The Intraday Behaviour of Bid-Ask Spreads Across Auction and Specialist Market Structures: Evidence From The Italian Market

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Abstract

Several studies have analysed liquidity across a trading day, and have documented that bid-ask spreads exhibit a U-shaped pattern, with spreads wider at the start and end of the trading day, whilst spreads are tighter in the middle of the day. This pattern has been attributed to inventory holding costs, the specialist's market power and adverse selection risk. On the 2nd April, 2001, several stocks on the Italian Bourse switched from an auction market to a specialist market. This provides a natural experiment where intraday spreads across different market structures can be compared. Results indicate that volume, volatility and bid-ask spreads exhibit the U-shaped intraday pattern both before and after the structural change. While time-weighted spreads are consistently higher throughout the trading day under the specialist structure, the specialists ability to offer price improvement with the best quotes results in the 'real' cost of trading being lower under a specialist system. These results are robust to the size of the firm, the event window around the structural change, as well as overall market-wide changes.

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1 Introduction

The provision of liquidity for a stock market is a primary consideration for regulators and participants, and is particularly of interest to academic researchers. Understanding how liquidity varies throughout a trading day has been a central objective of much of this research. Many studies have analyzed bid-ask spreads for stock markets worldwide, and have found time-varying spreads, caused by a myriad of factors. This variation has been described as U-shaped, in which spreads are higher at the open and close of trading, whilst they are lower in the middle of the trading day.

This U-shaped pattern has been attributed to three main factors – inventory holding costs, specialist market power and adverse information. The inventory based models (Stoll, 1978; Amihud and Mendelson, 1980; Ho and Stoll, 1981) argue that the spread exists to compensate inventory risk. Specifically, the market maker adjusts his or her bid and ask quotes to restore inventory imbalances. Lee, Mucklow and Ready (1993) find that bid-ask spreads widen in response to higher trading volume. Madhavan and Smidt (1993) show that quote revisions are related to order imbalances. Hasbrouck and Sofianos (1993) find that trades involving NYSE specialists have larger spreads. The increased volume at the open and close of trading leads to greater order imbalances, and thus the U-shaped pattern in spreads.

Brock and Kleidon (1992) claim that specialists on the NYSE are monopolistic market makers. As transaction demand is greater and less elastic at the open and close of trading due to overnight information (for the open), and fund managers concentration of trading near the close, a market maker can discriminate during these periods by charging higher prices. Their models thus predict periodic demand with high volumes and wide spreads, thus resulting in the U-shaped intraday pattern.

Information based models, including Copeland and Galai (1983); Glosten and Milgrom (1985); Kyle (1985); Easley and O'Hara (1987, 1992); Hasbrouck (1988); Foster and Viswanathan (1990, 1994); Madhavan (1992); and Admati and Pfleiderer (1992) focus on the adverse selection risk faced by market makers as the cause of the spread. As specialists are at an informational disadvantage, they must keep their spreads sufficiently wide to ensure that gains made from trading with the uninformed more than offset losses made when trading with the informed. As information asymmetry is most likely at the start and end of a trading day, the spreads are widest at the open and close of trading (and thus the U-shaped pattern exists).

The ambiguous nature of trading on the NYSE, which consists of both a specialist and a limit order book, make attributing the observed intra-day patterns to specialist specific behaviour difficult. In particular, as Demsetz (1997) argues, customer limit orders can obscure the link between observed bid-ask spreads and the costs of market making. Bid and ask quotes could reflect

supply and demand conditions of investors rather than the inventory, order processing and adverse selection components of professional market makers. The U-shaped pattern in bid-ask spreads could then be an aggregation of both specialist and public traders intraday behaviour, as well as the interaction between the two groups.

In this study, the authors have access to a unique dataset that allows an accurate comparison between two market structures. On the 2nd April, 2001, a specialist segment was introduced on the Italian Bourse. Stocks that originally traded in an auction market commenced trading in a specialist market. This specialist, rather than competing with the limit order book, receives all orders and decides whether to execute these against his / her own inventory, or to post them in a limit order book which he / she controls. This allows a direct comparison of spreads driven by public limit order traders in an auction market with spreads driven by a specialist. As the specialist is effectively a monopolist, the authors also directly test for how the specialist uses his or her market power throughout the day. Two hypotheses were developed, which will subsequently be tested in this paper. The first hypothesis conjectures that volume, volatility and spreads will exhibit the U-shaped intraday pattern documented in previous research. The second hypothesis conjectures that the specialist will use his or her market powers to consistently charge higher prices.

Results indicate that spreads exhibit a U-shaped intraday pattern both in an auction and specialist market structure. Comparisons of time weighted spreads across the trading day indicate that spreads are wider under a specialist market structure. However, the specialists' ability to offer price improvement within quotes results in the effective cost of trading being significantly lower under the specialist market structure. These results are robust once variations in trading volume, volatility and the day-of-week are controlled. Over the same time period, stocks that remained in the ordinary auction segment of the market exhibit minimal variation in intra-day spread patterns. The pattern of spreads within the day is also robust to the size of the firm.

The remainder of this paper is organized as follows. Section 2 describes the dataset and subsequent sample used. Section 3 sets out the research design; Section 4 presents the empirical results; while Section 5 reports several additional tests. Section 6 summarises the paper.

2 Data and Sample

The authors identify firms that were listed on the original market structure (liquid and less liquid securities), and moved to one of the three new segments (Blue Chip, SBO or Star). To control for major differences in liquidity and firm size, several stocks are automatically excluded from the sample. Stocks that traded as less liquid securities, or stocks that moved to the blue chip segment,

are not considered.[1] From the remaining stocks, the authors selected all stocks that traded for at least 12 months prior to and after the structural change. This leaves a total of 77 stocks. Of these 77 stocks, 57 continued trading in the ordinary auction market (SBO market), while 14 commenced trading in the new Star market.[2]

For these 14 Star stocks, the data includes the time (to the nearest second), price and volume for each trade, and the time and price of each bid and ask quote posted. The data extends from one year before to one year after the 2 April, 2001 structural change. Also included are daily high and low prices and daily turnover for each stock. Market capitalization of all 14 firms on the trading day prior to the structural change is also available. The data is sourced from a Reuter's database.

Table 1 provides summary statistics for the 14 Star stocks included in the sample. The average proportional spread prior to the structural change is 0.904 percent, whilst after the change the average has decreased to 0.882 percent. The average price has fallen, from €4.35 before to €4.05 after. Average daily volume prior to the 2 April, 2001 is 111,612, whilst after the event date the average has fallen to 94,034. The reduction in price and volume has lead to a reduction in average daily turnover, from 555,827 to 363,457. Average daily volatility, measured as the natural logarithm of ratio of high to low price, has also fallen after the switch, from 2.810 percent to 2.654 percent. The average market capitalization on the trading day prior to the structural change is €269.6 million.

3 Research Design

To analyze the intraday behaviour of bid-ask spreads, and to test the first hypothesis for this paper, the authors partitioned each trading day into 32 15-minute intervals.[3] Following the leads of both McInish and Wood (1992) and Chan, Chung and Johnson (1995), the time-weighted absolute bid-ask spreads in each time interval were calculated. The weighting method is based on the number of seconds the quotation was outstanding during the 15-minute interval. The authors then also calculated the midpoint of the bid-ask spread at the end of each 15-minute interval. The volatility for each 15-minute interval was thus calculated as the absolute midpoint-to-midpoint stock return. The use of quote midpoints is motivated by Chan, Chung and Johnson (1995) who claimed that the use of transaction prices is quite noisy due to bid-ask bounce. The volume is simply the total number of shares transacted in each 15-minute interval.

It is possible that the bid and ask quotes that are entered are unrealistic (in that a trade is not likely to eventuate unless better quotes are entered). Also, under the specialist market structure, the specialist can offer price improvement within the best quotes, which will not be captured in the time-

Table 1
Descriptive Statistics

This table reports intraday descriptive statistics (number of stocks, proportional spread, closing price, daily volume, daily turnover, daily volatility and market capitalization) for the 14 Star stocks. Stocks are included if they traded continuously for 12 months prior to and after the 2nd April, 2001 structural change. Volatility is calculated as the natural logarithm of the ratio of daily high to low stock prices. For each variable, the table reports the mean and median for the 12 months before and after the structural change. The market capitalization is referred to one day before the structural change.

		Star market	
		Before	**After**
Number of Stocks		14	
Time-Weighted Spread (%)			
	Mean	0.904	0.882
	Median	0.762	0.733
Closing Price (€)			
	Mean	4.85	4.14
	Median	2.82	2.11
Daily Volume (shares)			
	Mean	111,612	94,034
	Median	96,074	39,721
Daily Turnover (€)			
	Mean	555,827	363,457
	Median	276,526	104,261
Daily Volatility (%)			
	Mean	2.810	2.654
	Median	2.340	2.181
Mar ket Capitalization (€ million)			
	Mean	296.9	
	Media	258.8	

weighted bid-ask spread. If the specialist continually offers price improvement, then the 'real' cost of trading is significantly lower than is captured with the time-weighted method. To capture the effective cost of trading, the authors included only bid-ask spreads that lead directly to trades. Essentially this involves using the bid-ask spread immediately prior to each transaction.[4] Thus for each 15-minute interval, the authors calculated the volume-weighted effective percentage half spread as [Transaction Price – (Ask + Bid) / 2] / (Ask + Bid) / 2.[5]

To control for variations in bid-ask spreads across the day, caused by variations in volume and volatility, the following linear regression is estimated:

$$\mathrm{BAS}_t = \beta_0 + \beta_1 Vol_t + \beta_2 Volume_t + \sum_{n=1}^{32} \beta_{3,n} D_n + \sum_{d=1}^{4} \beta_{4,d} Day_d + \varepsilon_t$$

$$\mathrm{EBAS}_t = \beta_0 + \beta_1 Vol_t + \beta_2 Volume_t + \sum_{n=1}^{32} \beta_{3,n} D_n + \sum_{d=1}^{4} \beta_{4,d} Day_d + \varepsilon_t$$

In the first regression, BAS represents the time-weighted bid-ask spread in each 15-minute interval, while in the second regression, BAS represents the volume-weighted effective percentage half spread in each 15-minute interval. The volume variable is the natural logarithm of the number of shares transacted in each 15-minute interval. The volatility variable is the absolute midpoint-to-midpoint stock return for each 15-minute interval. Following the lead of McInish and Wood (1992), four dummy variables that equal one if the observations occur on Tuesday, Wednesday, Thursday or Friday, respectively, and zero otherwise were included. This should capture any day-of-the-week effects.

To analyze the intraday behaviour of the specialist with regards to the bid-ask spread relative to the spreads under an auction market, and thus to test the second hypothesis for this paper, 32 time-interval dummy variables were included for the entire two-year period. For example, if an observation fell into the first 15-minute interval and occurred after the 2nd April, 2001 structural change, then the D1 dummy variable took the value of one, zero otherwise. Thus if D1 is negative, then the bid-ask spread is significantly lower in the first 15-minute interval under the specialist market structure. As the trading day is longer under the specialist market structure (there are an additional three 15-minute intervals), we exclude the middle three 15-minute intervals from the specialist structure period.

4 Empirical Results

4.1 Intraday Pattern Results

Table 2 presents results for volume, volatility, time-weighted bid-ask spread and the volume-weighted effective percentage half spread in each 15-minute interval of the trading day, separately for the 12 months before and after the 2nd April, 2001 structural change. First, volume shows a U-shaped pattern both before and after the structural change, consistent with the findings of Chan, Chung and Johnson (1995). Volume is lower in each 15-minute interval after the structural change. This U-shaped pattern, and the difference between the before and after periods, is also evident in Figure 1.

Second, return volatility is highest at the start of the trading day, both before and after the structural change. However, like with Chan, Chung and Johnson (1995), volatility rises again at the end of the trading day. Interesting, there is a decrease in volatility around 2.30pm under both specialist and auction market structures, which lasts approximately 30 minutes, and then reverts back to prior levels. The U-shaped pattern is clearly illustrated in Figure 2.

Figure 1
Volume Across the Trading Day

This figure depicts the average volume across each 15 minutes during a trading day for the 14 stocks that moved from the auction market to the Star specialist market on the 2nd April, 2001.

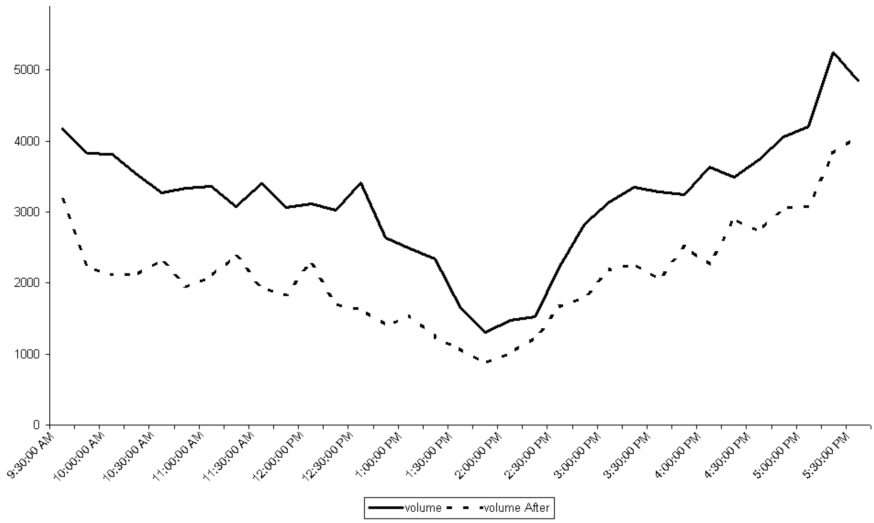


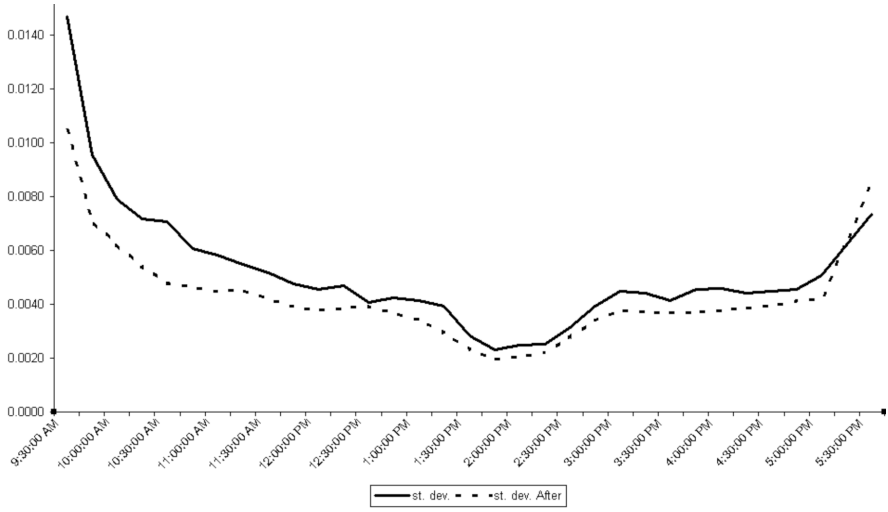
Table 2
Mean Values for Each 15 Minutes Intervals During the Trading Day for Star Stocks Before the Structural Change

This table reports the mean values for volume, volatility, time-weighted bid-ask spread, and the volume-weighted effective percentage half spread in each 15-minute interval of the trading day. The 14 Star stocks that were traded in the auction market before the 2nd April, 2001 are considered. Stocks are included if they traded continuously for 12 months prior to the structural change.

Time	Volume	Volatility	T.W. Spread (%)	Effective Spread (%)
9:30AM	4177	0.0147	1.4177	0.4800
9:45AM	3825	0.0096	1.1975	0.4978
10:00AM	3821	0.0079	1.0888	0.3899
10:15AM	3537	0.0072	1.0316	0.3464
10:30AM	3267	0.0071	0.9896	0.3425
10:45AM	3337	0.0061	0.9585	0.3244
11:00AM	3365	0.0058	0.9334	0.3217
11:15AM	3081	0.0055	0.9055	0.3105
11:30AM	3403	0.0052	0.8888	0.3050
11:45AM	3059	0.0048	0.8748	0.2972
12:00PM	3122	0.0046	0.8634	0.2889
12:15PM	3032	0.0047	0.8653	0.2912
12:30PM	3414	0.0041	0.8447	0.2982
12:45PM	2638	0.0042	0.8281	0.2804
1:00PM	2483	0.0041	0.8188	0.2851
1:15PM	2346	0.0039	0.8066	0.2771
1:30PM	1643	0.0028	0.8034	0.2847
1:45PM	1301	0.0023	0.7991	0.2756
2:00PM	1476	0.0025	0.7968	0.2886
2:15PM	1527	0.0025	0.7976	0.2867
2:30PM	2231	0.0031	0.7996	0.3340
2:45PM	2837	0.0039	0.7888	0.2840
3:00PM	3147	0.0045	0.7858	0.2776
3:15PM	3353	0.0044	0.7874	0.2761
3:30PM	3278	0.0041	0.7879	0.2738
3:45PM	3252	0.0045	0.7890	0.2741
4:00PM	3633	0.0046	0.7938	0.2731
4:15PM	3494	0.0044	0.7907	0.2763
4:30PM	3742	0.0045	0.8003	0.2780
4:45PM	4065	0.0046	0.8039	0.2841
5:00PM	4203	0.0051	0.8209	0.2926
5:15PM	5252	0.0062	0.8592	0.2961
5:30PM	4847	0.0074	0.8503	0.3329

Figure 2
Volatility Across the Trading Day

This figure depicts the average standard deviation across each 15 minutes during the trading day for the 14 stocks that moved from the auction market to the Star specialist market on the 2nd April, 2001.

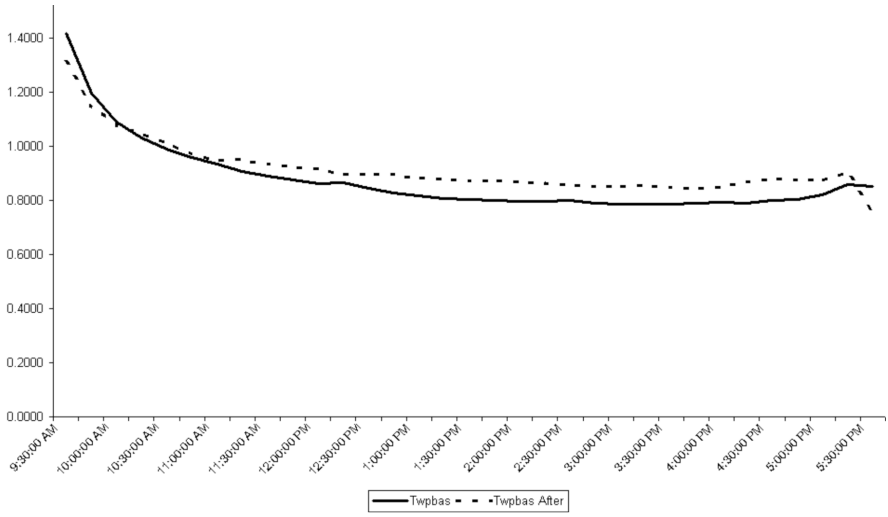


Turning our attention to bid-ask spreads, the time-weighted spreads for the Star stocks prior to the structural change exhibited a definite U-shaped pattern. Spreads were highest at the start of the trading day, and then fell throughout the day, beginning to rise again towards the end of the day. The time-weighted spread pattern after the structural change commenced in a similar fashion, with spreads highest at the opening of trade. However, time-weighted spreads in the final 15-minutes of trading were tighter than in any other 15-minute interval in the trading day. This drop in spreads towards the close of trading is also visible in Figure 3. Overall, apart from the final 15-minute interval, spreads were tighter under an auction rather than under a specialist market structure.

Finally, to capture the 'real' cost of trading to market participants, the volume-weighted effective percentage half spread was compared. Both before and after the structural change, the effective spread exhibits a U-shaped intraday pattern. Figure 4, which represents a graphical depiction of the effective spreads before and after the structural change, indicates that effective spreads are lower in the specialist market early in the trading day. However, the effective spread is generally higher in the specialist market towards the end of the trading day.

Figure 3
Time-Weighted Proportional Spread Across the Trading Day

This figure depicts the time-weighted proportional spread across each 15 minutes during the trading day for the 14 stocks that moved from the auction market to the Star specialist market on the 2nd April, 2001.



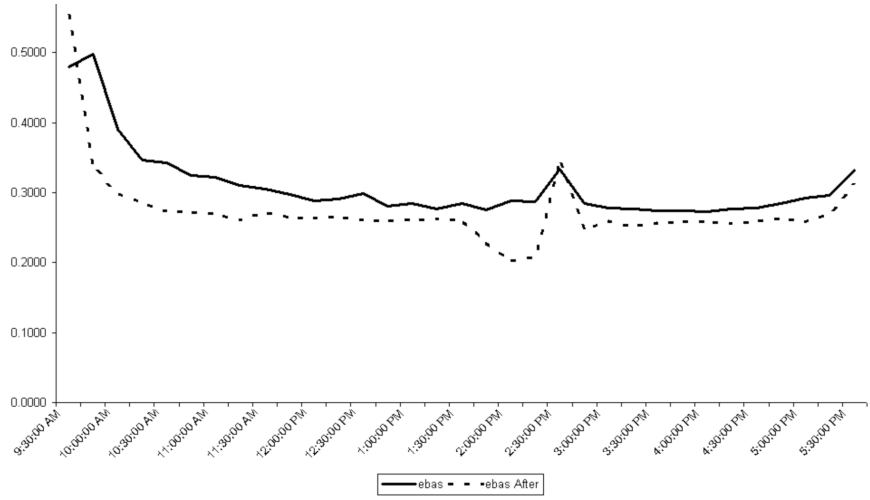
4.2 Regression Results

As the intraday results show, both volume and volatility exhibit considerable variation after the structural change. To control for these factors, and to test how the specialist behaves throughout the trading day (relative to spreads prior to the structural change), the regression described previously is estimated. The results of this are presented in Table 3. Starting with the time-weighted bid-ask spread, the volume variable is significantly negative. Larger volumes lead to reduced spreads, although the intraday results indicate that volume falls after the structural change. The volatility variable is significantly positive, indicating that increased risk leads to wider spreads, both under an auction and specialist market structure. The day-of-the-week dummy variables are all negative, with Tuesday, Thursday and Friday all significantly different from zero. Spreads are generally higher on Monday than on any other day of the week. Every time-interval dummy variable, except for the final 15-minute interval, is significantly positive. Time-weighted bid-ask spreads are wider throughout the entire trading day under the specialist market structure.

The second regression is based on the volume-weighted effective percentage half spread. As with the time-weighted regression results, the volume variable is significantly negative, while the volatility variable is

Figure 4
Volume-Weighted Effective Percentage Half Spread Across the Trading Day

This figure depicts the volume-weighted effective percentage half spread across each 15 minutes during the trading day for the 14 stocks that moved from the auction market to the Star specialist market on the 2nd April, 2001.



significantly positive. All four day-of-the-week variables are insignificantly different from zero. Consistent with the finding of McInish and Wood (1992), day-of-week effects are not robust. In a direct contrast to the time-weighted results, the majority of time-interval dummy variables are significantly negative. Except for the beginning of the trading session, the effective spreads are significantly lower under a specialist market structure.

In summary, the results indicate that the U-shaped intraday pattern in bid-ask spreads is relatively constant across both auction and specialist market structures. Trading volume also exhibits the classical U-shaped pattern, both before and after the structural change. Although volatility is at its highest at the start of the trading day, and falls throughout the day, under both the specialist and auction market structures, volatility does not rise towards the close of trading. Overall, the first hypothesis is accepted. Bid-ask spreads, volume and volatility exhibit a U-shaped pattern both in an auction and specialist market structure.

Comparisons of time-weighted bid-ask spreads across the trading day for both the auction and specialist market structures provides support for the second hypothesis. The quoted spreads are consistently higher under

Table 3
Mean Values for Each 15 Minutes Intervals During the Trading Day for Star Stocks

This table reports the mean values for volume, volatility, time-weighted bid-ask spread, and the volume-weighted effective percentage half spread in each 15-minute interval of the trading day. The 14 Star stocks that begun to trade in the Star market after the 2nd April, 2001 are considered. Stocks are included if they traded continuously for 12 months after the structural change.

Time	Volume	Volatility	T.W. Spread (%)	Effective Spread (%)
9:30AM	3174	0.0105	1.3108	0.5515
9:45AM	2227	0.0071	1.1525	0.3357
10:00AM	2123	0.0062	1.0783	0.3005
10:15AM	2116	0.0054	1.0470	0.2858
10:30AM	2329	0.0048	1.0146	0.2743
10:45AM	1957	0.0047	0.9722	0.2722
11:00AM	2096	0.0045	0.9467	0.2706
11:15AM	2389	0.0045	0.9509	0.2617
11:30AM	1940	0.0042	0.9337	0.2732
11:45AM	1839	0.0039	0.9251	0.2647
12:00PM	2288	0.0038	0.9190	0.2634
12:15PM	1713	0.0039	0.8977	0.2668
12:30PM	1634	0.0039	0.8952	0.2617
12:45PM	1404	0.0037	0.8981	0.2603
1:00PM	1545	0.0035	0.8844	0.2616
1:15PM	1246	0.0029	0.8802	0.2631
1:30PM	1079	0.0023	0.8735	0.2610
1:45PM	884	0.0020	0.8721	0.2294
2:00PM	1013	0.0021	0.8706	0.2033
2:15PM	1232	0.0022	0.8663	0.2099
2:30PM	1666	0.0028	0.8549	0.3458
2:45PM	1800	0.0034	0.8514	0.2487
3:00PM	2190	0.0038	0.8526	0.2605
3:15PM	2271	0.0037	0.8546	0.2522
3:30PM	2058	0.0037	0.8481	0.2573
3:45PM	2514	0.0037	0.8465	0.2589
4:00PM	2266	0.0038	0.8510	0.2591
4:15PM	2906	0.0039	0.8704	0.2561
4:30PM	2727	0.0039	0.8782	0.2604
4:45PM	4056	0.0041	0.8752	0.2639
5:00PM	3087	0.0042	0.8769	0.2587
5:15PM	3833	0.0064	0.9051	0.2705
5:30PM	4079	0.0085	0.7595	0.3101

a specialist system. However, the time-weighted spread does not capture specialist trading inside the best posted quotes. Comparisons of effective spreads before and after the structural change indicates that the effective cost of trading is consistently lower under a specialist market structure. Based on these results, the second hypothesis is rejected. The specialist does not use his or her market powers to consistently charge higher prices.

5 Additional Tests

5.1 Effect of Firm Size

Much of the literature has suggested that although specialist markets provide lower spreads than dealer markets, the benefit from shifting to a specialist market is greater for smaller firms. As the Italian Bourse already has a segment for large firms in excess of €800 million, known as "Blue Chips", the stocks remaining in the Star market are already medium to small capitalization stocks. To examine the impact of firm size, the samples of Star stocks are divided into two groups. The intraday analysis around the structural change is then completed separately for small and medium capitalization stocks. The results of this are presented in Figure 5 and Table 4 for small capitalization stocks, and Figure 6 and Table 5 for medium capitalization stocks.

The intraday pattern in spreads for the small and medium capitalization stocks is similar to the full sample results. The time-weighted spreads prior to the structural change exhibit the classical U-shaped pattern, while the pattern is similar with the specialist, except for the final 15-minute interval which sees a drop in spreads. The effective spreads also exhibit a U-shaped pattern, except for a period in the middle of the trading day for the small capitalization stocks which has considerable volatility, both before and after the structural change.

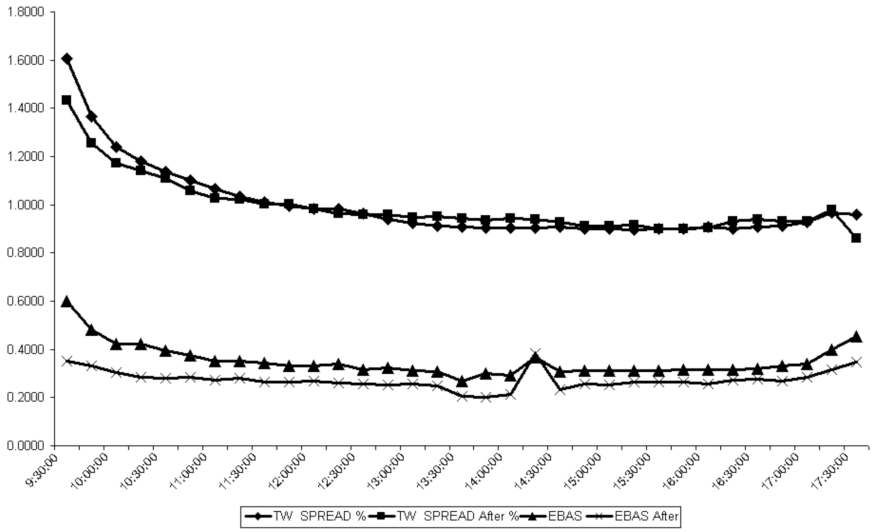
The regression results for the time-weighted spread are directly consistent with the aggregated results (spreads are higher throughout the trading day with the specialist), whilst the effective spread regressions show that the effective cost of trading is lower with a specialist except for the first two 15-minute intervals. Volume, volatility and day-of-the-week dummy variables provide consistent results. Overall, the reduced cost of trading under a specialist market structure is not dependant on firm size.

5.2 Length of Event Window

The sensitivity of results to the length of the event window was examined. As a 12-month pre- and post-event window could include significant variation in turnover and volatility, the authors repeated the analysis for both three and six months before and after the structural change. The results are presented in Figure 7 and Table 6 (three month window) and Figure 8 and Table 7 (six month window).

Figure 5
Time-Weighted Proportional Spread and Volume-Weighted Effective Percentage Half Spread for Small Stocks

This figure depicts the Time-Weighted Proportional Spread and Volume-weighted effective percentage half spread across each 15 minutes during a trading day for small stocks that moved from the auction market to the Star specialist market on the 2nd April, 2001.



The intraday pattern in spreads for the three and six month event windows are very similar to the 12 month results. The time-weighted spreads prior to the structural change exhibit the classical U-shaped pattern, while the pattern is similar with the specialist, except for the final 15-minute interval which sees a drop in spreads. The effective spreads also exhibit a U-shaped pattern, except for a period in the middle of the trading day for the small capitalization stocks which has considerable volatility, both before and after the structural change. The regression results are directly consistent with the 12 month results. Volume is negatively related, volatility is positively related, while day-of-the-week is generally irrelevant. Time-weighted spreads are higher throughout the trading day with the specialist, whilst effective spreads are lower with a specialist except for the first two 15-minute intervals. Overall, the reduced cost of trading under a specialist market structure is robust to the event window in which relevant variables are measured.

Table 4
Multiple Regression Results

This table reports results from the two regressions for the 14 stocks that moved from an auction market to the specialist Star market on the 2nd April, 2001. Stocks are included if they traded continuously for 12 months prior to and after the structural change. In the first regression the dependant variable BAS_t is measured as the time-weighted bid-ask spread, while in the second regression $EBAS_t$ is measured as the volume-weighted effective percentage half spread. Each change dummy variable takes the value of one after the structural change, zero otherwise. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

	$TWBAS_t$	**$EBAS_t$**		**$TWBAS_t$**	**$EBAS_t$**
Intercept	1.2273**	0.4294**	D19	-0.1355**	-0.1170**
Volatility	14.0909**	0.1146*	D20	-0.1202**	-0.0049
volume	-0.0609**	-0.0155**	D21	-0.1270**	-0.0710**
D1	0.4104**	0.0125**	D22	-0.0705**	-0.0571**
D2	0.1968**	-0.0280**	D23	-0.0891**	-0.0635**
D3	0.1140**	-0.0395**	D24	-0.0727**	-0.0609**
D4	0.0752**	-0.0483**	D25	-0.0824**	-0.0606**
D5	0.0622**	-0.0478**	D26	-0.0782**	-0.0662**
D6	0.0093**	-0.0506**	D27	-0.0658**	-0.0647**
D7	-0.0264**	-0.0612**	D28	-0.0409	-0.0641**
D8	-0.0143**	-0.0485**	D29	-0.0524	-0.0601**
D9	-0.0410**	-0.0544**	D30	-0.0301	-0.0646**
D10	-0.0216**	-0.0478**	D31	-0.0183*	-0.0502**
D11	-0.0366**	-0.0466**	D32	-0.0529**	-0.0104**
D12	-0.0661**	-0.0579**	Tuesday	-0.0075*	-0.0053**
D13	-0.0629**	-0.0629**	Wednesday	0.0027*	-0.0037**
D14	-0.0393**	-0.0518**	Thursday	-0.0006	-0.0030*
D15	-0.0744**	-0.0576**	Friday	0.0075*	-0.0056**
D16	-0.0833**	-0.0887**	R-square	0.0576	0.0182
D18	-0.1318**	-0.1158**			

** Indicates statistical significance at the 0.01 level

* Indicates statistical significance at the 0.05 level

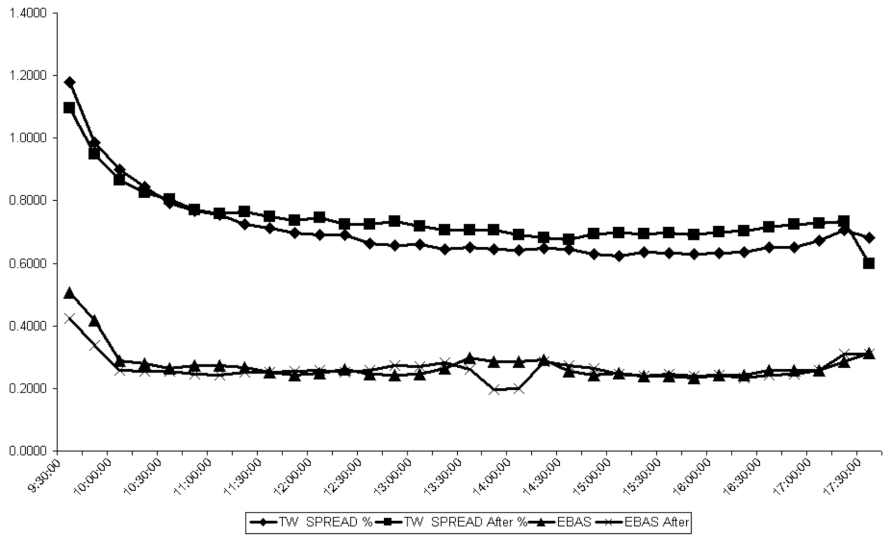
5.3 Intraday Spreads for SBO Stocks

Although findings in the previous section indicated that the cost of trading is lower under a specialist market structure, it could be that market wide forces are driving this reduced cost. For this reason, the authors repeated the analysis using the 57 stocks which remained in the SBO auction market. As both the before and after period is based on an order-driven environment, no trading takes place within the quotes. The analysis is thus restricted to time-weighted bid-ask spreads. The results of this analysis are presented in Table 8.

The time-weighted intraday spread pattern exhibits the classical U-shaped pattern, with spreads higher at the start and end of the trading day. Overall, the plot of spreads after the 2001 structural change indicates that spreads have increased rather than decreased, as with the Star market stocks. The regression results confirm the negative relationship with volume and the positive relationship with volatility. The four day-of-the-week dummy variables are all insignificantly different from zero, confirming the lack of any

Figure 6
Time-Weighted Proportional Spread and Volume-Weighted Effective Half Spread for Medium Stocks

This figure depicts the Time-Weighted Proportional Spread and Volume-weighted effective percentage half spread across each 15 minutes during a trading day for medium stocks that moved from the auction market to the Star specialist market on the 2nd April, 2001.



day-of-week effects. The time-interval dummy variables are generally positive for the early part of the trading day, indicating that spreads are higher after the structural change. However, dummy variables for the middle to later parts of trading are generally negative (and often insignificantly different from zero), indicating minimal difference in spreads before and after the structural change. Overall, the reduced cost of trading for Star stocks under the specialist system is not driven by market wide events.

Table 5
Small Stock Segment

This table reports results from the two regressions for small-size stocks that moved from an auction market to the specialist Star market on the 2nd April, 2001. Stocks are included if they traded continuously for 12 months prior to and after the structural change. In the first regression the dependant variable BAS_t is measured as the time-weighted bid-ask spread, while in the second regression $EBAS_t$ is measured as the volume-weighted effective percentage half spread. Each change dummy variable takes the value of one after the structural change, zero otherwise. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

	$TWBAS_t$	$EBAS_t$		$TWBAS_t$	$EBAS_t$
Intercept	1.3186**	0.5053**	D19	-0.1690**	-0.1694**
Volatility	13.0333**	0.1119**	D20	-0.1741**	-0.0139
volume	-0.0542**	-0.0187**	D21	-0.1799**	-0.1440**
D1	0.4040**	-0.0277**	D22	-0.1311**	-0.1210**
D2	0.1641**	-0.0514**	D23	-0.1552**	-0.1244**
D3	0.0803	-0.0708**	D24	-0.1208**	-0.1139**
D4	0.0310	-0.0881**	D25	-0.1516**	-0.1144**
D5	0.0119	-0.0860**	D26	-0.1482**	-0.1185**
D6	-0.0406	-0.0892**	D27	-0.1371**	-0.1109**
D7	-0.0796	-0.1013**	D28	-0.0860**	-0.1043**
D8	-0.0753	-0.0899**	D29	-0.1326**	-0.1036**
D9	-0.1163**	-0.1050**	D30	-0.1131**	-0.1075**
D10	-0.0847**	-0.1023**	D31	-0.0950*	-0.0905**
D11	-0.1056**	-0.1032**	D32	-0.0175	-0.0612**
D12	-0.1246**	-0.1106**	Tuesday	-0.0361**	-0.0062*
D13	-0.1236**	-0.1242**	Wednesday	-0.0394**	-0.0048*
D14	-0.1047**	-0.1219**	Thursday	-0.0261**	0.0016
D15	-0.1373**	-0.1223**	Friday	-0.0273**	-0.0103**
D16	-0.1290**	-0.1265**	R-square	0.058**	0.0398
D18	-0.2054**	-0.1831**			

**Indicates statistical significance at the 0.01 level
*Indicates statistical significance at the 0.05 level

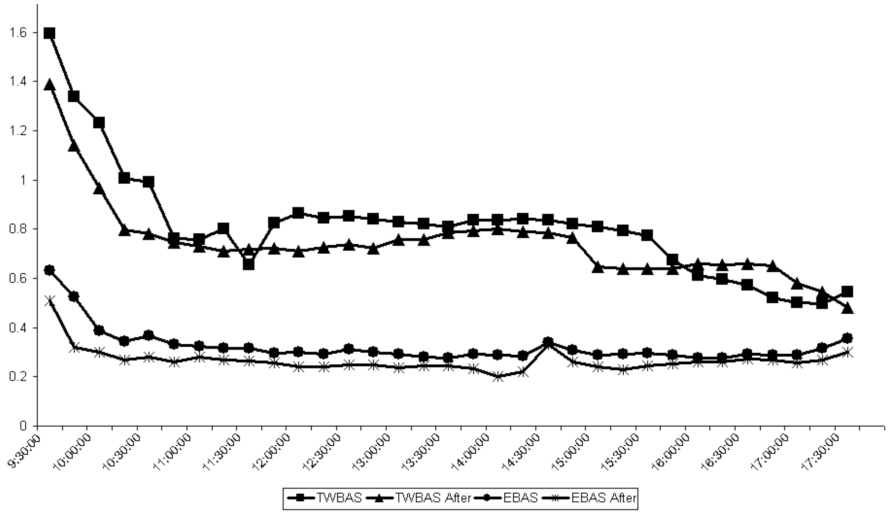
6 Summary

Intraday patterns in bid-ask spreads has been an extensively studied area in finance research. Most of this research has generally shown that spreads exhibit a U-shaped intraday pattern. Spreads are widest at the opening of trading, fall throughout the day, and then begin to rise towards the close of trading. This pattern has been attributed to the inventory holding costs of specialists, the market power of the specialist at the open and close of trading, and the adverse selection risk faced by market makers. However, the hybrid nature of trading on the NYSE, which incorporates both a specialist and a limit order book, could disguise the actual pattern of spreads dictated by a specialist.

On the 2nd April, 2001, a structural change was implemented on the Italian Bourse. Many stocks that traded in an auction market switched to a specialist market (Star), while other stocks remained in an auction market (SBO). This switch from an auction to a specialist market provides a 'natural' experiment where the intraday patterns in spreads can be directly compared across auction and specialist market structures. It also allows the evaluation of how a specialist uses his market power across the trading day.

Figure 7
Time-Weighted Proportional Spread and Volume-Weighted Effective Percentage Half Spread with 3 Months Window's Length

This figure depicts the Time-Weighted Proportional Spread and Volume-weighted effective percentage half spread across each 15 minutes during a trading day for STAR stocks traded continuously for 3 months prior to and after the 2nd April, 2001 structural change.



Results indicate that volume, volatility and bid-ask spreads exhibit a U-shaped pattern across the trading day, both before and after the structural change. While the time-weighted bid-ask spread is wider with a specialist, comparing effective spreads across the trading day confirms that the cost of trading to market participants is significantly lower under a specialist market structure. These findings are robust to the size of the firm, the event window around the structural change, as well as overall market-wide changes. Based on these results, the first hypothesis (which conjectured that volume, volatility and spreads exhibit U-shaped patterns) is accepted. However, the second hypothesis (which conjectures that the specialist uses his market powers to consistently charge higher prices) is rejected.

Table 6
Medium Stock Segment

This table reports results from the two regressions for medium-size stocks that moved from an auction market to the specialist Star market on the 2nd April, 2001. Stocks are included if they traded continuously for 12 months prior to and after the structural change. In the first regression the dependant variable BAS_t is measured as the time-weighted bid-ask spread, while in the second regression $EBAS_t$ is measured as the volume-weighted effective percentage half spread. Each change dummy variable takes the value of one after the structural change, zero otherwise. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

	TWBASt	EBASt		TWBASt	EBASt
Intercept	0.9754**	0.2558**	D19	-0.1161**	-0.0638**
Volatility	29.2900**	0.5726**	D20	-0.0880**	-0.0177**
volume	-0.0383**	-0.0023**	D21	-0.0951**	-0.0081
D1	0.3547**	0.0553**	D22	-0.0530**	0.0001
D2	0.1808**	-0.0087*	D23	-0.0635**	-0.0195**
D3	0.0857**	-0.0179**	D24	-0.0649**	-0.0247**
D4	0.0489**	-0.0189**	D25	-0.0530**	-0.0205**
D5	0.0589**	-0.0191**	D26	-0.0506**	-0.0317**
D6	0.0056	-0.0256**	D27	-0.0406*	-0.0312**
D7	-0.0236	-0.0291**	D28	-0.0430*	-0.0392**
D8	-0.0001	-0.0197**	D29	-0.0159*	-0.0331**
D9	-0.0127	-0.0171**	D30	0.0050	-0.0304**
D10	-0.0090	-0.0062	D31	0.0130	-0.0183**
D11	-0.0082	-0.0031	D32	0.0321*	-0.0371**
D12	-0.0461**	-0.0141	Tuesday	-0.0099**	-0.0034**
D13	-0.0424**	-0.0104	Wednesday	-0.0237**	-0.0066**
D14	-0.0209	0.0071	Thursday	-0.0222**	-0.0063**
D15	-0.0508**	0.0077	Friday	-0.0174**	-0.0002
D16	-0.0693**	0.0068	R-square	0.0399	0.0075
D18	-0.0862**	-0.0633**			

** Indicates statistical significance at the 0.01 level
* Indicates statistical significance at the 0.05 level

Figure 8
Time-Weighted Proportional Spread and Volume-Weighted Effective Percentage Half Spread with 6 Months Window's Length

This figure depicts the Time-Weighted Proportional Spread and Volume-weighted effective percentage half spread across each 15 minutes during a trading day for STAR stocks traded continuously for 6 months prior to and after the 2nd April, 2001 structural change.

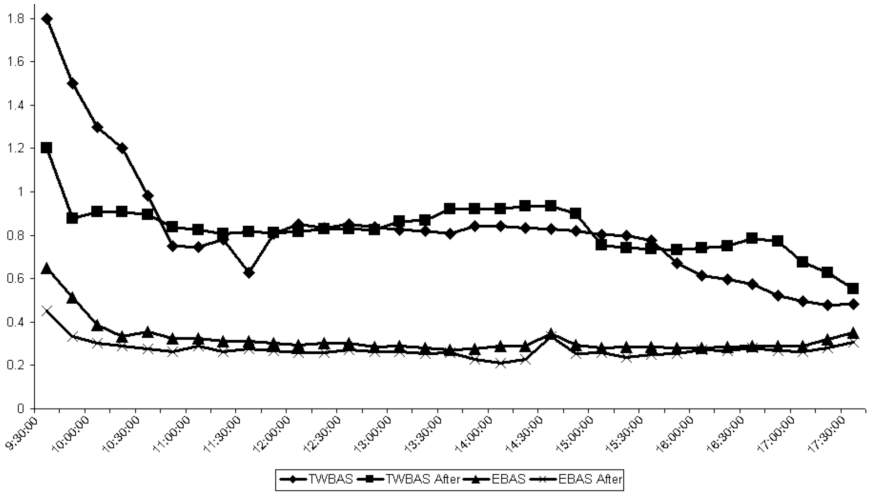


Table 7
Sensitivity to Event Window
3 Months Case

This table reports regressions results for Star stocks, as classified in Table 3. Stocks are included if they traded continuously for 3 months prior to and after the 2nd April, 2001 structural change. In the first regression the dependant variable BAS_t is measured as the time-weighted bid-ask spread, while in the second regression $EBAS_t$ is measured as the volume-weighted effective percentage half spread. Each change dummy variable takes the value of one after the structural change, zero otherwise. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

	BAS_t	$EBAS_t$		BAS_t	$EBAS_t$
Intercept	1.1784**	0.5207**	D19	-0.3422**	-0.1224**
Volatility	15.5774**	0.1268*	D20	-0.2947**	0.0039
volume	-0.0340**	-0.0251**	D21	-0.3225**	-0.0540**
D1	-0.2661**	-0.0225**	D22	-0.4419**	-0.0956**
D2	-0.2778**	-0.0473**	D23	-0.4525**	-0.0994**
D3	-0.2787**	-0.0690**	D24	-0.4549**	-0.0830**
D4	-0.2789**	-0.0502**	D25	-0.4299**	-0.0717**
D5	-0.3740**	-0.0659**	D26	-0.4441**	-0.0692**
D6	-0.3833**	-0.0502**	D27	-0.4477**	-0.0752**
D7	-0.4090**	-0.0762**	D28	-0.4378**	-0.0664**
D8	-0.4285**	-0.0726**	D29	-0.4459**	-0.0765**
D9	-0.4063**	-0.0706**	D30	-0.4886**	-0.0794**
D10	-0.3841**	-0.0770**	D31	-0.5106**	-0.0657**
D11	-0.4226**	-0.0892**	D32	-0.5152**	-0.0376**
D12	-0.3887**	-0.0799**	Tuesday	-0.0215**	-0.0107**
D13	-0.3882**	-0.0867**	Wednesday	-0.0482*	-0.0152**
D14	-0.3319**	-0.0884**	Thursday	0.0002	-0.0138**
D15	-0.2849**	-0.0844**	Friday	-0.0130	-0.0155**
D16	-0.2969**	-0.0774**	R-square	0.0071	0.0328
D18	-0.3116**	-0.1403**			

** Indicates statistical significance at the 0.01 level
* Indicates statistical significance at the 0.05 level

Table 8
Sensitivity to Event Window
6 Months Case

This table reports regressions results for Star stocks, as classified in Table 3. Stocks are included if they traded continuously for 6 months prior to and after the structural change. In the first regression the dependant variable BASt is measured as the time-weighted bid-ask spread, while in the second regression EBASt is measured as the volume-weighted effective percentage half spread. Each change dummy variable takes the value of one after the structural change, zero otherwise. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

	BAS_t	$EBAS_t$		BAS_t	$EBAS_t$
Intercept	1.0635**	0.5064**	D19	-0.1195**	-0.1057**
Volatility	18.2788**	0.1279**	D20	-0.0869**	-0.0039
volume	-0.0242**	-0.0249**	D21	-0.1509**	-0.0572**
D1	-0.1235**	0.0017**	D22	-0.2888**	-0.0674**
D2	-0.1421**	-0.0322**	D23	-0.3229**	-0.0759**
D3	-0.1455**	-0.0446**	D24	-0.3119**	-0.0625**
D4	-0.1612**	-0.0480**	D25	-0.3113**	-0.0597**
D5	-0.2521**	-0.0578**	D26	-0.3139**	-0.0558**
D6	-0.2687**	-0.0357**	D27	-0.2944**	-0.0529**
D7	-0.2880**	-0.0611**	D28	-0.2630**	-0.0469**
D8	-0.2866**	-0.0502**	D29	-0.3078**	-0.0631**
D9	-0.2995**	-0.0591**	D30	-0.3628**	-0.0638**
D10	-0.2590**	-0.0485**	D31	-0.3968**	-0.0438**
D11	-0.2721**	-0.0588**	D32	-0.4199**	-0.0214**
D12	-0.2463**	-0.0447**	Tuesday	-0.0172**	-0.0075**
D13	-0.2385**	-0.0643**	Wednesday	-0.0211*	-0.0097**
D14	-0.1583**	-0.0539**	Thursday	-0.0098**	-0.0055**
D15	-0.1064**	-0.0618**	Friday	-0.0027	-0.0068**
D16	-0.1416**	-0.0799**	R-square	0.0438	0.0265**
D18	-0.1477**	-0.1261**			

** Indicates statistical significance at the 0.01 level
* Indicates statistical significance at the 0.05 level

Notes

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1 Also excluded are foreign listed companies.
2 A list of all Star and SBO ticker symbols is provided in the Appendix.
3 Same partitioning as used by Chan, Chung and Johnson (1995).
4 Bessembinder (2003) and Peterson and Sirri (2003) show that estimates are least biased when measured using contemporaneous bid-ask quotes.
5 During the pre-period in which Star stocks traded in an auction market, the effective percentage spread is equal to proportional bid-ask spread as no transactions occurred within the quotes.

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