only 17% of the time. 57% of all transactions occurring between the quote midpoint and the bid are sales, only 24% are purchases. Of all trades occurring at the midpoint, 47% are classified as purchases and 36% as sales. Only 17% remain unclassified.

Table 1-8 shows the percentage of all trades that are uncategorized for the samples in section (i) and (ii) after applying the methodology described in this paper.

Table 1-8: Percentage of trades remaining unclassified.

Trade Price	Sample in section (i) (%)	Sample in section (ii) (%)
Between Ask & Qt. Mid.	0.39	0.31
At Qt. Mid.	1.96	1.30
Between Bid & Qt. Mid.	0.48	0.60

For the sample in section (i), 2% of the trades at the midpoint remain unclassified. For the sample in section (ii), where the quote revision can be directly attributed to the trade, less

than 1.3% of the trades at the midpoint remain uncategorized. The described methodology classifies a large fraction of previously uncategorized trades. The fraction classified is higher for trades which have the quote that occurred in the previous 5 seconds resequenced after it.

1-4 Conclusion

Many situations require trades to be categorized as purchases or sales. When trade prices or quote price information are used to classify trades, over 35% of all trades are not categorized. The methodology described in this paper allows almost all trades to be classified. It uses the fact that quote revisions involve depth changes more often than price changes. Any classification scheme that ignores quote depth data will be losing a large percentage of the information conveyed by quote changes.

Trades that occur within quote prices are effectively classified in this paper. As opposed to earlier research which omitted trades that occur at the quote midpoint, the methodology described allows over 90% of these trades to be categorized. It is also shown that the convention of classifying trades that occur between the ask and the quote midpoint as buys and trades that occur between the quote midpoint and the bid as sells, may be wrong in over 35% of the cases. As the described method of classification enables almost every trade to be categorized, it will be very useful in any situation that requires trades to be distinguished as purchases or sales.

2. A MICROSTRUCTURE INVESTIGATION OF THE MARKET FOR WHEN-ISSUED SECURITIES

2-1 A Brief Introduction

A stock split divides the market value of a company into finer pieces. In itself, a stock split should have no affect on the value of the firm. However, significant price changes, larger than usual volumes of trade and abnormal returns have been documented around the announcement date[1] as well as around the ex-date[2]. Firms continue to split their stock, in spite of the cost it entails, suggesting that this manipulation may be doing more than just further dividing the value of a firm.

A number of explanations have been proposed for the observed phenomenon. The managers of a firm maybe using the split to signal their favorable information to the market. This explanation relies on the assumption that firms with below average performance will not try to mimic the behavior of firms with positive performance. This may be rationalized by the fact that a split calls attention to a firm, and this would only be in the interest of a company with positive news.[3] Managers may have a desired trading range for their stock and undertake a stock split to return prices to the desired range. The split may be conveying positive information in this case as well. Managers of firms with unfavorable performance expect the stock price to fall and will not split their stock. This is also based on the assumption that firms with negative news will not attempt to inflate share prices by splitting their stock. These hypotheses seek to explain the return observed on the announcement date of a stock split.

---

[1] For example, in Grinblatt, Masulis and Titman (1984); Lakonishok and Lev (1987); Lamoureux and Poon (1987) and Brennan and Copeland (1988)

[2] For example, in Grinblatt, Masulis and Titman (1984) and Lakonishok and Lev (1987).

[3] A direct news release may have the same affect. However, a stock split enables the firm to avoid the disadvantages that a press release entails (for example, the problem of providing the competition with information).

The return observed on the ex-date can not be an information effect[1]. Grinblatt, Masulis and Titman (1984) conjecture that most trades in the stock occur at the bid before the ex-date. An abnormal return is observed when trading returns to normal. Maloney and Mulherin (1992) suggest that the observed return could be a micro structure effect. They find that the proportion of institutional investors trading in a stock increases after the stock split, this increased buying pressure results in a larger than average proportion of trades occurring at the ask on the ex-date. These are possible explanations for the above average returns observed around the ex-date.

The magnitude of the abnormal return observed on the ex-date is similar to the premium observed in the when issued market, suggesting that a similar phenomenon maybe in effect in this market. The when issued security market allows investors to trade in securities that are yet to be created. The rationale offered by the NYSE for the existence of the when issued market is that it allows shareholders to use the exchange market for their shares at the earliest[2]. As the when issued security is a claim to the same cash flows as the pre-split shares, it should be priced the same. However, it has been empirically observed by Choi and Strong (1983) and Lamoureux and Wansley (1989) that positive premiums exist in the when issued market.

Various explanations have been suggested for the documented premium. Investors may have a preferred price range for their investments and maybe willing to pay more to trade at split prices. There may be a premium in the when issued market as it enables investors, who would not be able to trade in round lots of the pre-split shares, to invest in the firm. The premium could also be due to the differential liquidity or different trading patterns in the two markets. This paper attempts to test the above hypothesis using intra day trade and quote data. Section 2-2 provides alternative theoretical explanations for the observed premium in the when issued market. The data source is described in Section 2-3. The empirical results are in Section 2-4. Section 2-5 tests various strategies to determine if the difference in trading structures can be exploited to make a profit, and Section 2-6 concludes.

---

[1] Grinblatt, Masulis and Titman (1984) find that only 4 out of more than a 1000 companies canceled an announced stock split.

[2] New York Stock Exchange Company Manual.

2-2 Alternative Explanations for the Observed Premium

A purchase of either a when issued security or a corresponding number of shares of the pre-split stock entitle the owner to identical future cash flows. However, stock transactions are required to be settled within 5 business days[1], where as when issued securities created as a result of a stock split are contracts for delivery 6 business days after the date of distribution. In effect, the purchase of when issued securities allows the investor to postpone payment. The when issued security should, therefore, sell at a higher price than the stock.

Choi and Strong (1983) adjust the when issued security price for this difference in settlement procedures. They find that a premium of over one percent, on average, still exists. Higher premiums are observed for splits that are more likely to result in the creation of odd lots. A possible explanation suggested for the observed premium is that investors may be willing to pay to avoid odd lot transactions. However, since premiums are observed even for cases where odd lots are not created there must be other factors that play a part in determining the relative prices of the when issued security and the pre-split shares.

Lamoureux and Wansley (1989) consider several possible reasons for the observed premium on when issued securities. The number of calendar days (as compared to the number of business days only that was used by Choi and Strong) was used to adjust prices for the difference in settlement procedures. This adjustment was unable to fully explain the observed premium. To verify if the premium could be explained by non synchronous trading in the two markets, the high, low and closing prices for the day were used in calculations. The premium was found to be positive in the majority of cases for all the three prices. Another possible explanation Lamoureux and Wansley suggest is that investors in the when issued market may be largely buyers. If investors in the stock market are not equally likely to be trading at the ask price, a comparison of prevailing prices across markets would result in an observed premium due to the spread. Using quote data for the when issued market they find premium to be positive when the ask price in the when issued market is compared to the stock price, but not when the bid price or quote midpoint are used, supporting their hypothesis.[2] Lamoureux and Wansley also find that premium is

---

[1] 3 business days as of June 1, 1995

[2] As quote data was available only on days with no trade in the WI market it was not possible to ascertain if most trades in the WI market did in fact occur at the

inversely related to the volume in the when issued security, suggesting that the premium may be a consequence of the lower liquidity of the market for the when issued security.

Intraday data will enable a number of the above issues to be addressed more satisfactorily. Trade and quote data for both the when issued security and the stock will enable the problem of non-synchronous prices to be better addressed. It will also allow verification of the conjecture that trades in the when issued market are more likely to be buys. Liquidity in the market can be measured by not only volume, as in Lamoureux and Wansley (1989), but also by the actual quoted depth of the market and the price impact of a trade.

2-3 Data Source

The data set provided by the Institute for the Study of Security Markets contains time stamped trade and quote data from the stock exchanges for the when issued securities and the pre-split shares for 1988. In this year there were 87 when issued securities traded, 20 of these were created as a result of stock splits. The others were created as a result of a merger or acquisition or in advance of the listing of a new security. It is not possible to accurately price these securities, so a comparison with prevailing stock market prices, where they do exist, is not feasible. Only when issued securities created as a result of a stock splits are used in the study.[1] Transactions are not explicitly classified as purchases or sales, this is inferred by comparing the trade price to the previous quote midpoint.

The days before the split ex-date, where data is available for both the stock and the when issued security, are used in the determination of the price premium. The interest rate used is the short term risk free rate obtained from the CRSP tapes. The number of days where data is available for both the when issued security and the pre-split shares varies from a minimum of 5 days to maximum of 25 days, with an average of 15.7. Statistics summarizing the cross sectional daily average trade volume in the when issued security and pre-split stock are provided in Table 2-1. A graphical illustration of the distribution of the number of trades per day and the volume per trade are provided in Appendix 2-1a and 2-

---

ask price or if trades in the pre-split shares were equally likely to be purchases and sales.

[1] All tests were also run on a sample of 64 companies that split their stock in 1984. As trading in the when issued security was not regular, the results have not been reported. However, the results observed are similar to those obtained with 1988 data.

1b. It is observed that the frequency of trading is significantly larger in the stock market, however the distribution of the average number of shares per transaction is not as different for the two securities.

Table 2-1: Average number of trades per day, average number of shares per trade and average dollar value per trade in the stock and when issued markets.

	Stock	WI security
Av.no. of trades per day	71.17	5.42
Av.no. of shares per trade	1149.64	346.13
Av. $ value per trade	61988.42	9720.95

The average price of the pre-split stock is $58.06 and the average price of the when issued security is $28.39. The distribution by split factor is given in Table 2-2.

Table 2-2: Distribution of firms by split factor.

Split Factor (shares per 1 original share)	Number of firms
1.25	1
1.50	4
2.00	12
3.00	3

2-4 Empirical Results

Two measures of premium are computed. The first is the absolute value of the premium and the second is the premium as a percentage of the adjusted stock price. The price is adjusted for the fact that the when issued security trade is settled 6 days after the end of trading in the pre-split shares, where as the stock trade is settled in five business days. The when issued stock price, p^W, is compared to the adjusted stock price, p^a , where

$$p^a = \left(\frac{\text{pre} - \text{split price}}{\text{split factor}} \right) * (1+r)^{(t+1)} \qquad (1)$$

where

r = daily rate on Treasury Bill closest to 30 days to maturity
t = number of trading days till the ex-date

As in Choi and Strong (1983), it is assumed that there are 252 trading days in the year. Following Lamoureux and Wansley (1989) the absolute premium value is $p^w - p^a$ and the percentage premium is $(p^w - p^a)/p^a$. The premium is averaged cross sectionally across firms, 19 out of the 20 firms exhibit positive average premiums. The mean observed premium is $0.24 and the mean percentage premium is 0.83%.

(i) Trade Distribution

The proportion of trades in the when issued market that occur above the quote midpoint is determined. Only trades that are classified on the ISSM tape as normal are categorized. Each trade is classified by comparing the price to the immediately preceding quote. Only quotes that occur on a major exchange and are best bid-offer eligible are used to determine if a transaction is a purchase or a sale. (As we are primarily interested in the price distribution of trades, and not the proportion of purchases and sales, the methodology described in chapter 1 has not been applied here).

Table 2-3: Classification of Trades

%	for the stock	for the WI security
> ask	0.98	2.20
= ask	27.00	33.88
> quote midpoint & < ask	13.58	27.56
= quote midpoint	23.43	13.11
< quote midpoint & > bid	12.24	8.08
= bid	22.29	14.72
< bid	0.48	0.45

The distribution of trades, averaged across companies, is provided in Table 2-3. It is observed that for the stocks 41.56% of all trades occur above the quote midpoint and for the when issued securities 63.64% of trades occur above the midpoint. Fewer trades occur below the quote midpoint for the when issued security. It is evident from the above figures

In the calculation of premium using trade prices, prices that are more likely to be at the ask in the when issued market are compared with prices in the stock market where transactions are not as likely to be above the quote midpoint. This could account for part or all of the observed premium.

In order to correct for the difference in the price distribution of transactions in the two markets, the premium is calculated using the prevailing quote midpoint, the ask and the bid, as opposed to actual trade prices. Table 2-4 contains the average dollar value and percentage premium observed when trade price, the quote midpoint, the ask quote and the bid quote are used in computations.

Table 2-4: Observed premium in the when issued market.

	trade price	quote midpoint	ask	bid
$ premium	0.24	0.11	0.34	-0.12
% premium	0.83	0.42	1.28	-0.44

When the premium is computed using the ask , it is found to be larger than when computed with trade prices. With bid quotes the premium is lower, in fact it is negative for 15 out of 20 firms. Premiums calculated using the quote midpoint are marginally positive.

(ii) Transaction Costs

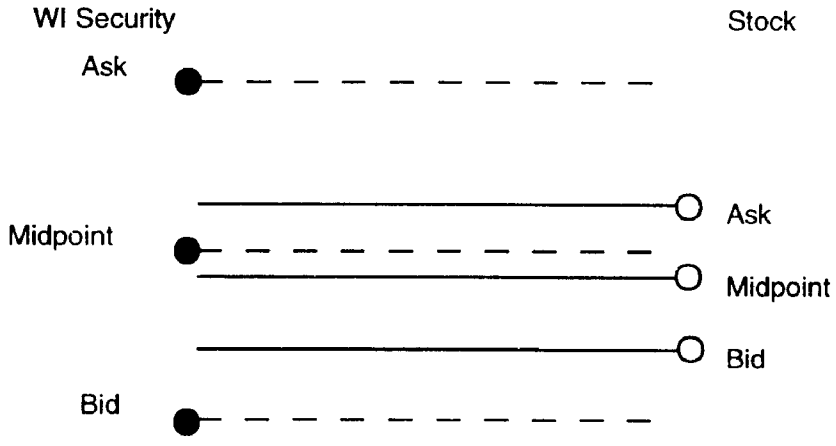


Figure 2-1: Relative price of when issued and stock securities.

The above results can be explained by Figure 2-1. The price structure shown above would imply that spreads are larger in the when issued market, this is supported by the data. The average spread in the stock market over the period when both securities traded simultaneously is $0.37, the spread in the when issued market is $0.69. Appendix 2-1c shows the distribution of dollar spreads. Costs in the when issued market are substantially higher when percentage spreads are considered. Not only is the dollar spread larger, but the security price is also lower[1]. The diagram above illustrates that profits will not be obtained by following a strategy of buying in the cheaper market and then selling in the costlier one. Transaction costs eliminate the profit associated with such trades.

The large quoted spread in the when issued market would not be a deterrent to trade if transaction were likely to be occur at prices within the spread. The effective spread is used to determine the actual costs of trading in the two markets. It is measured by

$$\text{Effective spread} = 2 * |\text{trade price} - \text{quote midpoint}| \qquad (2)$$

Appendix 2-2a shows the quoted and effective spreads in the two markets for each company. The t-statistic for the difference in spreads in significant in both cases, showing that trading costs are much larger in the when issued market.

As spread is only one measure of trading costs, quoted depth and price impact of a transaction are also considered. The distribution of quoted depths for the stock and the when issued security is provided in Appendix 2-1d.[2] It is observed that the quoted depth is substantially lower in the when issued market.

---

[1]To provide an illustration of how large the increase in costs is, consider a round turn transaction in the shares of Bemis Co. which underwent a 2:1 split. The absolute spread is $0.32 per pre-split share and $0.46 in the when issued market. To obtain identical positions in the firm would cost nearly 3 times more in the when issued market. In terms of percentage costs (dividing by the average price over the period of overlapping trading), in the stock market the percentage spread is 0.80% where as in the when issued market it is 2.29%.

[2]For the stock, the quoted depth is multiplied by the split factor to enable a comparison with the depth in the when issued market.

Following Glosten and Harris (1988), price impact is estimated using the following regression[1]

$$P_t - P_{t-1} = a_1 * (Q_t - Q_{t-1}) + a_2 * Q_t V_t + e_t \quad (3)$$

where

P_t = price of tth trade
P_{t-1} = price of (t-1)th trade
Q_t = sign of tth trade. (Q_t = 1 indicates a buy and Q_t = -1 indicates a sale)
Q_{t-1} = sign of (t-1)th trade
V_t = volume of tth trade in terms of number of shares

Normal trades are classified as buys or sells using the methodology followed in Lee and Ready (1991). Only best bid-offer eligible quotes that occur on either the NYSE or the AMEX are used to categorize transactions. A price at or above the ask indicates a purchase, a price at or below the bid indicates a sale. All trades that occur within the quotes are classified by comparing the trade price to the previous trade price. A higher price indicates a purchase and a lower price a sale. If prices are identical Q_t is set equal to zero. The coefficient a_2 is a measure of the cost of trading the security. The price impact is found to be larger in the when issued market for 15 of 20 companies. Appendix 2-2b contains the price impacts for each firm in the two markets. The t-statistic reveals that the price impact of a trade is significantly greater in the when issued market.

Appendix 2-1e shows the relation between the depth in the two markets, it can be seen that the price impact of a trade is larger for the when issued security. The market maker is charging a higher commission for trades, in terms of spread, in the when issued security even though the when-issued security entitles the investor to the same financial flows as the pre-split share. The quoted depth and liquidity (as measured by the price impact of a transaction) are substantially lower. The difference is particularly interesting in this situation since it can not be explained by a difference in firm characteristics. This gives rise to the question of why the market maker should treat the two markets so differently and why an investor would choose to trade in the when issued security.

---

[1]The price impact is the change in the value of the security caused by a transaction. The price impact measured above is identified as the permanent price change caused by a trade in the paper by Glosten and Harris (1988).

(iii) Difference in Spreads

This paper seeks to explain the observed difference in spreads between the stock market and the when issued market. The measure of relative cost, RC, that will be used is the cost of trading one share of the pre-split stock in the when issued market as compared to the same trade in the stock market. The cost in the when issued market is determined by the spread in the when issued market and the split factor.

$$RC = \frac{\text{Spread in WI market} * \text{Split factor}}{\text{Spread in stock market}} \qquad (4)$$

Earlier research[1] has found that volume of trade, price and volatility of returns are associated with the magnitude of the spread. Volatility of returns serves as a proxy for the underlying risk of the company, and as both securities entitle the holder to identical future cash flows this factor will not have an influence on the relative costs of trading in the two markets. Short term interest rates are used in determining the relative prices of the when issued security and the stock. A lower interest rate would lead to a smaller expected when issued price, and as price has been shown to be positively related to dollar spread, a lower relative cost.

The most obvious explanation for the observed difference in trading costs in the two markets is the lower liquidity of the when issued market. The specialist requires a larger compensation to be induced to trade in this market and therefore sets a larger spread. The effect of the volume differential maybe mitigated by the fact that trades in the when issued market maybe hedged by trades in pre-split shares. The liquidity of the market can be measured in a number of ways. Lamoureux and Wansley use the volume of trade in the when issued market relative to total trade volume in their research. The more appropriate measure in this case may be the volume in the when issued market, as compared to the volume in the stock market (both in pre-split terms). A larger differential would lead to a larger spread ratio. The variable that will be used as a measure of liquidity in this paper is the ratio of the number of trades in the when issued market to the number of trades in the stock market.

---

[1] For example, Tinic (1986) and Christie, Harris and Schultz (1994)

In earlier papers on the premium observed in the when issued market, premium was calculated for each day with respect to the ex-date. Choi and Strong do not observe a consistent change in premium with time, but they do find a slight decrease in premium close to the distribution date. Lamoureux and Wansley find premium to be positively related to time until settlement of the when issued security. It may be possible that spreads also change with time up to the ex-date. The pattern of the quotes and spreads over time for both the stock and the when issued security can be seen in Appendix 2-1f and 2-1g. Quotes are normalized by the quote midpoint on the ex-split date to obtain a measure comparable across firms. Similarly, the spreads in Appendix 2-1g are relative to the quote midpoint on the last day of trading of the when issued security. It can be seen that spreads are substantially larger in the when issued market and that they appear to increase close to the ex-split date.

The following regression is used to determine the effect of the above variables on the difference in spreads

$$RC = a_0 + a1 * INT + a_2 * RL + a_3 * day, \quad (5)$$

where

RC = relative cost

INT = short term interest rate

$$RL = \frac{\#\text{ of trades in WI market / split factor}}{\#\text{ of trades in stock market}}$$

day = day with respect to the split ex-date.

The day preceding the split ex-date is day 0, two days before the split ex-date is day -1, etc.

Table 2-5: Linear regression of relative cost on short term interest rate, relative liquidity and day with respect to the split ex-date.

	Parameter Estimate	t-stat
a_0	6.2221	5.531
a_1	-0.4436	-2.459
a_2	-4.8384	-2.163
a_3	0.0455	2.046

$r^2 = 0.08\%$

The regression results are presented in Table 2-5. The relation between cost and interest rates is opposite to that expected. The spread ratio decreases as the proportion of trades in the when issued market increases, showing that the market maker increases costs in thin markets.

(iii) Explanation for Occurrence of Trade on the When Issued Market

The quoted and effective spreads are larger in the when issued market. The price impact of trades is larger and quoted depths are lower. Trade is observed to occur on the when issued market in spite of the larger costs involved. There are several explanations for the behavior of investors.

Traders in the when issued market maybe largely small investors. They may prefer this market as it allows them to trade round lots at dollar values that would not be possible in the pre-split market. As a test of the hypothesis that most traders are small, the percentage of trades in the when issued market that are smaller than one round lot transaction in the pre-split market are determined. The results for each firm can be seen in Appendix 2-2c. The percentage varies from a minimum of zero to a maximum of 80%, the average is over 46%. This shows that trades in the when issued market are often at volumes of less than one round lot of the original shares. Transactions of larger than 5000 shares (in pre-split terms the volume is much smaller) are rarely observed on the when issued market.

Investors may also be using the when issued market to avoid odd lot costs. This is again of significance primarily to the small trader. After a stock split has been announced the small investor may prefer the when issued market to avoid the complications associated with holding and trading an odd lot later. As a test of this, the volume of trade is compared for cases where the split results in an odd lot and where it does not. It is found that the proportion of trade on the when issued market is not larger in cases where the split does result in the creation of odd lots. This suggests that the odd lot costs cannot explain the occurrence of trade on the when issued market.

2-5 Profitability of Trading Across Markets

It has been shown earlier that spreads are wider in the when issued market, as compared to the stock market, as a result of a higher ask and a lower bid. A number of trading

strategies are used to determine if it is possible to exploit the difference in trading structures to make a profit.

(i) Trading Strategies

(1) Buy in the when issued market, unwind position on the ex-split date

Limit orders for 100 shares are placed at the bid in the when issued market. With every quote change the limit price is revised. As the market maker must give precedence to individual investors for all listed stock, every time a sale is observed in the when issued market the limit order traders outstanding position must increase by 100 shares. Two possible methods of closing out the position on the ex-split date are considered. (i) a market order to sell is used. If the market maker quotes a depth larger than the size of the position, the entire position is closed out at the quoted bid. For larger positions, a series of market sell orders maybe needed to close out the position. (ii) limit orders to sell at the ask are placed. Every time a market purchase order arrives the outstanding position of the trader decreases.

(2) Sell in the when issued market, unwind position on ex-split date

As transactions in the when issued market are likely to be purchases more than 50% of the time, it is expected that many limit buy orders will not be hit. Strategy (2) is similar to (1), except for the fact that limit orders to sell 100 shares at the ask are placed in the when issued market. The position is closed out on the ex-split date using (i) market orders or (ii) limit orders at the bid. This strategy assumes no short sale constraints.

(3) Buy and sell in the when issued market

This strategy attempts to exploit the wide spreads in the when issued market by buying and selling via limit orders in this market. The trader places limit orders to buy 100 shares at the bid and sell 100 shares at the ask. Limit orders are updated every time quotes change. Any trade that occurs on the when issued market affects the outstanding position. The open position, if any, on the ex-split date is unwound using either (i) market orders or (ii) the appropriate limit orders.

(4) Buy in the when issued market, immediately unwind position in the stock market.

This strategy attempts to directly use the difference in quotes across the markets to make a profit. Limit orders to purchase 100 shares at the bid are placed in the when issued market,

the orders are revised with every quote change. As soon as enough shares have been accumulated in the when issued market to enable a round lot transaction in the stock market, the position is unwound in the stock market. This is done using either (i) market orders or (ii) limit orders at the ask.

(5) Sell in the when issued market, immediately unwind position in the stock market.
This strategy attempts to utilize the same fact as in (2), that trades are more likely to be purchases in the when issued market. Limit orders to sell 100 shares at the ask are placed in the when issued market. As soon as enough shares have been accumulated to trade a round lot in the stock market, the position is unwound using either (i) market orders or (ii) limit orders at the bid.

The strategies have not explicitly allowed for the difference in settlement periods across markets. For strategies (1), (2) and (3) trades in both markets are settled on the same day, so there is no effect on profits. In the case of strategy (4), as sales occur in the stock market and purchases in the when issued market, profits have been understated. Correspondingly the profits have been slightly overstated for strategy (5). All strategies are based on the assumption that other market participants do not change their strategies on observing the limit order trader. Transaction costs have been assumed to be zero. The strategies are contingent on the trader being able to place limit orders at the prevailing quotes and change limit orders with every change in quotes.[1] A summary of the results are presented in Appendix 2-2d for all firms for which the above strategies can be executed. It can be seen that in most cases where a limit order strategy is profitable in the stock market, a market order strategy is also profitable.

To test if the observed profits can be explained by movements in price, the direction of price change for each stock is determined. A rising market would cause a strategy of buying initially and then selling (as in strategies (1) and (4)) to be profitable. Correspondingly, a declining market would lead to a strategy of short selling and then buying to be profitable. As trading strategies (1) and (2) would be able to use market movements to the greatest advantage, they should result in the largest profits if the strategies are simply capturing price movements. It is found that the number of firms

---

[1] As the average time between quote changes in the when issued market is over an hour, the restriction does not pose a problem in the when issued market. However, it may not be possible to constantly update orders in the stock market to ensure that limit orders are executed.

exhibiting an uptrend, as evidenced by both actual price change and the relative number of upticks over the period where both securities traded, is nearly equal to the number of firms displaying a downtrend. The results for strategies (1) and (2) can be related to price movements. However, price trends alone cannot explain the results for all firms. Also, as there is an almost equal proportion of firms exhibiting upward and downward trends, strategy (4), which results in losses for most firms, and strategy (5), which results in profits for most firms, can not be explained by market movements.

It can be seen that placing limit orders in the stock market generally leads to larger profits than placing market orders (the profit associated with (ii) is greater than with (i)). As trades are largely purchases in the WI market, limit orders to buy are not executed a sufficient enough number of times to enable a positive profit to be made. This explains why strategies (1) and (4) are not profitable opportunities. However, strategies (2), (3) and (5) result in positive profits for a large proportion of the firms. The larger difference in ask quotes across markets, as can be seen by the larger relative ask premium as compared to the bid premium, also results in limit sale order strategies being more profitable than limit buy strategies. Strategy (5) results in the largest profit as it takes direct advantage of the difference in trading structures in the when issued market and the market for the underlying stock.

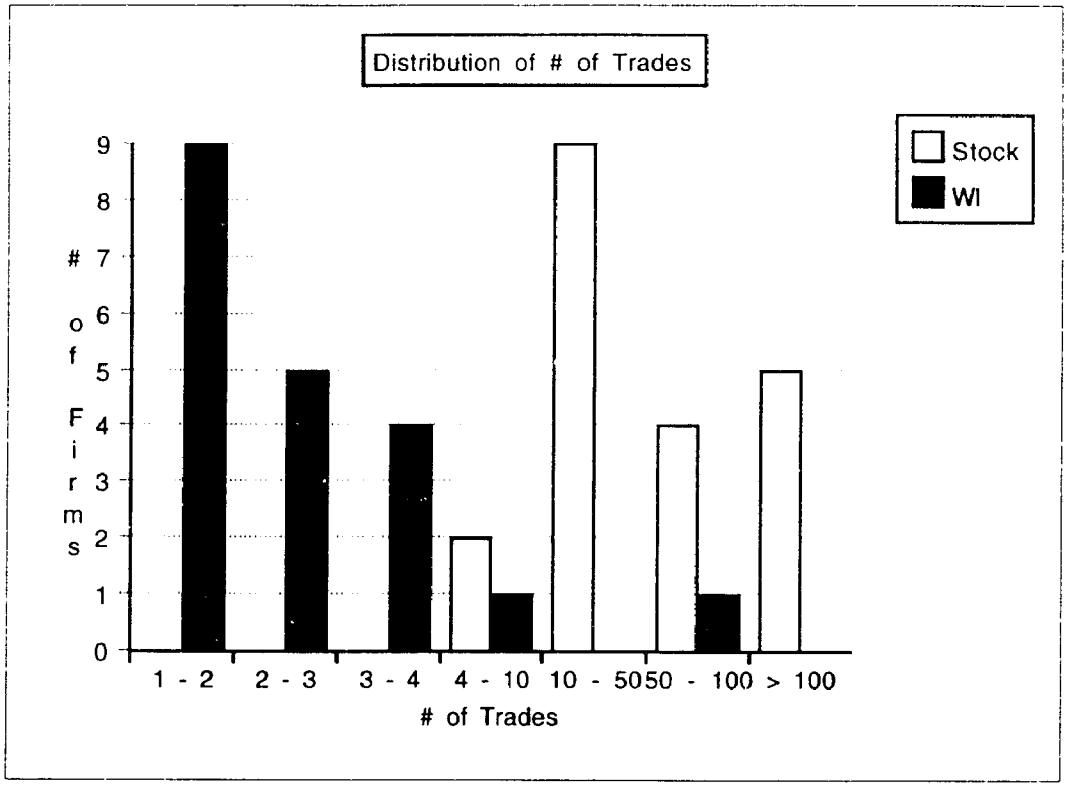
2-6 Conclusion

The premium observed by earlier researchers in the when issued market is a consequence of the distribution of trades in the market. Stock splits are of value to investors who do not have sufficient capital to trade round lots at pre-split prices. These traders are now able to enter the market leading to more purchases. Due to short sale constraints, stock splits do not lead to a corresponding large increase in the number of short sale trades in the when issued market. Investors who desire to unwind long positions would prefer the stock market in cases where the stock split leads to their holding an odd lot position, and be indifferent between the two markets otherwise. This should have a limited impact on the percentage of sales in the when issued market. Therefore, trades in the when issued market are more likely to be purchases than sales, where as in the stock market no such pattern is observed. The spread in the when issued market is larger than the spread in the stock market. This results in premiums being observed when the ask price is used, but not when the bid price is used in the computation of premium.

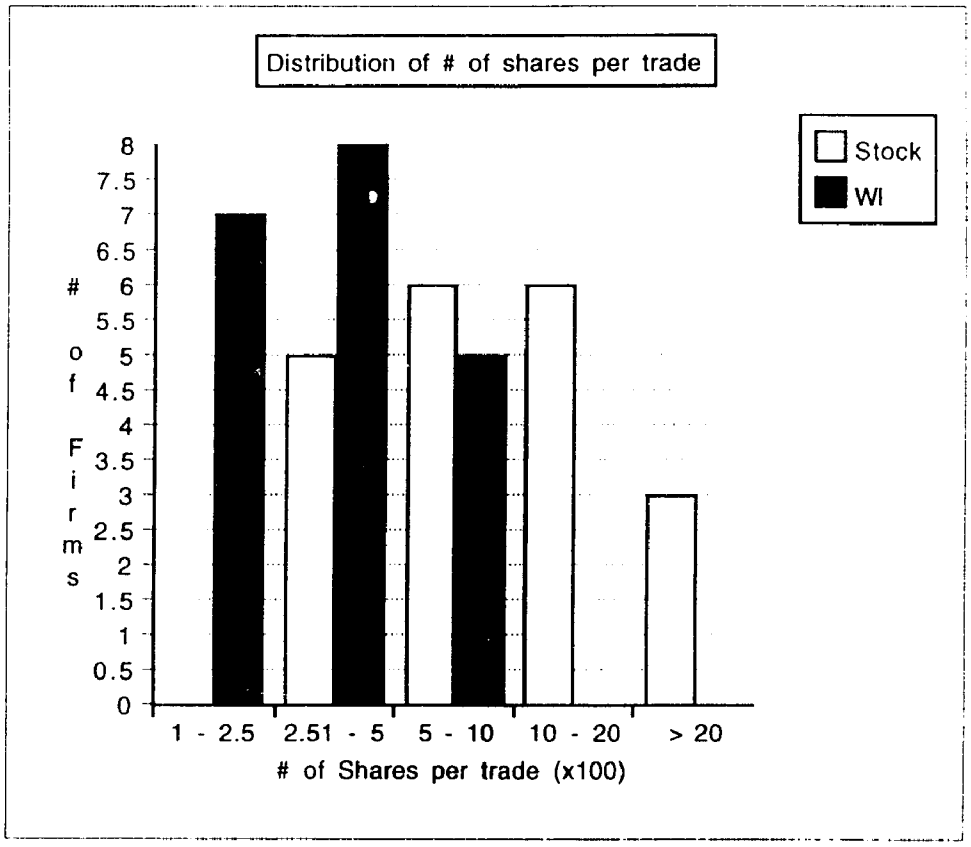
Transaction costs, as measured by both quoted and effective spreads, are larger in the when issued market. As both securities are claims to identical financial flows, the difference in observed transaction costs must be due to factors other than the firms characteristics. The difference in spreads in the two markets can be explained by several factors. It is found that the difference in spreads is smaller if the relative volume in the when issued market is large. Other measures of trading costs are also larger in the when issued market. The price impact of a trade is greater and the quoted depth is smaller.

The difference in trading structures across markets can be exploited to make a profit. The strategies of selling at the limit price in the when issued market and unwinding the position on the ex-split date, and buying and selling via limit orders in the when issued market both lead to positive profits for a large proportion of firms. The strategy of selling in the when issued market and immediately unwinding the position in the stock market, which uses both the fact that trades in the when issued are more likely to be purchases and that spreads are larger in the when issued market, results in positive profits for almost all companies .

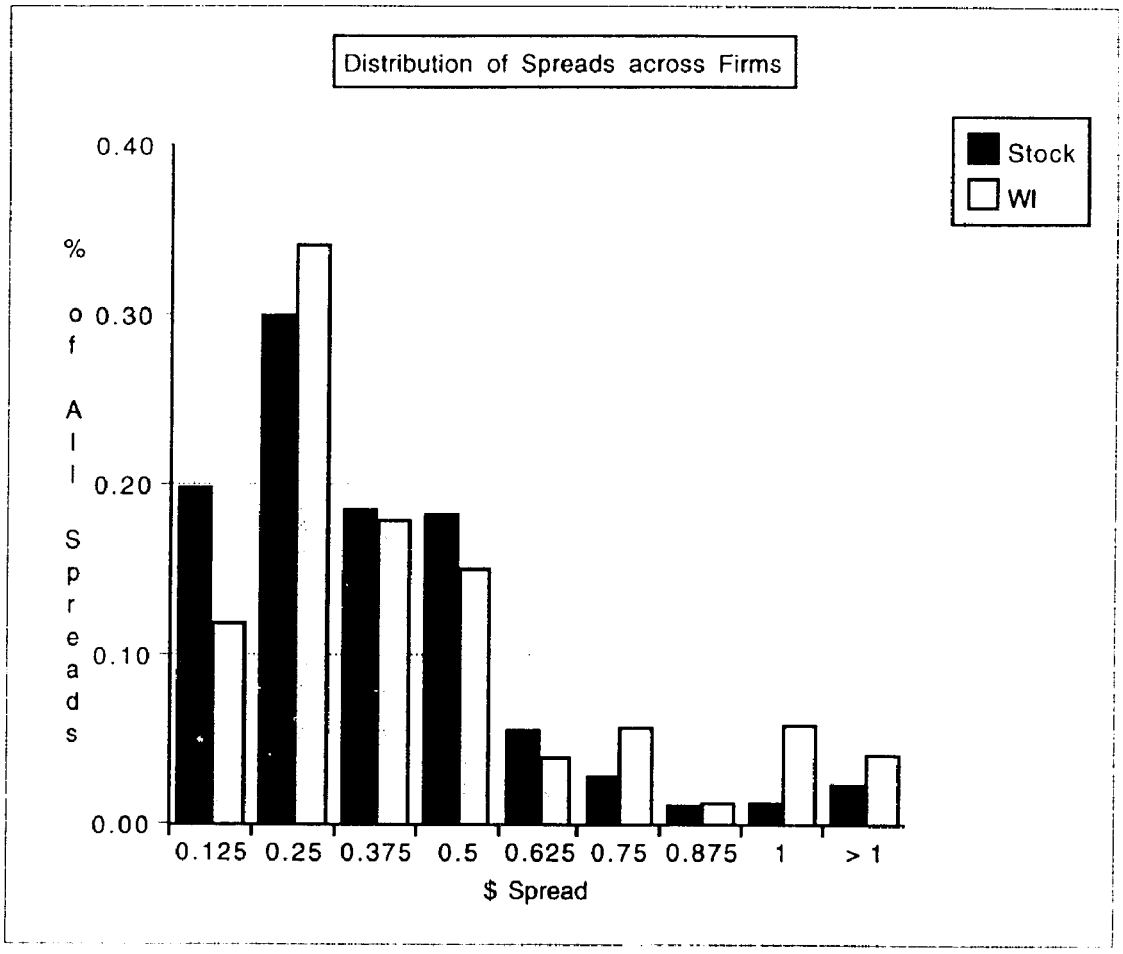
Appendix 2-1a: Distribution of Number of Trades



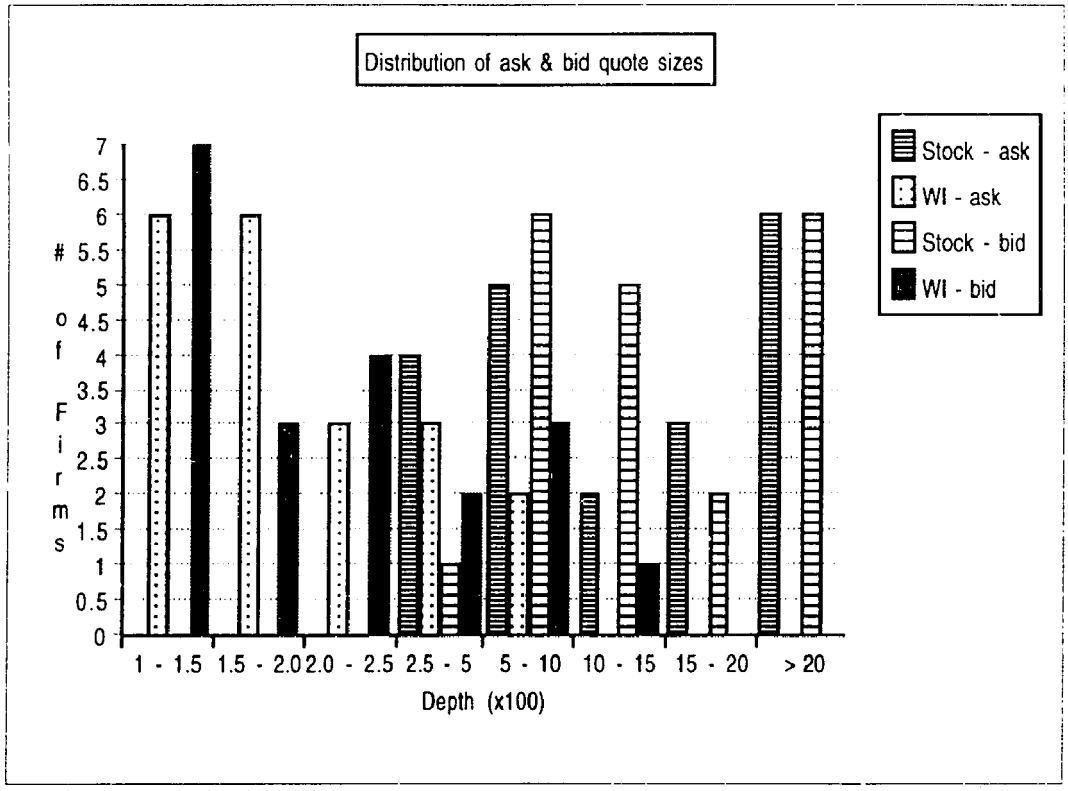
Appendix 2-1b: Distribution of number of shares per trade.



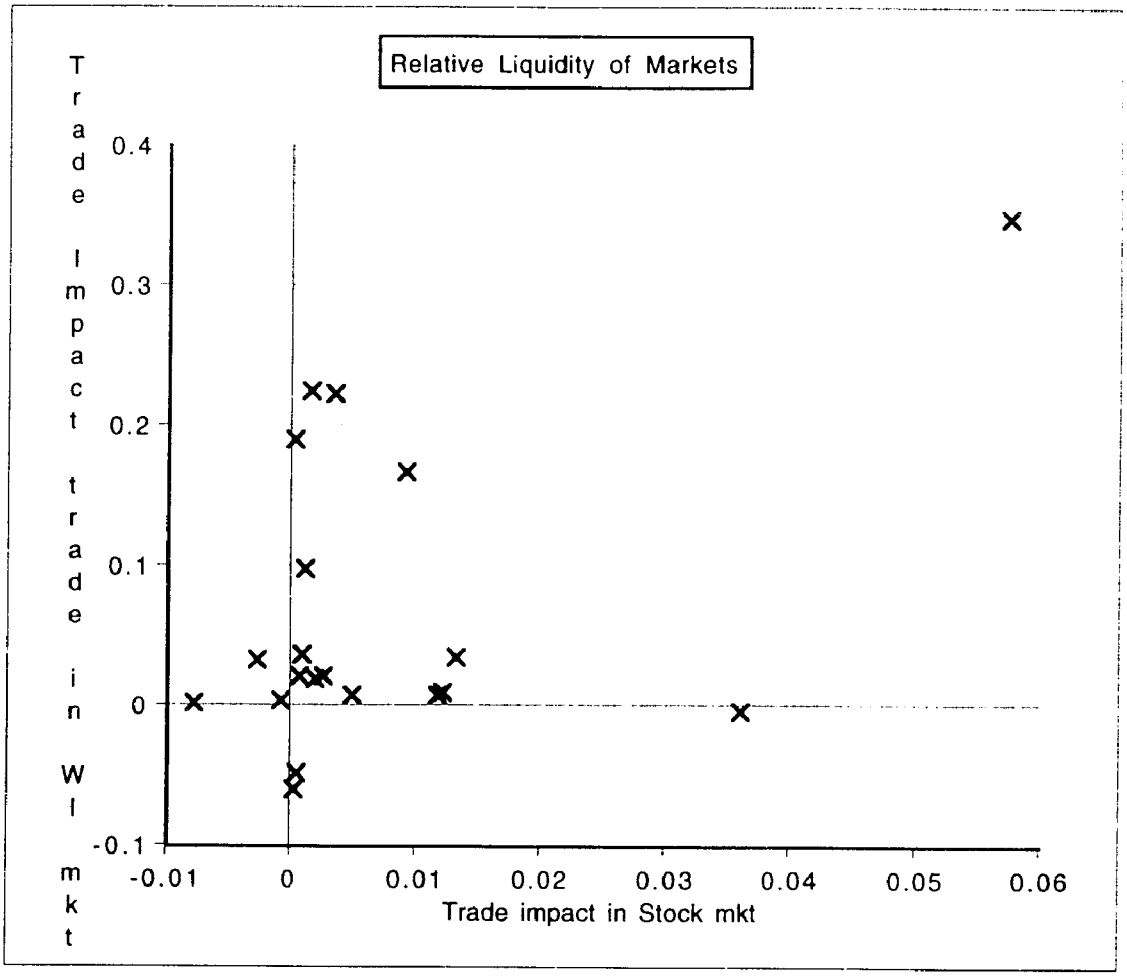
Appendix 2-1c: Distribution of Spreads across Firms.



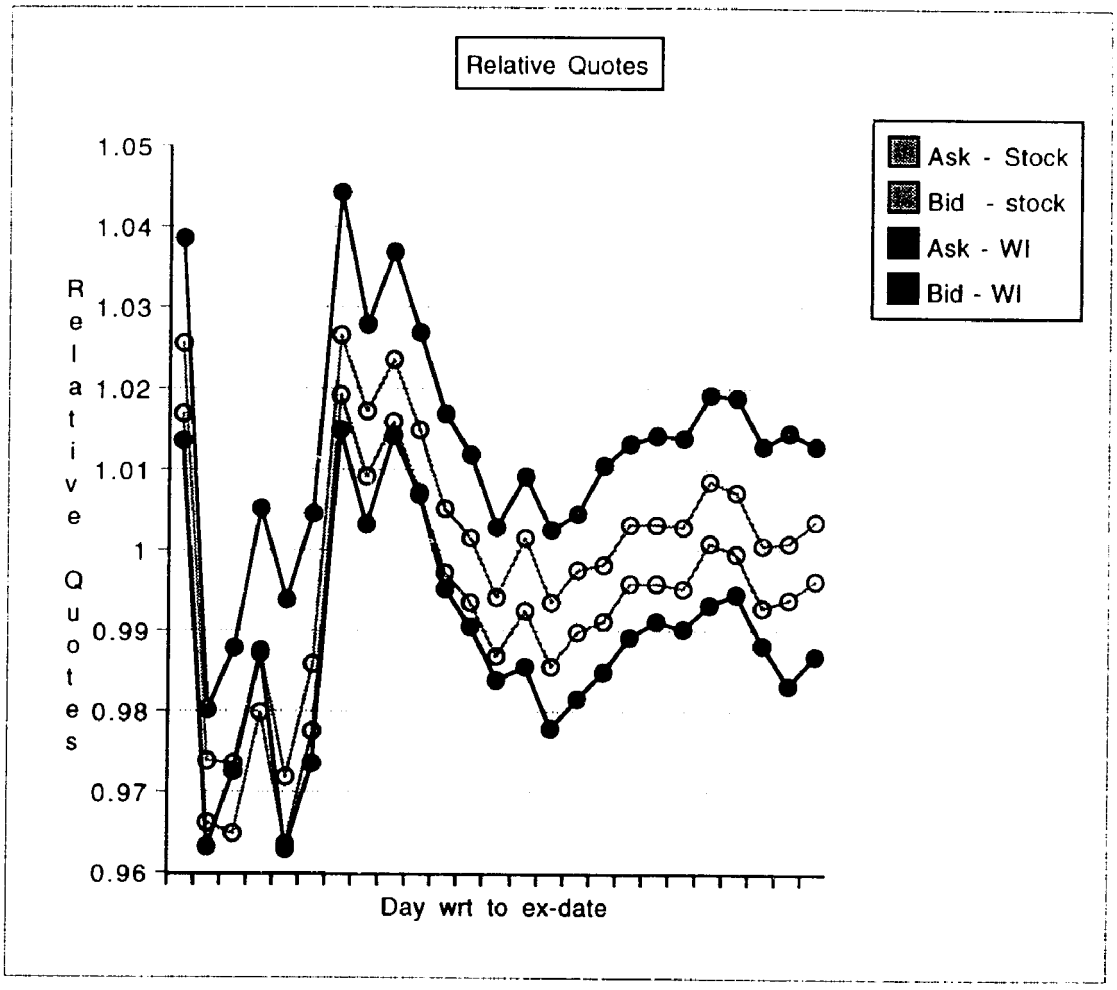
Appendix 2-1d: Distribution of ask and bid quote sizes.



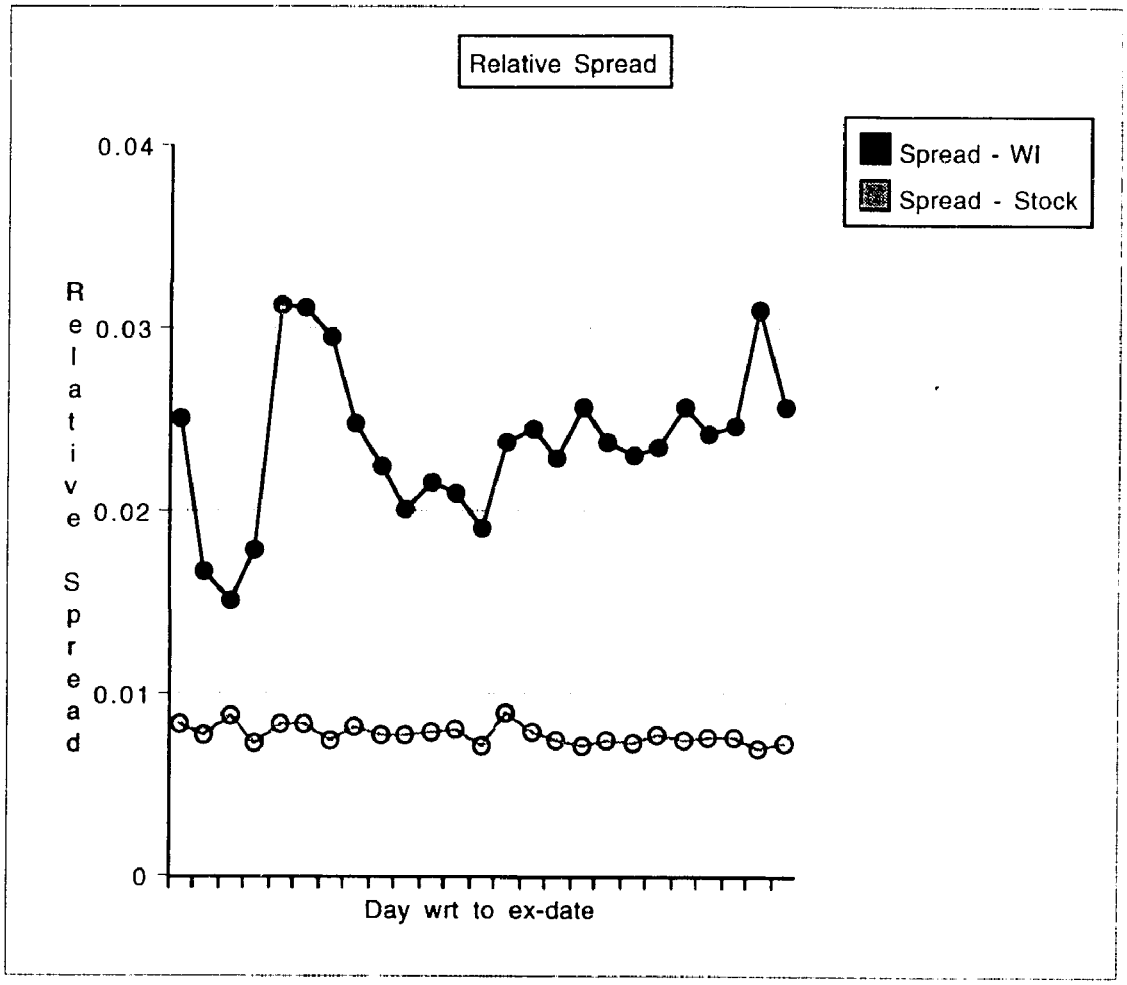
Appendix 2-1e: Relative Liquidity of Markets.



Appendix 2-1f: Relative quotes over time.



Appendix 2-1g: Relative spreads over time.



Appendix 2.2a: Dollar values of quoted and effective spreads for each firm in the two markets.

Ticker Symbol	Stock Spread ($)	WI Spread ($)	Effective Stock Spread ($)	Effective WI Spread ($)
AMH	0.23271	0.24008	0.16708	0.12732
BER	0.43116	0.82292	0.11110	0.16667
BMS	0.33439	0.45979	0.19163	0.37500
CCK	0.56960	0.61662	0.19006	0.22569
CTB	0.33093	0.70508	0.13600	0.20313
GFS.A	0.26876	0.37305	0.18016	0.21572
GW	0.30344	0.89977	0.20108	0.34375
HLT	0.38381	1.04373	0.22000	0.85000
KF	0.38422	0.40392	0.23940	0.21294
MRK	0.44266	0.31225	0.27088	0.20494
PRE	0.35346	1.47604	0.20798	0.20833
REN	0.24750	0.73172	0.14237	0.33333
SBL	0.37483	0.40440	0.15692	0.37500
SPP	0.46736	0.99038	0.28237	0.60739
STH	0.43268	0.53802	0.23366	0.39063
STO	0.41865	0.89929	0.24098	0.54609
TO	0.29453	0.37390	0.15784	0.27024
WPH	0.42670	0.71370	0.20820	0.40625
WWY	0.41287	1.32939	0.24493	0.91048
WY	0.37157	0.47548	0.22805	0.24616
Average	0.37409	0.69048	0.20053	0.36095

t-stat of difference in spreads = 4.169

t-stat of difference in effective spreads = 3.507

Appendix 2-2b: Permanent impact of a trade on prices in the when issued and pre-split markets for each firm.

Ticker Symbol	Price Impact in Stock Market	Price Impact in WI Market
AMH	0.000942	0.03671
BER	0.003437	0.22234
BMS	-0.002687	0.03268
CCK	0.011731	0.00741
CTB	0.001581	0.22500
GFS.A	0.012127	0.01049
GW	0.000185	0.19118
HLT	0.000388	-0.04830
KF	0.004879	0.00777
MRK	-0.000954	0.00393
PRE	0.009098	0.16667
REN	0.000584	0.02041
SBL	0.002623	0.02111
SPP	0.035902	-0.00347
STH	-0.007955	0.00244
STO	0.001042	0.09715
TO	0.057511	0.34866
WPH	0.002020	0.01986
WWY	0.013208	0.03555
WY	0.000203	-0.06029
Average	0.007293	0.06687

t-stat of the difference in price impacts = 2.570

Appendix 2-2c: Percentage of all trades for each when issued security that are smaller than one round lot transaction of pre-split shares.

Ticker Symbol	# of Small Trades	# of Trades	% of Small Trades
AMH	8	29	0.27586
BER	1	5	0.20
BMS	6	12	0.50
CCK	2	10	0.20
CTB	4	5	0.80
GFS.A	36	63	0.57143
GW	3	5	0.60
HLT	5	7	0.71429
KF	45	88	0.51136
MRK	814	1157	0.70354
PRE	0	4	0.00
REN	1	5	0.20
SBL	8	13	0.61539
SPP	8	21	0.38095
STH	2	5	0.40
STO	16	21	0.76191
TO	2	19	0.10526
WPH	10	17	0.58824
WWY	24	38	0.63158
WY	31	62	0.50

Appendix 2-2d: The number of firms for which each strategy resulted in positive and negative profits, and summary statistics of the average profit across all firms for which the strategy is executable are presented below.

Strategy	# of firms with positive profits	# of firms with negative profits	Average profit ($)	Std Dev	z-stat for sample proportion
1 (i)	5	11	-8.772	29.129	1.5
1 (ii)	9	7	-4.941	18.726	0.5
2 (i)	10	6	57.824	217.927	1.0
2 (ii)	13	4	50.346	176.862	2.18
3 (i)	13	6	48.855	194.584	1.61
3 (ii)	15	4	60.276	233.758	2.52
4 (i)	3	13	-3.699	7.584	2.5
4 (ii)	4	10	-1.926	4.491	1.07
5 (i)	16	1	19.847	65.010	3.64
5 (ii)	17	1	27.306	88.009	3.77

3. INVESTIGATION OF THE LISTING ON AN EQUITY OPTION ON THE TRADING CHARACTERISTICS OF THE UNDERLYING SECURITY

3-1 A Brief Overview

Numerous studies have investigated the impact of option listing on the volume and volatility of the underlying security. Differences in measures including return volatility, volume of trade, mean excess return and systematic risk of the stock have been documented by researchers. The direction of the changes and their significance were not necessarily the same when different time periods and methodology were used. In contrast to earlier papers, we focus on the impact of option listing on microstructure trading characteristics of the stock.[1] This paper empirically investigates the effect of option listing on transaction costs in equity markets, and on factors that effect these costs. Data from recent option listings is used to ensure that the observed effects are not a consequence of the fact that investors are unfamiliar with the contingent claim.

The listing of a derivative security may affect the costs of trading in the cash market. As less investment is needed to obtain a position in the stock through the options market, speculators maybe encouraged to enter the market. This could have a destabilizing affect on price and increase volatility. This was one of the main concerns addressed in earlier evaluations of the impact of options listing. Unlike earlier research, this paper focuses on transaction costs in terms of spreads, depths and price impacts. This is of interest to traders and regulators, and of particular importance to investment funds and investors who trade large volumes.

The listing of options provides investors with a way to hedge their trades, risk averse investors may now be willing to take a position in the security and traders already in the market may take larger positions. Investors may also be willing to place more limit orders, since they have a way to protect themselves against unfavorable moves in the stock price. This contributes to the liquidity of the market. Spreads may decline as market makers are now faced with less inventory risk, market makers may also be willing to quote larger

---

[1] An exception is Fedenia and Grammatakois (1992) who consider the effect of option listing on the bid-ask spread.

depths further improving the terms of trade. The options market may provide the equity exchanges with competition for investor order flow, forcing market makers on the equity exchanges to offer more competitive quotes. As options allow investors to exploit information with less risk and at a lower cost, it may provide traders with an increased incentive to acquire information. If option introduction does lead to an increase in informed trade, the specialists may be forced to widen the offered spread and/or decrease the depth of the market to protect themselves against possible adverse selection. As the effect of option listing on trading costs is not definitive, it is an issue that must be investigated empirically.

Jennings and Stark (1986) investigate the difference in the speed of adjustment of optioned and non-optioned stock to an earnings announcement. They find a distinct difference, with the optioned stock adjusting to the news quicker than the non-optioned stock. Manaster and Rendleman (1982) find that option prices may contain information not already contained in the stock price. As information is transmitted between markets, this suggests that information incorporation into prices maybe different for stocks with and without listed options. Anthony (1988) finds that option volume leads stock volume. Both the above papers are in accordance with Black (1975), who suggests that informed traders may prefer the options market. If the existence of the options market changes the incentive of traders to acquire information or the speed with which information is incorporated into stock prices, a difference in the behavior of stocks on option listing will be observed.

Equity options were first traded on an exchange in 1973. Daily option volume exceeded stock volume, in terms of stock equivalent, for a number of stocks within a couple of years of the first option listing. This suggests that options form an important part of an investor's trading strategy. In the initial year of option listing, 48 call options were listed on 16 underlying stock. In 1988, options had been listed on over 400 stocks. An investigation of the trading characteristics of all large, widely traded companies shows that the stocks that had been chosen for option listing are significantly different from stocks without listed options. The optioned stock had larger daily volumes of trade, lower percentage spreads, larger quoted depth on the ask side of the market and exhibited less of a price reaction to large purchases. (However, depth on the bid side and the impact of large sales was similar for both sets of stock.) If the difference in characteristics is a listing effect we would expect to see these differences when the period before option listing is compared to that after. However, the differences between the optioned and nonoptioned stock need not necessarily be a listing effect, the decision to list the derivative security could itself be a consequence of the observed difference in characteristics. In this paper we

determine if listing explains the difference in characteristics between stocks with and without traded options.

In the initial years of option trading the underlying stocks experienced significant changes around the option listing date. As investors have become increasingly familiar with the implications of options trades in recent years, the effects of option listing are now expected to be different from the effects observed at earlier introductions. Call options have been traded since 1973 and put options since 1977. Index options were introduced in 1982, this is expected to decrease the impact of option listing on individual stocks. In this paper a number of microstructure characteristics of stocks are compared in a short period of two months and a longer period of six months around the option listing date. Option listings in 1988 are used. By this period, investors had been trading stock options for over ten years and index options for over five years. We use daily averages, instead of opening or closing values, to investigate the effects of option listing. Little difference is observed in the average values of trading costs in the periods before and after listing. However, the intertemporal behavior of characteristics changes around the listing date. This may lead to a difference in the average level of costs over a larger time horizon. Section 3-2 discusses the theoretical and empirical literature in this area. In Section 3-3 we describe the data source. Section 3-4 provides an analysis of measures that will be used in comparing trading characteristics. Section 3-5 describes the empirical results and Section 3-6 concludes.

3-2 Review of Literature

(i) Empirical Results

A number of papers have investigated the volume and volatility impacts of option listing. The conclusions reached by studies using different time periods and methodologies are not the same.

Risk and Return Predictions:

Branch and Finnerty (1981) find positive mean excess returns in the period before and immediately after options listing, this was hypothesized to be the result of the selection process of the options exchanges that tended to over represent better performing stock. Klemkosky and Maness (1980) find that stocks experienced decreases in excess return after listing, they suggest that this could be an implication of increased efficiency of the market on option listing. Detemple and Jorion (1990) document a decrease in return volatility.

They find that the observed effects are less pronounced in recent years, they attribute this to the increased completeness of the market. Hayes and Tennebaum (1979), Skinner (1986) and Bansal, Pruitt and Wei (1989) find a decrease in volatility. However, Ma and Christopher (1988) find that volatility increases for more stable stocks and decreases for less stable stocks. A decrease in the systematic risk of a stock was documented by Trennepohl and Duke (1979). However, Detemple and Jorion (1990), Klemkosky and Maness (1980) and Bansal, Pruitt and Wei (1989) observe no shift in stock betas.

Volume Predictions:
An increase in volume after options listing has been documented by Skinner (1989), Hayes and Tennebaum (1979), Branch and Finnerty (1981) and Bansal, Pruitt and Wei (1989). A possible explanation proposed for the volume increase was that option listing increased the marketability of the underlying security. Whiteside, Dukes and Dunne (1983) find no change in the volume of trade or the variability of volume.

These papers use data from the initial option listings, those that also used data from later periods found the observed effects to be of less significance in later years.

(i) Theoretical Predictions.

Informational Consequences:
Grossman (1988) argues that the options market is not informationally redundant. The information conveyed by a trade in the options market is different from that revealed when there are trades only in cash and bond markets. The presence of an optioned security reveals to the market the future intentions of traders, trade in the cash market will not reveal the intensity of investors to trade at different prices. Without the derivative market liquidity suppliers will not be able to gauge accurately the demands for their services in the future. This would have the effect of increasing the volatility of prices. To make this point clear, Grossman uses the example of a synthetic put option. If a large number of traders insure their portfolios synthetically a drop in prices may trigger a wave of selling. Traders would no longer be able to ensure that their sales occurred at the desired price, this problem would not occur if investors bought actual put options where they could guarantee a minimum price to be received for a sale. The synthetic strategy increases volatility, since prices move further than they would with the existence of a market for the real security. The option is no longer redundant in this scenario, this is expected to affect the trading characteristics of the security. More information is revealed, as compared to the case of stocks without

options. As market makers are better aware of when their services will be required they can adjust their supply of capital appropriately. This would enhance the liquidity of the market and should decrease the impact of a trade on price. Since prices move less return volatility is predicted to be lower.

Completeness of the Market:

Detemple and Selden (1991) show that in an incomplete market the option is not redundant. The valuation of the stock and option is simultaneous, with the value of the stock depending on the characteristics of the derivative security. The introduction of the option will affect the completeness of the market (and thereby affect equilibrium values), with the stock price depending on the exercise price of the option. Detemple and Jorion (1990) find that the effect of option listing on the completeness of the market was significant in the early years of introduction. Later introductions of options contributed less to the completeness of the market. This implies that changes in the market should have been larger in the earlier years of options trade.

Increased Speculative Activity:

Stein (1987) considers the effect of increased speculation due to the introduction of options. Investors who do not have access to borrowing and lending facilities maybe able to take a position in a security through the options market. Traders will find it easier to take short positions using options. In many cases margin requirements are less in the derivative market. Investors with access to low cost borrowing and lending opportunities or less stringent margin requirements transmit this demand from the options to the stock market. Depending on the diversity of the information of the new traders, prices may either be stabilized or destabilized. Welfare improves due to the increase in the aggregate risk sharing capacity of the market.

The above papers predict change in trading characteristics due to the listing of an option on a stock. This paper focuses on microstructure characteristics to see if the above predicted changes have an affect on intra-day trading costs and price impacts. These are factors of concern to investors, a change in costs would have implications for the trading strategy investors choose to use. Unlike earlier tests that were performed on firms that were initially chosen for options listing, this paper uses later listings that are for firms that are not as well established. Some of the effects that were associated with an option listing in earlier years are no longer observed, suggesting that the market now reacts differently to the listing of an option as compared to in the early years of option trading. This could be a

consequence of a better understanding of the implications of options trading. It could also be a result of the listing of index options in 1982, now options on individual stocks can be expected to have less pronounced effects on listing.

3-3 Data Source

The data used in the comparison of market characteristics consists of time stamped transactions from the ISSM (Institute for the Study of Securities Markets) tape for 1988. The data set contains details of transactions and quotations for stocks traded on the exchanges. It provides the ask and bid quotations of the specialist, as well as the price and volume of any transaction that occurs. Trades are not explicitly classified as buys or sells, this is inferred by comparing the trade price to the previous quote midpoint. All the stocks being considered are traded on exchanges with a single specialist, this rules out differences in characteristics due to the number of dealers making a market in the particular stock.

The stocks used in the sample were those that had options listed on them in 1988. A list of all stocks that had listed options was obtained from the Chicago Board Options Exchange. It includes the date of listing, as well as the types of options listed (a call or put or both). 120 stocks had options listed on them in 1988, of these stocks 46 did not have trading information available on the ISSM tape (most of these were for optioned stocks that were traded over the counter). Of the remaining stocks, 33 stocks had options listed on them in December and 1 had an option listed on it in January. These stocks did not have enough data to compare the period before options listing to the period after listing. Of the remaining 40 stocks, 7 did not have data available for the period immediately around the option listing date. When comparing data for a period of 20 days (approximately one month) around the option listing dates 33 companies had the requisite date. For the six month period 21 companies had sufficient data. The characteristics of the larger sample in terms of average price over the year, number of shares of stock outstanding at the beginning of the year and volume of trade over the year are provided in Table 3-1. Summaries in terms of exchange listed on, the month of listing and whether a call or a put or both are listed are provided in Tabie 3-2, Table 3-3 and Table 3-4 respectively.

Table 3-1: Lowest price, number of shares outstanding and total trade volume averaged over the sample.

	Mean	Std.Dev.	Minimum	Maximum
Lowest price	23.29	13.20	2.88	48.75
Shares outstanding(000)	37161.00	31319.40	9002.00	150000.00
Total trade volume(000)	33509.79	19253.75	10184.40	95274.80

Table 3-2: Number of firms with options listed by exchange.

AMEX	10	CBOE	7
PHLX	11	PSE	4
NYSE	1		

Table 3-3: Number of firms with options listed in each month.

Feb.	2	July	5
March	2	Aug.	6
April	2	Sept.	1
May	4	Oct.	5
June	4	Nov.	2

Table 3-4: Number of firms with only call options or both call and put listings.

Call option only listed	5
Call & put options listed	28

3-4 Trading Characteristics

The measures used to compare the characteristics of the stock before option listing to the characteristics after listing are presented below.

(i) Volume.

Volume of trade is considered by the options exchange when deciding whether to list an option on a particular stock. We consider average daily volume, the number of transactions per day, the volume per trade, the number of large transactions per day and the large trade volume per day. These measures reflect the overall trading interest in the stock, as well as the institutional interest in the security.

The listing of the contingent claim may increase investor interest in the stock for the following reasons. Options allow investors to hedge risks that they would otherwise be exposed to, risk averse investors may therefore be willing to take a position in the cash market and traders already in the stock market may be willing to take larger positions. Institutional interest in the stock may also increase. Arbitrageurs would contribute to demand if they perceive the values of the stock and option to be out of line. Specialists from the options market may unwind their trades in the cash market, thereby transmitting the demand of investors who choose to deal in the options market to the stock market. Investors constrained to trade large volumes may find the market more attractive now. On the other hand, trades may migrate off the stock exchanges to the options markets. Risk averse investors, who were previously using the cash and bond market to obtain their desired pattern of returns, may be able to obtain it directly with option trading. Traders with limited capital may prefer the options market since the investment required to obtain a desired position in the stock is lower there. Traders with uncertain information may use the derivative market as their dollar potential loss for an equivalent stock position is lower with option transactions. If both the buyer and writer use the options market and chose not to unwind their positions in the cash market, the option transaction would have the affect of decreasing the volume of trade in the cash market.

(ii) Return Volatility.

Return volatility is a factor of concern to both investors and regulators. Investors would not actively trade options if they felt stock prices would not fluctuate, there must be a certain degree of volatility in the security if the options exchange considered the stock to be suitable for options listing. Papers by Skinner (1989), Damodaran and Lim (1991) and Detemple and Jorion (1990) document decreases in daily return volatility after listing. In this paper we consider intra-day volatility.

One of the initial concerns that arose on options listing is that it could increase the volatility of the market to the detriment of investors. It was contended that the options market drew speculative capital away from new-issue markets and low price stocks. The presence of the speculators in the market was expected to lead to wide fluctuations in price and large volatilities. However, it is also possible that options listing can lead to a decrease in volatility. As the derivative security reveals to the market the future intentions and expectations of traders, liquidity suppliers are better prepared for future price movements. For example, if the volume of trade in put options is large and the price of the option is being pushed up this would signal that traders think the stock is overpriced. Specialists would be prepared to deal with a larger than usual volume of sell orders and would have more time to find investors willing to take the other side of the market. It is not clear if these effects would be more pronounced in a shorter time period. Intra-day and daily return variances may be affected.

Volatility depends on the depth of the market. A highly liquid market would mean that individual trades move prices little and volatility is low. In thin markets even small trades cause large movements in price and thereby increase volatility. To the extent that options listing affects the liquidity of the market, volatility is affected. Damodaran and Lim (1991) consider factors affecting return volatility. The three principal components they looked at are variance of the intrinsic value, a price adjustment coefficient and a noise component. With the introduction of options investors may expend more effort on the collection of information, since they have a lower cost way of exploiting it. If prices adjust slowly to this information volatility is low, if prices over react volatility maybe large. The noise component depends on the spread in the market, if options listing has an impact on the spread it will also affect volatility.

(iii) Depth of the market.

A measure of depth is obtained by looking at the average volume quoted by the specialist on the ask and bid sides of the market. This is a lower limit on the actual depth in the market. In a highly liquid market the specialists would not have a problem buying or selling stock, therefore large depths may be quoted. Alternatively, in illiquid markets the specialists face large inventory risk and are willing to trade only small quantities. If option listing affects the liquidity of the market, it will affect the quoted depth.

As the option markets provide competition to the stock exchanges, the market makers in the equity markets may be forced to offer better terms of trade. One of the ways this can be done is by increasing the quoted depth. Another explanation for larger quoted depth would be a decrease in adverse selection in the cash market as informed traders migrate to the options exchange. Alternatively, the specialist may decrease the quoted depth if the amount of private information in the stock market is more than it was without the option listing (as a consequence of aggressive information acquisition by traders).

As the impact of option listing on the quoted depth on the ask and bid sides of the market are not necessarily the same, they have been considered separately. Investors face few constraints when buying a security, but individual traders cannot easily short stock. The introduction of the options market provides investors with an easier way to obtain the desired short position, they can either buy put options or write call options. Option dealers may be able to transmit this demand to the cash market, as they face fewer constraints when shorting stock. The increase in short positions causes the changes observed on the bid side of the market to be different from those seen on the ask side. To facilitate the increased volume on the bid side the specialist in the equity market may increase the quoted depth. On the other hand, specialist may decrease the quoted depth. As more people now desire to short the stock the market makers can adjust the terms of trade to their advantage.

(iv) Price Impact of Large Trades.

This is a measure of the liquidity of the market. Trades cause price impacts for a number of reasons. If the market maker perceives that a trader has private information a higher ask price and/or a lower bid price will be quoted to mitigate losses to the informed. If large blocks are more likely to be motivated by information than smaller trades, larger price change are expected with bigger trades. Market makers may demand price concessions before they trade large blocks. Besides the increased possibility of adverse selection, this is also a consequence of inventory risk. The impact of trades is also a result of the shape of the demand and supply curves. For large quantities demanded the price will increase, and for large quantities supplied the market price will decrease.

Option listing could change the price impact of large trades. Private information in the cash market may decrease as informed traders migrate to the options exchange or increase as traders chose to acquire information more aggressively. A decrease would lead to smaller price changes, and an increase would lead to larger price impacts. Price impacts could also

be affected by changes in the trading behavior of investors (and consequent changes in the slopes of the demand and supply curves).

Chan and Lakonishok (1993) show that the impact of large buys and sells are significantly different. One of the proposed explanations is that the choice of a particular stock to buy has more informational implications than the sale of a block. Option listing would probably not cause much of a difference in the informational implications of large buys and sells, the fact that a trader chooses a particular stock to buy would still signal stronger information than a block sale. Another possible reason for the difference in the impact of block buys and sells is that sales are more likely to involve intermediaries than purchases. The compensation demanded by the middle men cause larger immediate price impacts to be observed. With the existence of options markets more traders may be willing to take the other side of the block, as they can hedge their positions. Competition among traders will lead to lower observed price concessions.

(v) Spread.

This is a direct measure of the cost of trading in a security. The specialist sets a spread which is assumed to consist of essentially three components - a fixed cost component which compensates the specialist for time and effort, an adverse selection component which is used to protect the specialist from a loss due to a trader basing an order on private information, and an inventory cost component which provides a return on the capital of the specialist and protects against adverse price moves. To the investor the spread is of importance. The analysis below was done for each component of spread to see how the options listing affects each and therefore the spread overall. Depending on the net effect of the change in the various components, the quoted spread may decrease or increase.

The fixed cost component depends on the same factors that volume does. A large volume would lead to a lower fixed cost charged per share, a smaller volume would imply a higher fixed cost per unit. Increased competition from the options market could lead to the market maker demanding a higher fixed cost to compensate for the increased effort, or a lower fixed cost since the specialist has to offer a more attractive deal to attract customers. Limit order placement may increase since traders would have a way to protect themselves against unfavorable price moves. This would also be a source of competition to the market maker.

The introduction of an option could provide traders with a larger incentive to acquire private information, the specialist may then set a larger adverse selection component. If the informed traders choose to trade in the options market (and thus the fraction of informed trade on the stock market is less) the adverse selection component may fall.

The inventory cost component would depend on the frequency of transactions and the average number of shares traded per transaction. A greater frequency of trade would enable the specialist to hold stock for a shorter period of time and decrease the inventory cost component. If the average number of shares per transaction increases the specialist is required to lock up more capital on a trade. This would lead to a larger inventory component of spread.

3-5 Comparison of the period before and after option listing

Companies with listed options are typically large with a high volume of interest, their characteristics are expected to be different from that of the overall market. In order to check whether the results observed for the optioned stock are due to the listing of the derivative or to market wide phenomena, control samples are used. Control samples are created in two different ways. For each of the 33 stock in the sample with listed options a control stock is chosen from a sample of all stocks that satisfied the option listing requirements in terms of shares outstanding, volume of trade and price, but did not have listed options. In control sample one, the control stock is one that matches, as closely as possible, the optioned stock in terms of minimum price over the year and the number of shares outstanding at the beginning of the year. The number of shares outstanding is independent of the option listing and the price is determined by the fundamentals of the company (these characteristics are expected to be relatively unaffected by the listing of the derivative security). The second control sample is chosen based on characteristics that option listing may have an effect on, the optioned and control stocks are matched by volume of trade over the year and intraday return volatility.[1] As these are characteristics that option listing is expected to impact, we expect to find less pronounced differences between the optioned and control samples when control 2 is used. For a 60 day period only 21 optioned stock had the requisite data. The corresponding stocks from the controls are used in comparisons.

---

[1] These are two of the main attributes considered by the options exchange in their decision to list an option on a stock.

(i) Volume

All averages are computed over 20 day and 60 day horizons. Large trades are those with a volume of at least 10,000 units. Over a 20 day period on either side of the option listing dates the average daily trading volume for the optioned sample is found to increase, but the change is not found to be significant when a t-test is used (Appendix 3-2a). The change for control 1 is also insignificant. For control 2 an increase in volume is observed. No changes are significant for the 60 day period. The above results support the study of Whiteside, Dukes and Dunne (1983), who find no significant change in daily volume around the option listing date. Similar results are observed for the frequency of trade, the number of large trades per day, volume per trade and volume per large trade in Appendix 3-2b to 3-2e. No differences are apparent between the optioned and control samples.

The volumes for the optioned sample and the controls for the 60 day period are graphed in Appendix 3-1a (in all figures the graph on the upper left is for the optioned stock, the one on the upper right is for the control 1 and the graph on the lower left is for control 2). Daily volumes are averaged across the sample, for each day relative to the option listing date. Volume increases immediately around the listing date, but returns to the pre-listing level soon afterwards. This pattern is even more pronounced in the number of trades and the frequency of large trades in Appendix 3-1b and Appendix 3-1c. The control sample exhibits no such pattern. It is not possible to detect this pattern using a simple t-test for equality of means. No clear pattern is discernible in the volume per trade and large transaction volume per trade, as seen in figures 3-1d and 3-1e.

A pooled regression, where the independent variable is the difference between the optioned and control samples, was performed to test for the significance of changes around the listing date.

$$Y_{it} - Y_{ct} = (a_0 + a_1.D) + (b_0 + b_1.D)t + e_{it} \qquad (1)$$

where Y_{it} = the variable being considered for the optioned stock at time t

Y_{ct} = the same variable for the corresponding control stock at time t

D = 0 for the pre-listing period and 1 for the post-listing period.

When Y_t is the daily average volume b_0 is significantly positive, showing that the volume of the stock increases as compared to the controls in the pre-listing period.[1] (All regression results are in Appendix 3-3). When Y_t is the number of trades b_0 is significantly positive

[1] Corrections were made for heteroskedasticity, contemporaneous correlation across securities and autoregression as in Parks (1967).

and b_1 is significantly negative. It shows that the relative volume of the optioned stock increases in the pre-listing period and declines after the listing date. A similar pattern is observed for the number of large trades. For the volume per trade and volume per large trade no significant differences are observed between the optioned and control securities.

(ii) Return volatility

The average daily variance of intra-day returns is calculated. Prices for irregular trades are not used in computations. If no price is recorded in a 5 minute interval the return in this period is considered zero. Return volatility calculations will be most affected by errors in the data. To control for possible errors, whenever a price that is over 50% away from the daily average is observed, the record is considered an error and omitted.

Appendix 3-2f shows that a decrease in return volatility is observed for all the samples over the time periods considered, this suggests that market wide volatility is declining. A sign test reveals that the number of cases where a decline is observed is significant for the optioned sample and control 2 for the 20 day period at the 5% level. For the 60 day period, control 1 exhibits a significant decline. The pattern for the data can be seen in Appendix 3-1f, it does not reveal any significant difference between the samples. This would support the result in Detemple and Jorion (1990), that the decrease in return volatility observed on option listing has become insignificant.

A regression similar to the performed in the previous section was used to test for the difference between the optioned and control stocks. The independent variable is the difference between the return variances of the optioned and control samples. The coefficient b_1 is found to be significantly negative with both controls, implying that after listing volatility of the optioned stock decreases more rapidly than that of the controls. This could be due to the fact that the volatility of the optioned stock was higher in the pre-listing period as compared to the controls, this would reflect the selection process of the options exchanges that tends to choose stocks with higher volatilities.

(iii) Average depth

To obtain a measure of depth of the market over the day, a time weighted average of the size of quotes on each side of the market is used. This daily average is averaged over the period being compared to obtain a measure of depth. Only quotes that are BBO (best bid-

offer) eligible are used in computations. As quotes are considered to be BBO eligible even when there is more size behind the quotation than is revealed, this measure is only an indication of the minimum depth of the market. The depth on the ask side is larger than the depth on the bid side in almost all cases, confirming that the market maker does not set quotes symmetrically on both sides of the market. For each day,

$$\text{depth}_{a,b} = \sum_i \text{quote}_i \text{ depth}_{a,b} * \text{fraction of time quote}_i \text{ prevailed}$$

a = ask, b = bid

The average depth is highly variable as seen in Appendix 3-2g and 3-2h, values as low as a few 100 shares to as high as over 10,000 shares are observed. On the ask and bid sides of the market, the market depth increases for the optioned and control stocks. Most of the changes are insignificant. Appendix 3-1g and 3-1h reveal the pattern for values of the depth on the ask and bid sides of the market respectively. The optioned stock seem to exhibit a more pronounced pattern of increase in depth as compared to the control samples, especially on the ask side of the market. The increase in depth seems to occurs immediately around the option listing date. The differences are not apparent enough to conclude that option listing affects the depth of the market.

A regression with Y_t set equal to the depth on the ask and bid sides of the market was performed. The results, when the difference between the optioned stock and control 1 is regressed on time, reveal that the depth increases up to the listing date , after which it decreases. With control 2, a_1 is positive and b_1 is negative, the depth increases on listing but decreases afterwards. With both controls depth is found to decline for the optioned stock more rapidly than for the controls after listing. The pre-listing increase in volume (as compared to control 1) or the increase on listing (as compared to control 2) would account for the higher average level of depth in the post-listing period. Tests must be performed using a longer time horizon before it can be conclusively stated that depth increases on option listing.

(iv) Price impact

Trades are classified as large if the volume of the transaction is greater than 25% of the median daily trade volume.[1] Following the methodology in Holthausen, Leftwich and

[1] Holthausen, Leftwich and Mayers (1987) classify trades as large based on the size of the trade compared to the outstanding equity, the daily trading volume and the dollar value of

Mayers (1987) three measures of the impact of each large trade are considered. For each trade,

$$\text{temporary price impact} = \ln \frac{\text{(price of block trade)}}{\text{price after block}}$$

$$\text{permanent price impact} = \ln \frac{\text{(price after block)}}{\text{price before block}}$$

$$\text{total price impact} = \ln \frac{\text{(price of block trade)}}{\text{price before block trade}}$$

The price of the transaction that occurred 5 trades before the block trade is used as the price before the block and the price of the transaction that occurred 5 trades after the block is used as the next price.[1] A principal weighted average of impacts is used in comparisons.[2] Both the temporary and total effects are expected to be affected by the spread in the market, the permanent effect should, however, be unaffected by the spread. The impact of large trades is calculated separately for large buy and sell transactions, to allow for a possible asymmetry in response to block trades. The impact of buy trades are expected to be positive and those of sells are expected to be negative.

A trade is classified as a buy or a sell by comparing the trade price to the midpoint of the previous quote (as few large trades are expected to occur within the quote prices, the methodology of chapter 1 is not used here). As in Lee and Ready (1991), if the previous quote occurred within 5 seconds of the trade then the quote before that is used. This is to ensure that the quote being used to classify the trade actually occurred before the trade. If the trade price is higher than the midpoint of the quotes then the trade is considered a buy, otherwise it is classified as a sell. The effect of option listing on the price impact is a measure of the change in the liquidity of the market. If option listing leads to more liquidity

---

daily trading volume. The results are fairly similar across these measures. In the case of daily trading volume, a trade is large if the volume of the transaction is larger than the median daily volume. In the optioned and control samples few trades of this size are observed.

[1] Holthausen, Leftwich and Mayers (1990) find that most price adjustments occur with 5 trades of the block.

[2] This is the procedure used in Chan and Lakonishok (1993). To obtain a measure of the price impact for a particular company they weight each impact by the dollar value of the transaction.

the price impact of large trades should decrease, if listing leads to less liquidity the impact is expected to increase.

The price impact is calculated separately for large buy trades and large sell trades as shown in Appendix 3-2i and 3-2j . For the 20 day period the number of cases in which the impact of large sell trades decreases is significant for only the optioned stock. This suggests that traders are now more willing to take the other side of the block sale, as they have a way to hedge their trade. For large buy trades the behavior of the samples is similar. The above does not explain the observed difference between the optioned and non-optioned stock, with optioned stock exhibiting less of a price reaction to large buy trades. This could be a consequence of the fact that few large trades were observed in the period under consideration.

(v) Spread

A time weighted average of spread is calculated, similar to the way in which average depth on the ask and bid sides of the market was computed. Only BBO eligible quotations are considered. In all calculations, if a spread larger than $5.00 is observed the record is considered an error and omitted from calculations.

The results in Appendix 3-2k show that spread is found to decrease significantly for the optioned sample. Appendix 3-2l shows that the percentage spread decreases market wide, but the changes are not significant. Appendix 3-1i and 3-1j show the values of spread and percentage spread. The patterns appear similar for both the optioned stock and control 2. As volume is observed to be similar in both periods the fixed and inventory cost components should be similar in both periods. As spreads decline slightly it is expected that the amount of private information in the market may decrease, resulting in a lower adverse selection component.

A regression with the dependent variable set equal to the difference in the spreads and percentage spreads between the optioned and control samples reveals a_1 to be negative, suggesting that spread declines on option listing. When the difference between the optioned stock and control 1 stocks are regressed on time b_1 is found to be significantly negative, showing that the decrease in spread is more pronounced for the optioned stock. With control 2 no pattern over time is detected.

3-6 Conclusions

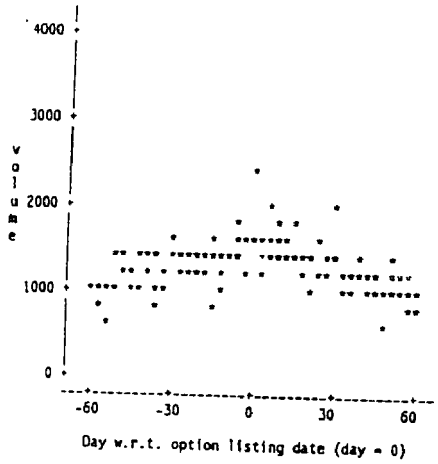
The theoretical prediction of a change in the price process followed by the underlying asset and an increase in the amount of information available on option listing have little effect on the way a stock trades in the market. Daily volume increases immediately around option listing, suggesting that around the listing date investor interest in the security increases. Traders obtain their new desired positions in the stock, after which volume declines. Spread and volatility decrease market wide, the decline experienced by the optioned stock is more pronounced than that experienced by the rest of the market. The depth of the market increases up to the listing date, after which it begins to decline. Though an option may convey information about future trading plans of investors and provide a payoff not attainable with the stock and riskless asset alone, it does not have a marked affect on the cost of trading. Spreads and price impacts decline and depth of the market increases. The changes are more significant than those observed in the rest of the market. The fact that trading characteristics show little change in recent years, as compared to in the early years of introduction, could be the result of a better understanding of the implications of options trades and/or a results of trading in index options.

As options have little negative affect on the trading characteristics of stocks there seems to be little evidence to suggest that the introduction of this derivative security could be to the detriment of the small investor, in terms of trading costs. The large volume of trade in the options suggests the contrary, options seem to be providing a valuable payoff pattern to investors. As option listing is of value to both the investors and the options exchanges we would expect to see more and more options being listed. Indeed this does seem to be the case. The criteria that must be met by a stock before it becomes eligible to have listed options have been relaxed.[1] Today most stocks which have an adequate number of shares outstanding and a sufficient degree of investor interest have listed options.

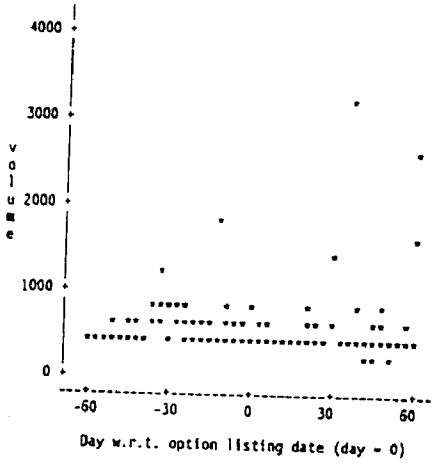
---

[1] In 1988, the standard requirements that a stock had to meet to enable it to have listed options were (i) it must be listed and registered on a national security exchange, (ii) it must have at least 7,000,000 shares outstanding held by at least 6,000 shareholders, (iii) it must have a volume of trade of at least 2,400,000 shares in the previous 12 months, (iv) it must have a closing price of at least $10.00 for the preceding three months (v) it must not be in default on interest, principal, sinking fund or preferred dividend payments during the past 3 years and (vi) it must have a minimum after tax income of at least $1,000,000 over the previous 8 quarters. [Cox & Rubenstein, 'Options Markets'. 1985]. The regulations have been relaxed, the minimum number of shareholders is 2,000, the average price required over the preceding 3 months is at least $7.50 and (v) is no longer a requirement.

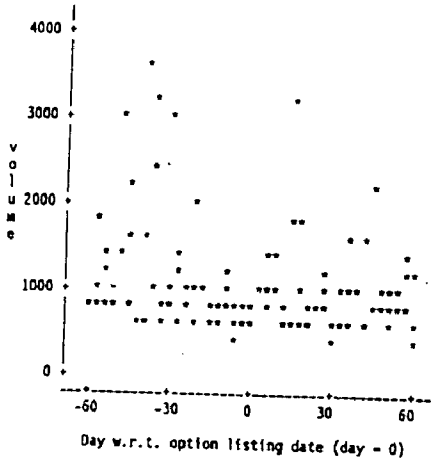
Table 3-1a: Daily volume of trade ('00)



NOTE: 31 obs hidden. 1 obs out of range.

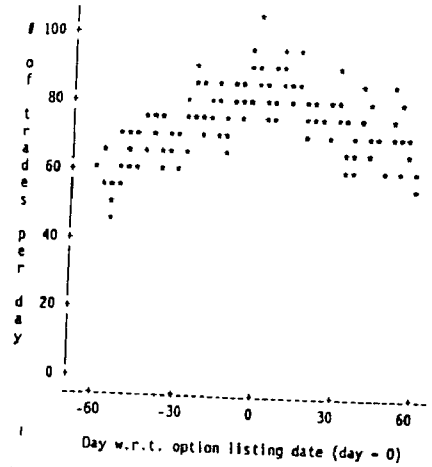


NOTE: 43 obs hidden. 1 obs out of range.

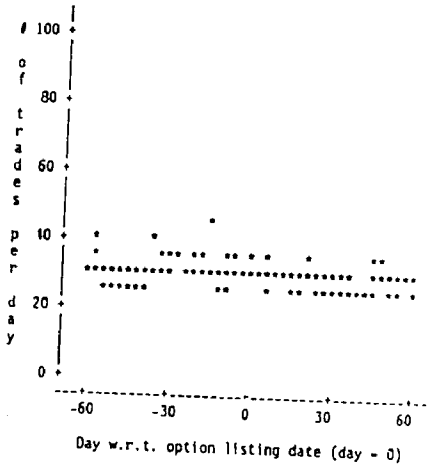


NOTE: 22 obs hidden. 5 obs out of range.

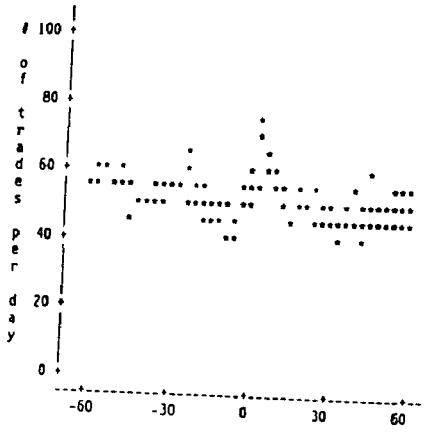
Table 3-1b: Daily average number of trades



NOTE: 21 obs hidden.

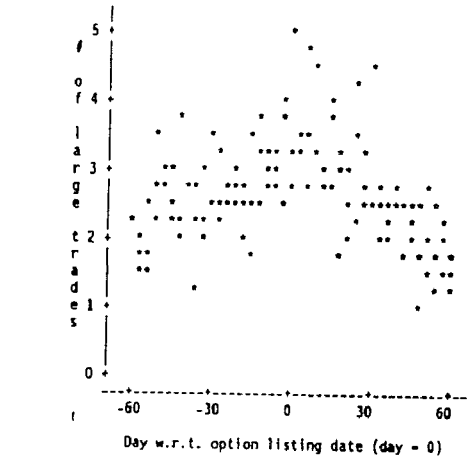


NOTE: 45 obs hidden.



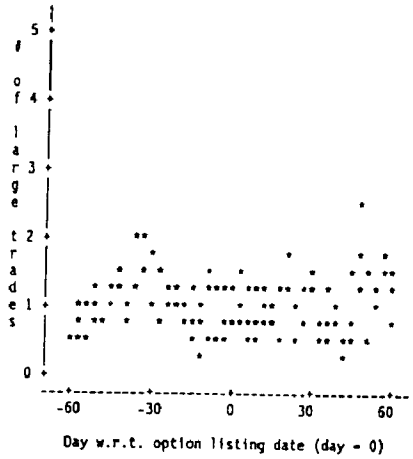
NOTE: 39 obs hidden.

Table 3-1c: Daily average number of large trades

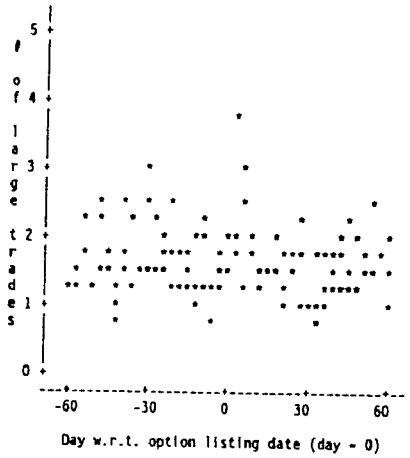


NOTE: 11 obs hidden.

14:29 Saturday, April 16, 1994 2

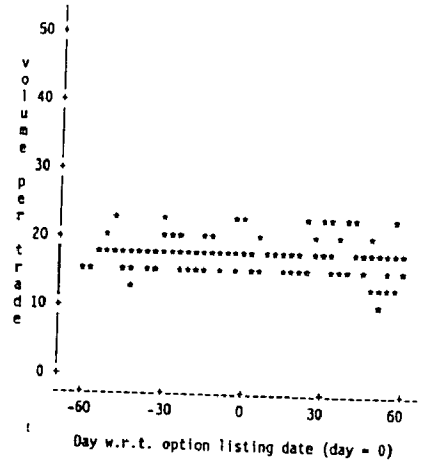


NOTE: 27 obs hidden.



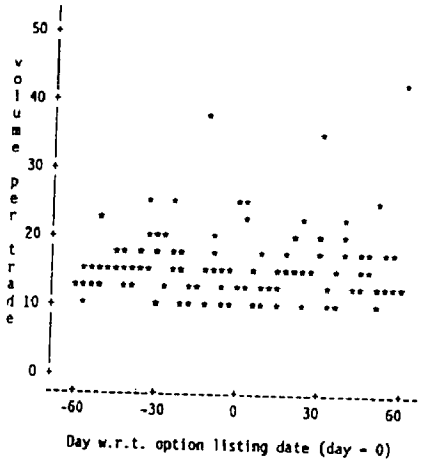
NOTE: 25 obs hidden.

Table 3-1d: Daily volume per trade

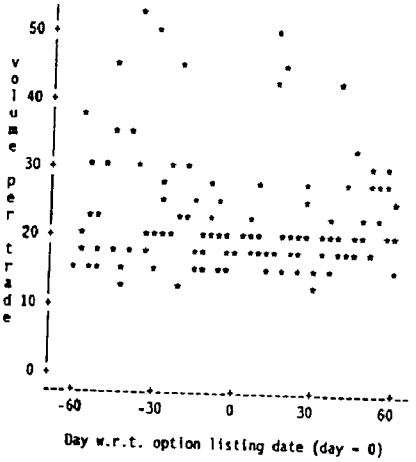


NOTE: 36 obs hidden.

14:29 Saturday, April 16, 1994 3

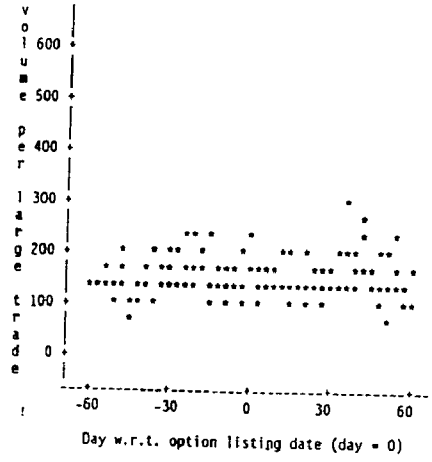


NOTE: 24 obs hidden. 3 obs out of range.

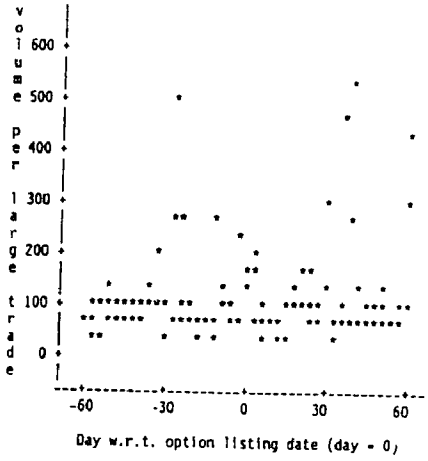


NOTE: 13 obs hidden. 6 obs out of range.

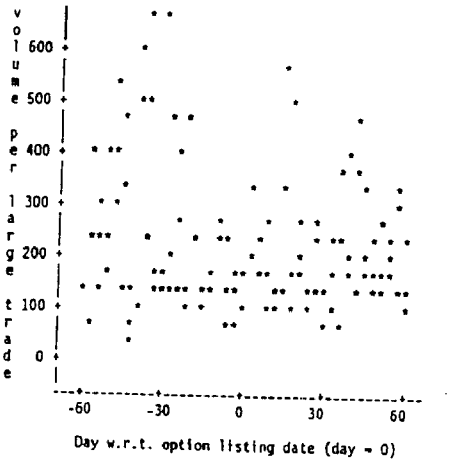
Table 3-1e: Daily volume per large trade



NOTE: 25 obs hidden.

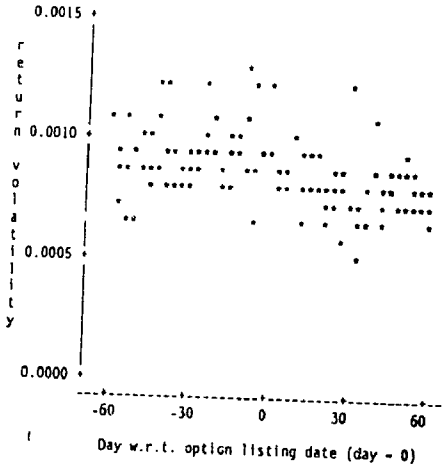


NOTE: 31 obs hidden.

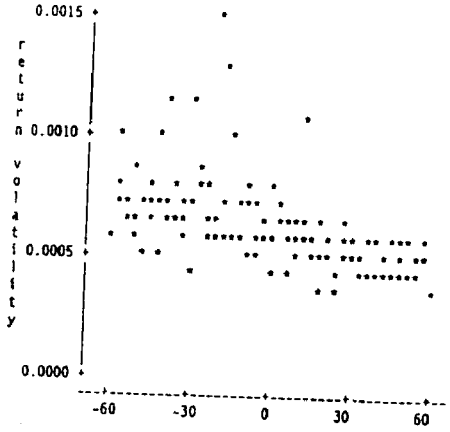


NOTE: 11 obs hidden. 1 obs out of range.

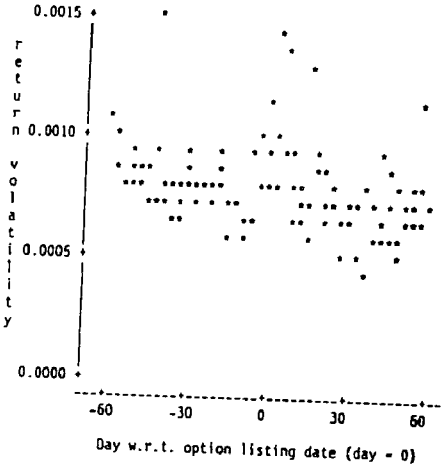
Table 3-1f: Daily return volatility (x100)



NOTE: 22 obs hidden. 1 obs out of range.

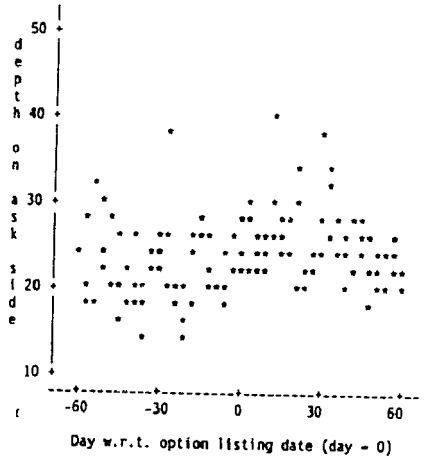


NOTE: 22 obs hidden.



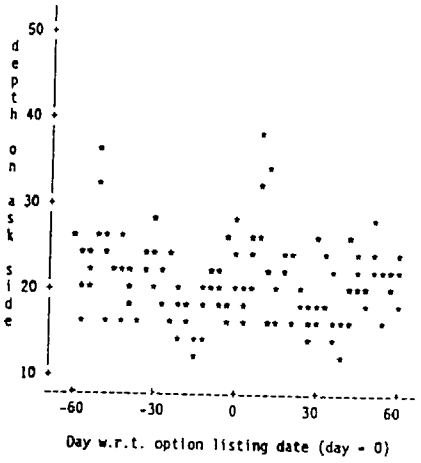
NOTE: 26 obs hidden. 2 obs out of range.

Table 3-1g: Depth on the ask side of the market

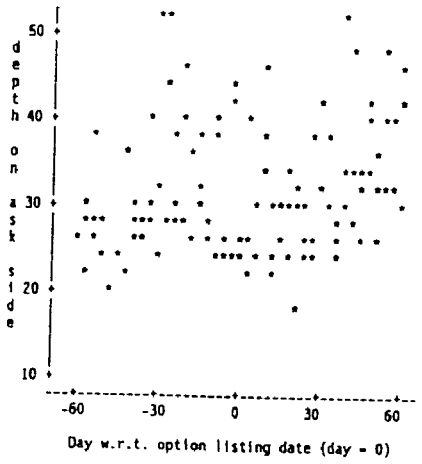


NOTE: 15 obs hidden. 1 obs out of range.

14:39 Saturday, April 16, 1994 1

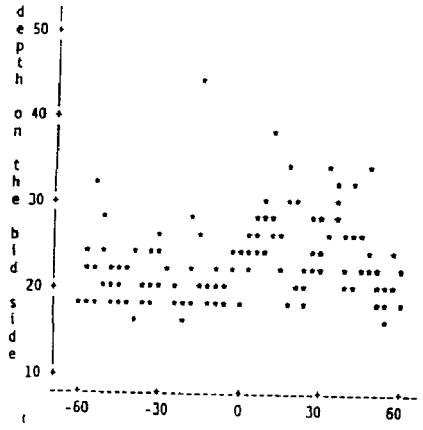


NOTE: 19 obs hidden.

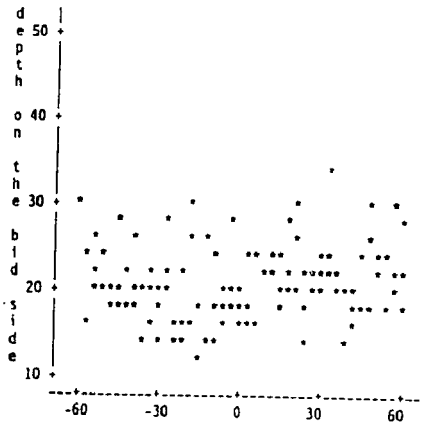


NOTE: 15 obs hidden. 1 obs out of range.

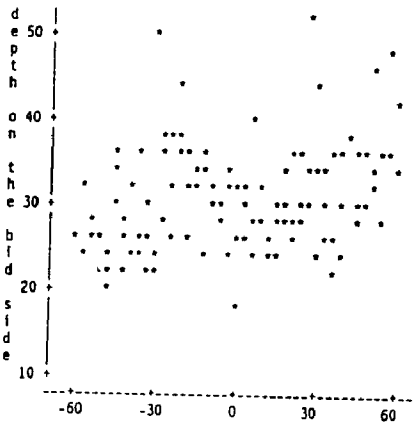
Table 3-1h: Depth on the bid side of the market



NOTE: 17 obs hidden.

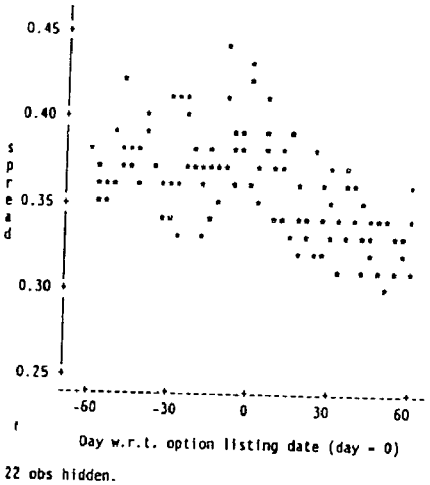


NOTE: 18 obs hidden.

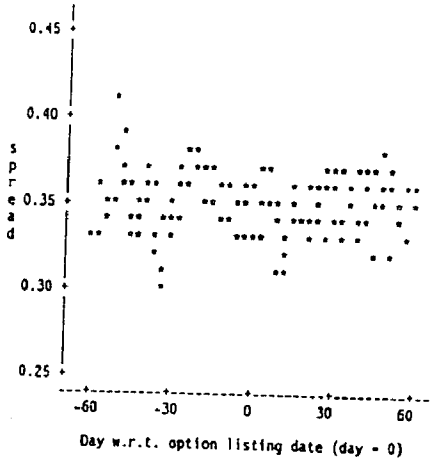


NOTE: 12 obs hidden. 3 obs out of range.

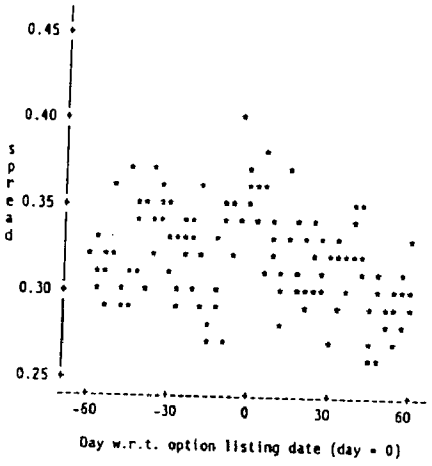
Table 3-1i: Spread



NOTE: 22 obs hidden.

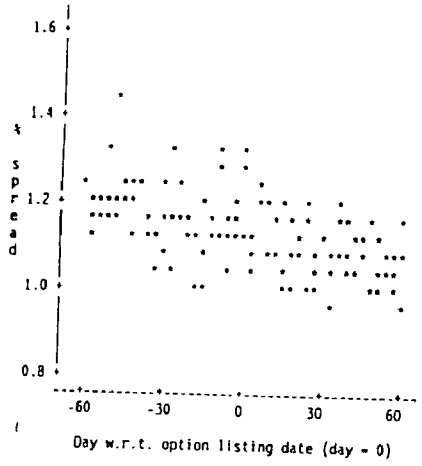


NOTE: 17 obs hidden.

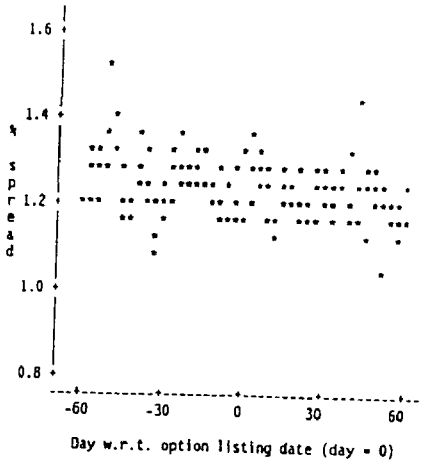


NOTE: 10 obs hidden.

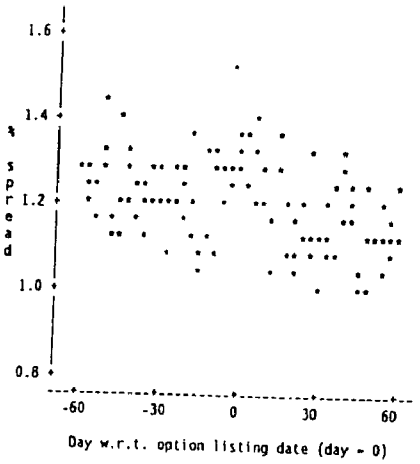
Table 3-1j: % Spread



NOTE: 20 obs hidden.



NOTE: 13 obs hidden.



NOTE: 22 obs hidden.

Appendix 3-2

Table 3-2a: Daily volume of trade ('00)

	Before Listing				After Listing				
	N	Mean	S.D.	Min.	Max.	N	Mean	S.D.	Min.	Max.
20 Days:										
sample	33	1831	1622	507	7359	33	1838	1810	261	7949
control1	33	989	2441	76	13982	33	863	1907	82	10315
control2	33	819	570	119	3222	33	1753	2644	170	13722
60 Days:										
sample	21	1303	672	555	3274	21	1275	736	315	3672
control1	21	625	696	96	2983	21	575	525	99	1805
control2	21	1223	806	237	3387	21	1420	1154	203	5058

Difference	t_stat	sign(sig)	rank(sig)	+ve
20 Days:				
sample	0.03	0.30	0.56	13
control1	-0.27	1.00	0.75	17
control2	2.05	0.73	0.27	18
60 Days:				
sample	-0.25	0.38	0.47	8
control1	-0.51	1.003	0.96	10
control2	0.72	0.66	0.91	9

Table 3-2b: Daily average number of trades

	Before Listing					After Listing				
	N	**Mean**	**S.D.**	**Min.**	**Max.**	**N**	**Mean**	**S.D.**	**Min.**	**Max.**
20 Days:										
sample	33	87.4	38.5	30.2	199.2	33	90.9	58.6	25.7	314.6
control1	33	46.3	66.1	7.1	355.6	33	46.9	78.5	7.5	432.0
control2	33	49.8	24.9	3.1	117.6	33	56.7	35.4	5.2	149.2
60 Days:										
sample	21	71.3	22.4	40.4	1121.0	21	74.7	31.2	24.7	151.7
control1	21	31.3	16.4	10.2	65.8	21	28.0	15.4	8.0	56.1
control2	21	51.9	31.2	4.4	122.5	21	50.2	30.4	12.8	128.7

Difference	**t_stat**	**sign(sig)**	**rank(sig)**	**+ve**
20 Days:				
sample	0.42	0.49	0.71	14
control1	0.21	0.72	0.93	17
control2	2.37	0.30	0.03	20
60 Days:				
sample	0.57	0.38	0.80	8
control1	-1.61	1.00	0.13	11
control2	-0.45	0.19	0.18	7

Table 3-2c: Daily average number of large trades

	Before Listing					After listing				
	N	**Mean**	**S.D.**	**Min.**	**Max.**	**N**	**Mean**	**S.D.**	**Min.**	**Max.**
20 Days:										
sample	33	3.80	4.11	0.55	22.40	33	4.04	4.79	0.40	18.90
control1	33	1.00	1.21	0.00	4.35	33	1.03	1.17	0.00	4.30
control2	33	1.39	1.00	0.15	4.10	33	1.58	1.00	0.05	3.35
60 Days:										
sample	21	2.70	1.50	0.92	5.93	21	2.63	2.09	0.52	10.37
control1	21	1.04	1.07	0.02	4.13	21	1.02	1.12	0.08	4.88
control2	21	1.60	0.71	0.45	2.87	21	1.67	0.88	0.15	4.62

Difference	**t_stat**	**sign(sig)**	**rank(sig)**	**+ve**
20 Days:				
sample	0.46	0.49	0.88	14
control1	0.26	1.00	0.62	15
control2	1.15	0.86	0.36	17
60 Days:				
sample	-0.22	0.66	0.45	9
control1	-0.24	0.82	0.79	11
control2	0.28	1.00	0.70	10

Table 3-2d: Daily volume per trade ('00)

	Before Listing					After listing			
	N	Mean	S.D.	Min.	Max.	N	Mean	S.D.	Min.	Max.
20 Days:										
sample	33	18.56	8.41	7.05	45.69	33	19.24	12.30	9.54	68.04
control1	33	18.70	30.76	4.46	183.28	33	14.16	8.30	6.00	42.69
control2	33	19.08	11.83	5.88	58.77	33	31.72	44.47	5.25	251.05
60 Days:										
sample	21	17.3	7.3	9.4	40.2	21	17.2	8.0	9.8	44.6
control1	21	17.0	11.5	5.8	51.5	21	17.7	9.4	6.3	39.2
control2	21	25.1	14.8	8.4	64.3	21	28.0	18.3	7.4	91.8

Difference	t_stat	sign(sig)	rank(sig)	+ve
20 Days:				
sample	0.42	0.30	0.48	13
control1	-0.90	0.73	0.83	18
control2	1.61	0.49	0.69	14
60 Days:				
sample	-0.18	0.66	0.83	9
control1	0.35	0.38	0.53	13
control2	0.62	1.00	0.73	11

Table 3-2e: Daily volume per large trade ('00)

	Before Listing					After listing				
	N	Mean	S.D.	Min.	Max.	N	Mean	S.D.	Min.	Max.
20 Days:										
sample	33	160.2	70.3	48.5	347.2	33	154.2	63.2	48.0	321.0
control1	33	155.0	359.7	0.0	2087.6	33	124.2	164.2	0.0	753.4
control2	33	200.7	270.4	19.6	1613.4	33	287.3	335.6	8.9	1634.7
60 Days:										
sample	21	147.7	49.7	59.7	226.6	21	155.6	54.0	77.5	297.0
control1	21	105.5	97.5	6.8	438.7	21	120.6	105.8	8.5	442.5
control2	21	235.9	151.1	33.9	637.6	21	231.4	150.0	14.1	677.5

Difference	t_stat	sign(sig)	rank(sig)	+ve
20 Days:				
sample	-0.52	0.49	0.50	14
control1	-0.54	0.73	0.67	18
control2	1.35	1.00	0.56	16
60 Days:				
sample	0.75	0.38	0.35	13
control1	1.46	0.19	0.04	14
control2	-0.15	1.00	0.99	11

Table 3-2f: % Daily return volatility (x100)

	Before Listing					After listing				
	N	**Mean**	**S.D.**	**Min.**	**Max.**	**N**	**Mean**	**S.D.**	**Min.**	**Max.**
20 Days:										
sample	33	0.10	0.06	0.02	0.22	33	0.09	0.06	0.01	0.24
control1	33	0.08	0.06	0.01	0.25	33	0.07	0.05	0.01	0.24
control2	33	0.11	0.06	0.02	0.24	33	0.08	0.06	0.02	0.24
60 Days:										
sample	21	0.09	0.05	0.02	0.18	21	0.08	0.05	0.01	0.24
control1	21	0.07	0.05	0.01	0.22	21	0.05	0.03	0.01	0.12
control2	21	0.08	0.05	0.02	0.23	21	0.08	0.06	0.01	0.26

Difference	**sign(sig)**	**rank(sig)**	**+ve**
20 Days:			
sample	0.04	0.05	10
control1	0.30	0.24	13
control2	0.01	<0.01	9
60 Days:			
sample	0.08	0.11	6
control1	0.03	0.01	5
control2	0.38	0.36	8

Table 3-2g: Depth on the ask side of the market

	Before Listing					After listing			
	N	**Mean**	**S.D.**	**Min.**	**Max.**	**N**	**Mean**	**S.D.**	**Min.**	**Max.**
20 Days:										
sample	33	29.06	17.38	12.81	98.78	33	35.56	44.05	9.07	223.14
control1	33	21.60	20.89	3.57	106.74	33	20.85	23.36	5.77	109.46
control2	33	26.60	16.73	4.21	71.09	33	28.96	19.78	5.09	82.21
60 Days:										
sample	21	22.41	7.94	14.27	45.73	21	24.14	10.37	12.38	52.03
control1	21	19.88	16.68	4.67	76.00	21	20.32	18.96	4.01	87.01
control2	21	29.07	16.33	4.74	65.14	21	32.56	21.24	5.70	88.97

Difference	**t_stat**	**sign(sig)**	**rank(sig)**	**+ve**
20 Days:				
sample	1.21	0.73	0.72	15
control1	-0.40	0.49	0.98	19
control2	1.09	0.08	0.15	22
60 Days:				
sample	0.79	1.00	0.96	10
control1	0.20	0.66	0.60	12
control2	1.14	0.38	0.15	13

Table 3-2h: Depth on the bid side of the market

	Before Listing					After listing				
	N	Mean	S.D.	Min.	Max.	N	Mean	S.D.	Min.	Max.
20 Days:										
sample	33	27.49	19.24	10.60	84.53	33	31.69	33.72	11.59	186.75
control1	33	20.07	17.47	5.17	86.33	33	26.17	29.59	6.19	133.52
control2	33	26.54	15.85	4.07	62.26	33	30.25	21.22	5.42	100.92
60 Days:										
sample	21	20.90	6.80	10.45	33.22	21	23.61	9.95	11.50	54.54
control1	21	19.25	14.63	6.68	67.60	21	22.55	20.06	6.31	96.51
control2	21	28.84	16.44	4.71	62.00	21	35.36	26.67	5.55	128.18

Difference	t_stat	sign(sig)	rank(sig)	+ve
20 Days:				
sample	1.10	0.73	0.69	18
control1	2.05	<0.01	<0.01	25
control2	1.65	0.01	0.08	24
60 Days:				
sample	1.71	1.00	0.33	11
control1	1.44	1.00	0.16	11
control2	1.72	0.03	0.05	16

Table 3-2i: Principal weighted impact of large buy trades

	Before Listing					After listing				
	N	Mean	S.D.	Min.	Max.	N	Mean	S.D.	Min.	Max.
20 Days:										
Temporary										
sample	33	-0.01	0.42	-1.03	0.90	33	0.05	0.39	-1.18	0.73
control1	33	0.04	0.58	-2.32	1.00	33	0.14	0.37	-0.97	0.95
control2	33	0.09	0.26	-0.51	0.55	33	0.21	0.48	-0.46	2.33
Permanent										
sample	33	0.57	0.84	-0.90	2.72	33	0.56	1.08	-0.46	5.46
control1	33	0.42	0.69	-1.17	2.88	33	0.39	0.61	-0.66	1.79
control2	33	0.34	0.52	-0.90	1.85	33	0.21	0.67	-2.31	1.25
Total										
sample	33	0.56	0.59	-0.34	2.47	33	0.61	0.99	-0.10	5.46
control1	33	0.46	0.37	-0.17	1.34	33	0.54	0.42	-0.20	1.51
control2	33	0.42	0.47	-0.68	1.93	33	0.43	0.37	-0.09	1.29

Difference	**t_stat**	**sign(sig)**	**rank(sig)**	**+ve**
20 Days:				
Temporary				
sample	0.84	0.70	0.41	15
control1	0.91	0.30	0.10	20
control2	1.65	0.22	0.08	20
Permanent				
sample	0.02	0.85	0.88	13
control1	-0.16	0.73	0.92	15
control2	-1.19	0.72	0.32	14
Total				
sample	0.33	1.00	0.80	13
control1	0.92	0.16	0.27	21
control2	0.08	0.38	0.99	19

	Before Listing				After listing				
	N	Mean	S.D.	Min.	Max.	N	Mean	S.D.	Min.	Max.
60 Days:										
Temporary										
sample	21	-0.04	0.14	-0.28	0.19	21	-0.08	0.28	-0.37	0.72
control1	21	0.16	0.26	-0.30	0.74	21	0.21	0.25	-0.25	0.76
control2	21	0.22	0.31	-0.19	1.08	21	0.56	1.22	-0.16	5.18
Permanent										
sample	21	0.58	0.30	0.12	1.19	21	0.44	0.86	-0.17	3.99
control1	21	0.46	0.40	-0.08	1.52	21	0.23	0.44	-0.73	1.20
control2	21	0.26	0.35	-0.19	1.03	21	-0.03	1.34	-4.88	2.02
Total										
sample	21	0.55	0.27	0.05	1.02	21	0.52	0.81	0.01	3.94
control1	21	0.62	0.35	0.22	1.50	21	0.44	0.30	-0.08	1.16
control2	21	0.48	0.28	0.13	0.96	21	0.53	0.79	-0.07	3.84

Difference	t_stat	sign(sig)	rank(sig)	+ve
60 Days:				
Temporary				
sample	1.79	0.38	0.14	13
control1	0.64	1.00	0.56	10
control2	1.24	0.66	0.41	12
Permanent				
sample	-0.83	0.03	0.02	5
control1	-2.81	0.08	0.01	6
control2	-1.01	0.19	0.30	7
Total				
sample	-0.16	0.08	0.03	6
control1	-2.42	0.03	0.03	5
control2	0.28	0.38	0.30	8

Table 3-2j: Principal weighted impact of large sell trades

	Before Listing					After listing			
	N	Mean	S.D.	Min.	Max.	N	Mean	S.D.	Min.	Max.
20 Days:										
Temporary										
sample	33	-0.23	0.60	-2.90	0.60	33	-0.17	0.41	-1.37	0.76
control1	33	-0.39	0.82	-4.27	0.42	33	-0.35	0.38	-1.53	0.21
control2	33	-0.25	0.53	-2.78	0.64	33	-0.15	0.36	-1.26	0.70
Permanent										
sample	33	-0.28	0.39	-1.53	0.50	33	-0.47	0.61	-2.05	0.67
control1	33	-0.20	0.94	-2.34	4.02	33	-0.22	0.62	-1.73	4.02
control2	33	-0.12	0.61	-1.35	2.40	33	-0.28	0.44	-1.61	0.42
Total										
sample	33	-0.51	0.62	-2.99	0.60	33	-0.63	0.63	-1.89	1.01
control1	33	-0.60	0.6	-3.12	0.00	33	-0.57	0.67	-2.45	0.59
control2	33	-0.37	0.26	-0.96	0.05	33	-0.44	0.40	-1.74	0.05

Difference	**t_sta**	**sign(sig)**	**rank(sig)**	**+ve**
20 Days:				
Temporary				
sample	0.86	0.46	0.20	17
control1	0.28	1.00	0.70	16
control2	0.85	0.49	0.49	19
Permanent				
sample	-2.00	0.14	0.05	10
control1	-0.07	0.16	0.48	21
control2	-1.32	1.00	0.42	16
Total				
sample	-1.19	0.18	0.10	10
control1	0.24	0.73	0.61	18
control2	-0.81	1.00	0.70	17

		Before Listing					After listing		
	N	Mean	S.D.	Min.	Max.	N	Mean	S.D.	Min.	Max.
60 Days:										
Temporary										
sample	21	-0.09	0.35	-0.41	1.19	21	-0.22	0.23	-0.93	0.07
control1	21	-0.34	0.47	-2.06	0.09	21	-0.26	0.16	-0.57	0.07
control2	21	-0.12	0.53	-1.14	1.78	21	-0.25	0.49	-2.14	0.51
Permanent										
sample	21	-0.43	0.37	-1.40	0.06	21	-0.47	0.34	-1.47	0.05
control1	21	-0.17	0.60	-1.06	1.56	21	-0.27	0.31	-1.14	0.20
control2	21	-0.42	0.64	-1.95	1.19	21	-0.21	0.31	-0.75	0.39
Total										
sample	21	-0.52	0.32	-1.53	-0.20	21	-0.69	0.39	-1.56	-0.16
control1	21	-0.50	0.41	-1.46	0.51	21	-0.53	0.36	-1.48	-0.21
control2	21	-0.55	0.51	-2.50	0.06	21	-0.46	0.52	-2.50	0.04

Difference	**t_stat**	**sign(sig)**	**rank(sig)**	**+ve**
60 Days:				
Temporary				
sample	-1.52	0.38	0.28	8
control1	0.70	0.38	0.70	8
control2	-0.91	1.00	0.85	11
Permanent				
sample	-0.44	1.00	0.96	11
control1	-0.71	0.66	0.96	12
control2	1.58	0.38	0.19	13
Total				
sample	-1.72	0.08	0.08	6
control1	-0.29	0.66	0.93	12
control2	0.53	0.66	0.27	12

Table 3-2k: Spread

	Before Listing				After listing				
	N	**Mean**	**S.D.**	**Min.**	**Max.**	**N**	**Mean**	**S.D.**	**Min.**	**Max.**
20 Days:										
sample	33	0.36	0.08	0.23	0.51	33	0.35	0.10	0.17	0.63
control1	33	0.33	0.10	0.18	0.69	33	0.33	0.09	0.17	0.60
control2	33	0.31	0.11	0.17	0.75	33	0.31	0.09	0.19	0.61
60 Days:										
sample	21	0.38	0.07	0.25	0.50	21	0.35	0.08	0.23	0.53
control1	21	0.35	0.11	0.23	0.74	21	0.35	0.12	0.20	0.70
control2	21	0.33	0.13	0.18	0.79	21	0.31	0.11	0.19	0.67

Difference	**t_stat**	**sign(sig)**	**rank(sig)**	**+ve**
20 Days:				
sample	-0.61	0.30	0.12	13
control1	-0.42	0.73	0.81	18
control2	-0.72	0.73	0.76	15
60 Days:				
sample	-3.02	0.19	0.01	7
control1	-0.35	0.50	0.58	8
control2	-1.45	0.48	0.17	7

Table 3-21: % Spread

	Before Listing					After listing				
	N	Mean	S.D.	Min.	Max.	N	Mean	S.D.	Min.	Max.
20 Days:										
sample	33	1.13	0.37	0.47	1.86	33	1.09	0.42	0.43	2.08
control1	33	1.30	0.53	0.56	2.76	33	1.30	0.47	0.42	2.39
control2	33	1.15	0.34	0.57	1.95	33	1.13	0.31	0.57	1.87
60 Days:										
sample	21	1.19	0.38	0.51	1.73	21	1.11	0.40	0.44	2.03
control1	21	1.27	0.43	0.70	2.17	21	1.23	0.44	0.43	2.07
control2	21	1.23	0.30	0.68	1.83	21	1.18	0.30	0.58	1.69

Difference	t_stat	sign(sig)	rank(sig)	+ve
20 Days:				
sample	-0.75	0.86	0.56	15
control1	-0.08	1.00	0.60	17
control2	-0.60	0.60	0.50	14
60 Days:				
sample	-1.63	0.19	0.11	7
control1	-0.74	0.66	0.36	9
control2	-1.36	0.66	0.27	9

Appendix 3-3: Regression Results

The following pooled regression is used

$$Y_{it} - Y_{ct} = (a_0 + a_1.D) + (b_0 + b_1.D)t + e_{it}$$

where Y_{it} = the variable being considered for the optioned stock at time t

Y_{ct} = the same variable for the corresponding control stock at time t

D = 0 for the pre-listing period and 1 for the post-listing period.

Dependent variable	a_0	a_1	b_0	b_1
Y_t = daily volume				
c = control1	963.38	38.56	9.44	-20.36
	(10.28)**	(0.30)	(3.51)**	(-5.16)**
c = control2	892.73	-1352.95	21.55	-8.43
	(4.71)**	(5.23)**	(3.96)**	(-1.04)
Y_t = # of trades				
c = control1	56.73	-1.36	0.53	-0.95
	(14.95)**	(-0.29)	(4.78)**	(-5.53)**
c = control2	36.89	-6.13	0.44	-0.70
	(11.75)**	(-1.51)	(4.84)**	(-5.06)**
Y_t = volume per trade				
c = control1	-0.18	1.79	-0.00	-0.08
	(-0.14)	(0.98)	(-0.04)	(-1.55)
c = control2	-2.65	-14.39	0.14	0.12
	(-0.90)	(-3.55)**	(1.68)*	(1.00)
Y_t = # of large trades				
c = control1	2.16	0.14	0.01	-0.04
	(10.53)**	(0.50)	(2.50)**	(-4.60)**
c = control2	1.21	0.06	0.01	-0.02
	(5.93)**	(0.21)	(1.24)	(-2.85)**
Y_t = vol per large trade				
c = control1	53.14	8.18	0.14	-0.56
	(4.09)**	(0.44)	(0.37)	(-1.03)
c = control2	6.67	-87.06	1.71	-0.41
	(0.27)	(-2.51)**	2.44)*	(-0.40)

Y_t = return volatility	(a_0 x 10^4)	(a_1 x 10^5)	(b_0 x 10^6)	(b_1 x 10^5)
c = control1	3.03	-0.77	1.98	-3.62
	(7.74)**	(-0.14)	(1.76)*	(-2.18)*
c = control2	1.72	-5.25	2.58	-4.71
	(3.59)**	(0.79)	(1.88)*	(-2.34)*
Y_t = ask depth				
c = control1	5.87	0.92	0.07	-0.11
	(4.50)**	(0.51)	(1.89)*	(-2.05)*
c = control2	-5.64	5.70	-0.02	-0.21
	(-2.14)*	(1.56)	(-0.29)	(-1.85)*
Y_t = bid depth				
c = control1	5.79	1.65	0.08	-0.20
	(4.11)**	(0.84)	(2.02)*	(-3.30)**
c = control2	-5.33	6.42	-0.04	-0.25
	(-2.68)**	(2.31)*	(-0.66)	(-3.04)**
Y_t = spread				(b_1 x 10^3)
c = control1	0.03	-0.03	0.00	-5.39
	(4.63)**	(-2.76)**	(0.25)	(-1.78)*
c = control2	0.07	-0.03	0.00	-3.34
	(7.35)**	(-1.84)*	(0.78)	(-0.81)
Y_t = % spread				(b_1 x 10^2)
c = control1	-0.03	-0.09	0.00	-2.46
	(-1.22)	(-2.31)*	(0.64)	(-2.21)*
c = control2	-0.06	-0.10	0.00	1.38
	(-1.49)	(-1.75)*	(-1.08)	(0.75)

** t-stat significant at the 1% level. * t-stat significant at the 10% level.

References

Anthony, Joseph H., "The Interrelation of Stock and Options Market Trading - Volume Data," *Journal of Finance*, 43 (September 1988), 949-964.

Back, Kerry, "Asymmetric Information and Options," *Review of Financial Studies*, 6 (1993), 435-472.

Bansal, Vipul K, Pruitt, Stephen W. and Wei, John K.C, "An Empirical Reexamination of the Impact of CBOE Option Initiation on the Volatility and Trading Volume of the Underlying Equities : 1973-1986," *Financial Review*, 24 (February 1989), 19-29.

Berkowitz, Stephen A., Logue, Dennis E. and Noser, Eugene A.,Jr., "The Total Cost of Transactions on the NYSE," *Journal of Finance*, 43 (March 1988), 97-112.

Black, Fischer and Scholes, Myron, "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy*, 81 (May/June 1973), 637-654.

Black, Fischer, "Fact and Fantasy in the Use of Options," *Financial Analysts Journal.*, 31 (July/August 1975), 36-41.

Branch, Ben and Finnerty, Joseph E., "The Impact of Option Listing on the Price and Volume of the Underlying Stock," *The Financial Review*, 1-15.

Brennan, Michael J. and Copeland, Thomas E., "Stock Splits, Stock Prices and Transaction Costs," *Journal of Financial Economics*, 22 (October 1988), 83-101.

Chan, Lawrence K.C. and Lakonishok, Josef., "Institutional Trades and Intraday Stock Price Behavior," *Journal of Financial Economics*, 33 (April 1993), 173-199.

Choi, Dosoung and Strong, Robert A., "The Pricing of When-Issued Common Stock: A Note," *Journal of Finance.*, 38 (September 1983), 1293-1298.

Cox, John C. and Rubinstein, Mark., *Options Markets*.. Prentice-Hall, 1985.

Chrisitie, William G., Harris, Jeffrey H., and Schultz, Paul H., "Why Did NASDAQ Market Makers Stop Avoiding Odd-Eighth Quotes?," *Journal of Finance*, 49 (December 1994), 1841-1860.

Damodaran, Aswath and Lim, Joseph, "The Effects of Option Listing on the Underlying Stocks' Return Processes," *Journal of Banking & Finance* , 15. (1991). 647-664.

Detemple, Jerome and Selden, Larry, "A General Equilibrium Analysis of Option and Stock Market Interactions," *International Economic Review*, 32 (May 1991), 279-303.

Detemple, Jerome and Jorion, Phillipe, "Option Listing and Stock Returns: An Empirical Analysis," *Journal of Banking and Finance*, 14 (October 1990), 781-801.

Glosten, Lawrence R. and Harris, Lawrence E., "Estimating the Components of the Bid/Ask Spread," *Journal of Financial Economics*, 21 (May 1988), 123-142.

Grinblatt, Mark S., Masulis, Ronald W. and Titman, Sheridan, "The Valuation Effects of Stock Splits and Stock Dividends," *Journal of Financial Economics.*, 13 (December 1984), 461-490.

Grossman, Sanford J., "An Analysis of the Implications for Stock and Futures Price Volatility of Program Trading and Dynamic Hedging Strategies," *Journal of Business*, 61 (July 1988), 275-298.

Harris, Lawrence, "S&P 500 Cash Stock Price Volatilites," *Journal of Finance*, 44 (December 1989), 1155-1175.

Hasbrouck, Joel, "Measuring the Information Content of Stock Trades," *Journal of Finance*, 46 (March 1991), 179-207.

Hayes, Samuel L. III and Tennenbaum, Michael E., "The Impact of Listed Options on the Underlying Shares," *Financial Management*, 8 (Winter 1979), 72-76.

Holthausen, Robert W., Leftwich, Richard W. and Mayers, David, "The Effect of Large Block Transactions on Security Prices: A Cross-Sectional Analysis," *Journal of Financial Economics* , 19 (December 1987), 237-267.

Holthausen, Robert W., Leftwich, Richard W. and Mayers, David, "Large-Block Transactions, the Speed of Response, and Temporary and Permanent Stock-Price Effects," *Journal of Financial Economics*, 26 (July 1990), 71-95.

Jegadeesh, Narasimhan and Subrahmanyam, Avanidhar, "Liquidity Effects of the Introduction of the S&P 500 Index Futures Contract on the Underlying Stock," *Journal of Business*, 66 (April 1993), 171-187.

Jennings, Robert and Starks, Laura, "Earnings Announcements, Stock Price Adjustment, and the Existence of Option Markets," *Journal of Finance*, 41 (March 1986), 107-125.

Klemkosky, Robert C and Maness, Terry S., "The Impact of Options on the Underlying Securities," *Journal of Portfolio Management*, 6 (Winter 1980), 12-18.

Lakonishok, Josef and Lev, Baruch, "Stock Splits and Stock Dividends: Why, Who and When," *Journal of Finance*, 42 (September 1987), 913-932.

Lamoureux, Christopher G. and Poon, Percy, "The Market Reaction to Stock Splits," *Journal of Finance.*, 42 (December 1987), 1347-1370.

Lamoureux, Christopher G. and Wansley, James W., "The Pricing of When-Issued Securities," *Financial Review*, 24 (May 1989), 183-198.

Lee, Charles M.C. and Ready, Mark J., "Inferring Trade Direction from Intraday Data," *Journal of Finance*, 46 (June 1991), 733-747.

Ma, Christopher K. and Rao, Ramesh P., "Information Asymmetry and Options Trading," *Financial Review*, 23 (February 1988), 39-51.

Maloney, Michael T. and Mulherin, Harold J., "The Effects of Splitting on the Ex: A Microstructure Reconciliation," *Financial Management.*, 21 (Winter 1992), 44-59.

Manaster, Steven and Rendleman, Richard J., Jr., "Option Prices as Predictors of Equilibrium Stock Prices," *Journal of Finance*, 37 (September 1982), 1043-1057.

Parks, Richard W., "Efficient Estimation of a System of Regression Equations when Disturbances are both Serially and Contemporaneously Correlated," *American Statistical Association Journal*, (June 1987), 500-509.

Skinner, Douglas J., "Options Markets and Stock Return Volatility," *Journal of Financial Economics*, 23 (June 1989), 61-78.

Stein, Jeremy C., "Informational Externalities and Welfare-Reducing Speculation," *Journal of Political Economy*, 95 (December 1987), 1123-1145.

Stoll, Hans R., "Equity Trading Costs In-The-Large," *Journal of Portfolio Management*, 19 (Summer 1993). 41-50.

Tinic, Seha, M., "The Economics of Liquidity Services," *Quarterly Journal of Economics*, (1986), 79 -83.

Trennepohl, Gary L. and Dukes, William P., "CBOE Options and Stock Volatility," *Review of Business and Economics Research*, 14 (Spring 1979), 49-60.

Vijh, Anand M., "Liquidity of the CBOE Equity Options," *Journal of Finance*, 45 (July 1990), 1157-1179.

Whiteside, Mary M., Dukes, William P. and Dunne, Patrick M., "Short Term Impact of Option Trading on Underlying Securities," *Journal of Financial Research,* 6 (Winter 1983), 313-321.

Watt, Wing H.,Yadav, Pradeep K. and Draper, Paul, "The Impact of Option Listing on Underlying Stock Returns: The UK Evidence," *Journal of Business Finance and Accounting*, 19 (June 1992), 485-503.

Wood, Robert A., McInish, Thomas H. and Ord, Keith J., "An Investigation of Transaction Data for NYSE Stocks," *Journal of Finance.*, 40 (July 1985) 723-741.