BID-ASK SPREADS AND LIQUIDITY DETERMINANTS ACROSS VARIOUS MARKET STRUCTURES ON THE ITALIAN BOURSE

by

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DEDICATION

To my family and friends, who in various ways contributed to this outcome.

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Synopsis

This dissertation consists of three essays that examine liquidity across several market structures. The research provides empirical evidence on increasingly significant issues given the rapid increase in structural changes across international equity markets. Each essay addresses some inconclusive research in order to aid researchers, investors and regulators in the course of understanding and managing the liquidity provision of various market structures.

The first essay analyzes liquidity surrounding earnings announcements on the Italian Bourse. Studies of market reaction surrounding earnings announcements use bid-ask spreads to proxy for information asymmetry. It is proposed that the use of spreads posted by NYSE specialists or Nasdaq dealers is problematic in previous tests since dealer spreads reflect the market power of dealers. This essay addresses these problems by examining bid-ask spreads surrounding earnings announcements for stocks that trade in a purely order-driven environment. The problems encountered in previous studies are mitigated. The results indicate that bid-ask spreads increase significantly around earnings announcements, reflecting an increase in information asymmetry in contrast to previous studies using daily data from US markets.

The second essay analyzes liquidity across auction and specialist market structures. Several studies find that bid-ask spreads for stocks listed on the NYSE are lower than for stocks listed on Nasdaq. However, the hybrid nature of trading on the NYSE, which comprises a specialist and a limit order book, clouds the comparison. In 2001, a structural change was implemented on the Italian Bourse, which provides a cleaner experiment for examining this issue. Many stocks that traded in an auction market switched to a specialist market, where the specialist controls the order book. Results indicate that spreads tighten when stocks move to the specialist market. This reduction in spreads is robust to market capitalization, industry affiliation and different observation periods around the structural change. The specialist's ability to offer price improvement further lowers the cost of executing trades. Specialist market structures are more advantageous to market participants.

The final essay analyzes intraday patterns in bid-ask spreads across auction and specialist market structures. Several studies have analyzed 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. The structural change on the Italian Bourse provides a natural experiment where intraday patterns in 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 within 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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Chapter 1: Introduction

1.1 Background and Overview

The liquidity of any market, particularly a stock market, is a fundamental factor in the design of any stock exchange. Individual and institutional investors both prefer liquid markets that offer low trading costs and can absorb large orders without severe price penalties. The provision of liquidity has been central to much interest from both academics and market regulators. As the organization of trading directly affects the provision of liquidity to market participants, understanding the structure of a market, and the 'real' costs of trading in the market, is imperative. The primary objective of this dissertation is to thoroughly explore the liquidity of various market structures via thorough analysis of bid-ask spreads.

The various types of market structures in place worldwide, and the ever-changing structure within many already established markets, has lead to significant amounts of academic research. The introduction and proliferation of the limit order book alongside the specialist on the NYSE has driven research attempting to decipher if the limit order book has benefited market participants. This research has progressed to determining if removal of the specialist, leaving the limit order book as the sole provider of liquidity, is the optimal structure.

Also, comparisons across market structures have attracted the interest of many academics. For example, comparing the dealer market of Nasdaq to the hybrid structure of the NYSE, has been central to much of this research.

This dissertation brings further evidence to bear on the liquidity of various market structures. Chapter 2 presents a comprehensive review of all literature pertaining to the area, and ultimately develops several hypotheses that will subsequently be tested in the three essays which comprise this dissertation. The first essay analyzes the variation in liquidity caused by earnings announcements for the largest stocks trading in a pure order-driven environment on the Italian Bourse. The structural change implemented on the Italian Bourse, in which several stocks that originally traded in an auction market switched to a specialist market structure, motivate the remainder of the thesis. In particular, the second essay directly compares bid-ask spreads for several stocks before and after the structural change in an attempt to determine which structure offers optimal liquidity. The final essay compares the intraday pattern of liquidity across auction and specialist market structures.

1.2 Bid-Ask Spreads Around Earnings Announcements

The study of market reactions surrounding earnings announcements raises questions concerning information asymmetry and the relationship between private and public information in securities markets. Arguing the two are substitutes, Morse and Ushman (1983) and Bushman, Dutta, Hughes and Indjejikian (1997) suggest that if public announcements discourage private information gathering, earnings announcements could coincide with lower information asymmetry. However, if some investors can acquire private information by processing public announcements, private and public information could be complementary, increasing information asymmetry surrounding earnings announcements (see Indjejikian, 1991; Harris and Raviv, 1993; Kim and Verrecchia, 1991, 1994).

Empirical research has focused on this issue directly by examining bid-ask spreads surrounding earnings announcements. Spreads are commonly considered a proxy for information asymmetry (Glosten and Milgrom, 1985), with increased spreads surrounding earnings announcements consistent with an increase in information asymmetry. The evidence from empirical studies is inconclusive. Most studies find no evidence of significant changes in bid-ask spreads surrounding earnings announcements, despite evidence that the adverse selection component of the spread widens significantly surrounding earnings announcements.[1]

In the first essay, I propose that the inconclusive evidence is related to the use of spreads posted by NYSE specialists or Nasdaq dealers in prior studies. Dealer spreads confound a number of factors, potentially clouding the examination of

[1] See Morse and Ushman, 1983; Venkatesh and Chiang, 1986; Lee, Mucklow and Ready, 1993; Brooks, 1994; Krinsky and Lee, 1996; Affleck-Graves, Callahan and Chipalkatti, 2002.

information asymmetry surrounding earnings announcements. The first essay thus addresses this problem by examining bid-ask spreads surrounding earnings announcements for stocks listed on the Italian Bourse. Since the stocks examined trade in a purely order-driven environment, the problems encountered in previous studies are mitigated. This enables a cleaner test of information asymmetry surrounding earnings announcements.

1.3 Bid-Ask Spreads Under Auction and Specialist Market Structures

Stock exchanges worldwide implement various methods of trading equity securities. Each exchange has a set of rules that dictate how orders are submitted, who handles and processes these orders, and ultimately how prices are set (O'Hara, 1995). The organization of trading directly affects the provision of liquidity to market participants. Individual and institutional investors both prefer liquid markets that offer low trading costs and can absorb large orders without severe price penalties. The provision of liquidity has been central to much interest from both academics and market regulators. In particular, comparing specialist markets (such as the NYSE) with other market structures (such as the dealer structure of Nasdaq) to determine which offers optimal liquidity is of significant practical importance. The second essay investigates the variation in liquidity caused by the change from an auction market to a specialist market on the Italian Bourse.

Almost all research on liquidity comparisons is US based. The overwhelming majority of studies find that a specialist market results in lower costs of trading compared to a dealer market. Affleck-Graves, Hedge and Miller (1994), Huang and Stoll (1996) and Bessembinder and Kaufman (1997) compare the magnitude of bid-ask spread components for NYSE / AMEX stocks to Nasdaq stocks. They show that execution costs are lower for NYSE / AMEX listed companies, regardless of capitalization. They also find that adverse selection is not causing the wider spreads on Nasdaq.[2]

Christie and Huang (1994) and Barclay (1997) examine if structurally induced changes in trading costs occur when firms relocate from a dealer market to a specialist market. Their results confirm that the move away from Nasdaq leads to a significant reduction in bid-ask spreads.[3] Amidst these studies finding lower costs on the NYSE (and AMEX), several studies find that execution costs are lower on Nasdaq. Dubofsky and Groth (1984) and Cooper, Groth and Avera (1985) find that the highest liquidity exists for Nasdaq stocks. Chan and Lakonishok (1997) show that the cost of trading in small firms is lower on Nasdaq, while the NYSE provides better execution for larger firms.

[2] Neal (1992) compares the bid-ask spread for options on AMEX, which operate a specialist structure and the Chicago Board of Exchange (CBOE), which operate a competitive market maker structure. He finds that when trading volume is low, the specialist structure provides more liquidity, although the benefit decreases when trading volume increases.

[3] Nimalendran and Petrella (2003) find that specialist intervention improves liquidity for the most illiquid stocks on the Italian Stock Exchange.

While these studies are comparing liquidity across exchanges, the exact nature of the comparison is unclear. Nasdaq is a 'competitive' dealer market, employing several market makers for each security. The NYSE, however, is ambiguous. Brock and Kleidon (1992) describe specialists on the NYSE as monopolistic market makers. Huang and Stoll (1996) describe the NYSE as an auction market that employs a specialist for each security. Affleck-Graves, Hedge and Miller (1994, p1473) describe the specialist as "enjoying an exclusive franchise to make a market in a listed stock and to manage the book of public limit orders". The adoption of a limit order book to provide additional liquidity is considered as competition to the specialist (Glosten, 1994). Overall, the exact nature of trading on the NYSE cannot be classified as a single, definitive market structure.

Demsetz (1997) argues that the limit order book alongside the specialist makes comparisons using the NYSE difficult. In particular, 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. This is confirmed by Kavajecz (1999) who finds that public limit orders are represented in about 64 percent of NYSE specialists' quotes, and Ross, Shapiro and Smith (1996) who report that limit orders account for 65 percent of all executed orders. This, as Demsetz (1997, p92) clearly states, "… must yield an average NYSE spread that, for similar stocks, is smaller than on the Nasdaq". Thus comparing bid-ask spreads on the NYSE and Nasdaq can be misleading as spreads on the NYSE do not accurately represent the costs of making a market.

This hybrid nature of trading on the NYSE makes comparing liquidity across dealer and specialist markets ambiguous. For the second essay, I have access to a dataset that allows an accurate comparison between two market structures. On 2 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 or her own inventory, or to post them in a limit order book which *they* control.

In addition to this 'clean' experimental design, I directly test for the advantages of a specialist market over an auction market. The majority of stock exchanges worldwide are organized as auction markets. Glosten (1994) proposes that traders will benefit from a completely open electronic limit order book. This is an indirect claim that an order-driven auction system is more advantageous to market participants compared to the specialist market currently used by the NYSE. Examining the benefits (or costs) of moving between the most commonly used market structure and a specialist market is of immediate practical importance. Finally, over the transition period, a third market segment on the Italian Bourse continued trading as normal. I am thus able to ascertain the exact impact on liquidity of relocating from an auction market to a specialist market, while controlling for overall market changes with the third market segment.

1.4 The Intraday Behavior of Bid-Ask Spreads Across Auction and Specialist Market Structures

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 wider at the open and close of trading, whilst they are tighter 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 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, and fund managers concentration of trading near the close, a market maker can discriminate during these periods by charging higher prices. Their model thus predicts 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), Admati and Pfleiderer (1988), Foster and Viswanathan (1990, 1994) and Madhavan (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 behavior 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 behavior.

For the final essay, I have access to a dataset that allows an accurate comparison between two market structures. On 2 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 or her own inventory, or to post them in a limit order book which they control. 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, I also directly test for how specialists use their market power throughout the trading day.

1.5 Summary

The three essays in this dissertation provide evidence regarding the behavior of bid-ask spreads on the Italian Bourse. This chapter motivates each essay by illustrating the importance of this evidence to both academics and practitioners faced with a litany of inconclusive literature in an area of ever growing importance.

The remainder of this dissertation is organized as follows. In Chapter 2, prior literature pertaining to the measurement and behavior of bid-ask spreads for various stock exchanges worldwide is reviewed. Also included is a thorough discussion on the evolution of the Italian Bourse, especially the transition from an auction market to a specialist market for several stocks. Chapters 3, 4 and 5 present the three essays discussed in this chapter. Each essay contains sections describing the data and sample, research design, empirical results, additional tests and conclusions reached. Chapter 6 concludes by highlighting how the evidence presented in this dissertation can be used by academics and practitioners to help understand bid-ask spreads under various market structures.

Chapter 2: Literature Review

Worldwide exchanges trading equity securities follow sets of rules which regulate how orders are submitted, who handles and processes these orders, and ultimately how prices are set (O'Hara, 1995). The differing organization of trading directly influences the provision of liquidity to market participants. Individual and institutional investors both prefer liquid markets that offer low trading costs and can absorb large orders without severe price penalties. It is this liquidity provision that has been central to much interest from both academics and market regulators.

Specifically, the main objective of this dissertation is to examine the magnitude and behavior of specialist intervention with regards to liquidity on the Italian Bourse. This chapter provides an extensive review of the literature pertaining to specialist, dealer and auction market structures. However, the wide-ranging literature almost always compares a specialist market with a dealer market (i.e. NYSE versus Nasdaq). The comparison of pure specialist markets with pure auction markets is effectively non-existent. This dissertation is thus the first direct comparison of specialist markets with an auction market structure to determine which offers optimal liquidity on the Italian Bourse.

The remainder of this chapter is structured as follows. Section 2.1 outlines empirical research focused on bid-ask spreads surrounding earnings announcements. Section 2.2 presents a thorough review of literature, but with a tighter focus on particular bid-ask spreads issues. Section 2.2.1 adopts an international perspective, describing how spreads vary across markets. Section 2.2.2 details previous studies which have focused on the intraday analysis of the bid-ask spread pattern. Section 2.3 presents a thorough account of the institutional detail on the Italian Bourse. It commences with the market structure prior to the 2001 structural changes. Details of the structural change, and thus the new trading specifications, are then discussed. Section 2.4 summarizes this chapter.

2.1 Earnings Announcements

The bid-ask spread surrounding earnings announcements is used as a proxy for analyzing the information asymmetry in an auction market. Spreads are commonly considered a proxy for information asymmetry (Glosten and Milgrom, 1985), with increased spreads surrounding earnings announcements consistent with an increase in information asymmetry. Most studies find no evidence of significant changes in bid-ask spreads surrounding earnings announcements, despite evidence that the adverse selection component of the spread widens significantly surrounding these announcements (see Morse and Ushman, 1983; Venkatesh and Chiang, 1986; Lee, Mucklow and Ready, 1993;

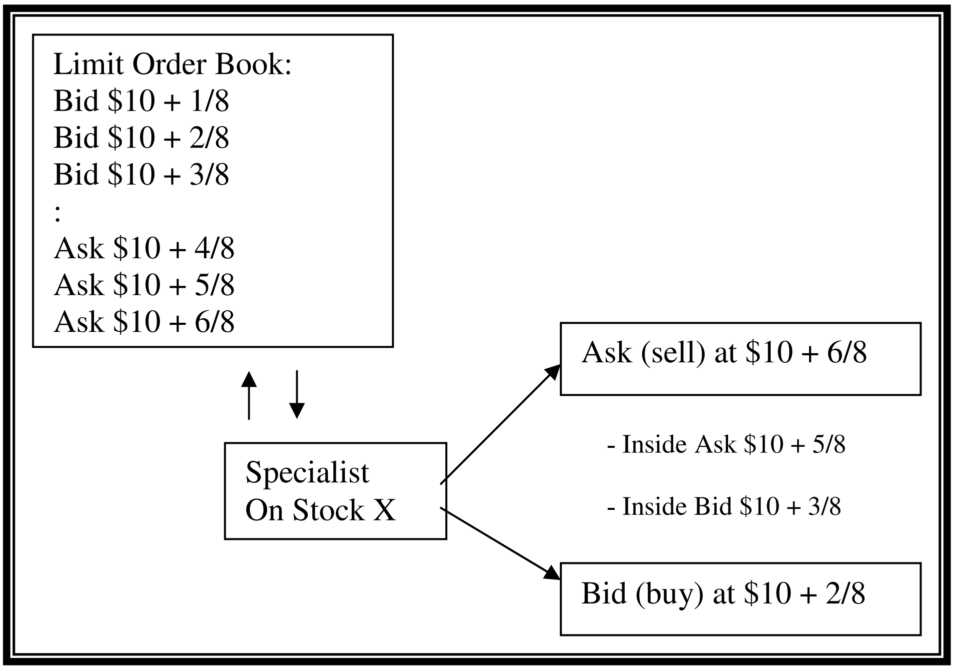
Brooks, 1994; Krinsky and Lee, 1996; Affleck-Graves, Callahan and Chipalkatti, 2002). The inconclusive evidence from prior studies is unsurprising given the focus on spreads posted by dealers on the NYSE and Nasdaq.

McInish and Wood (1995) analyze hidden limit orders on the NYSE. According to the US Securities and Exchange Commission (SEC) policy and rules, it is necessary to display the best bid and ask, but in contrast the specialist has significant freedom to set the price (NYSE Rule 60, 1991). Hasbrouck and Sosebee (1992) observe that quotes posted from specialists are representative, and there is not any mechanism that shows these quotes automatically and in real time.

Stemming from this is the notion of 'price improvement', which occurs when a market order is executed at the detriment of a hidden limit order (Figure 2-1). However, this improvement is just illusory if it is measured in relation to the best quoted bid and ask, and not relative to the inside bid-ask spread (i.e. the effective spread).

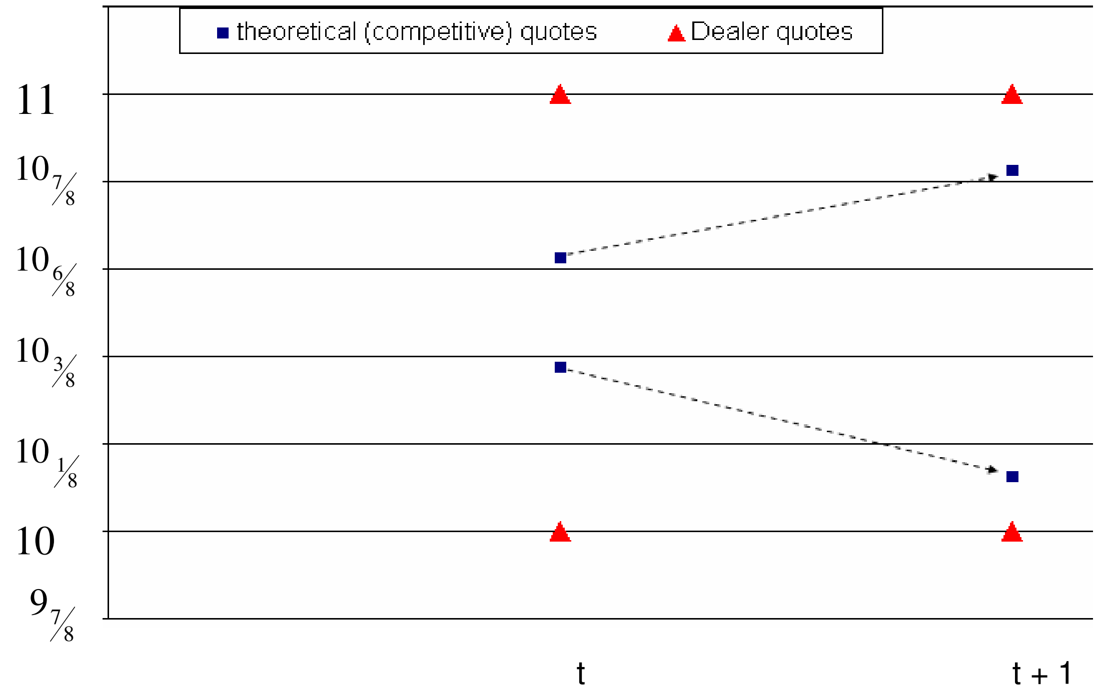
Analyzing a sample of stocks from TORQ (NYSE), McInish and Wood (1995) distinguish hidden orders from shown orders on the basis of posting and execution times. The descriptive statistics reveal large frequencies of hidden limit orders, representing those orders at a price inside the current best bid and ask that will not be displayed to the market (creating disadvantages to investors).

Figure 2-1
Price-Improvement of a Hidden Limit Order for a NYSE Stock



Dealer spreads are widely known to reflect order processing and inventory holding costs (transitory components) as well as adverse selection costs (which derive from information asymmetry, and are considered a permanent component). Nasdaq is a dealer market, where the absence of a limit order book and the presence of several dealers for a single stock creates high competition. The results show a tacit collusion between dealers who compete on Nasdaq to post even-eighth quotes, but avoid odd-eighth quotes. Christie and Schultz (1994) show that 70 percent of the Nasdaq sample exhibit an absence of odd-eighth quotes. Misuse of market power by dealers – for example by avoiding odd-eighth quotes – has been shown to artificially inflate posted spreads (see also Harris, 1991). Therefore, dealer spreads could be contaminated by the market power (and anti-competitive behavior) of dealers.

Figure 2-2
Possible Clouding Effect for Competitive Quotes



Analyzing Figure 2-2, a dealer posts the best bid and ask for a generic stock at time *t*. At the same time he or she does not show the competitive inside bid and ask (true values), which has a tighter spread than the one posted. Suppose that in *t*+1, the dealer posts the same bid and ask, and the market volatility increases due to the release of price-sensitive information, implying an increase of the inside spread. This effect is not likely to be captured from the quote data used in previous studies.

Studies examining the components of the bid-ask spread mitigate this problem by focusing on the adverse selection component. However, doubt remains as to the accuracy of spread decomposition methods (see Van Ness, Van Ness and Warr, 2001). After the Christie and Schultz (1994) study, Nasdaq dealers changed their behavior, frequently adopting odd-eight quotes. (The paper was published on 24 May, 1994 and on 26 / 27 May, 1994; the number of dealers posting quotes solely in even-eights declined rapidly).

Currently the Nasdaq quote system is in sixteenth. As of January 2002, Nasdaq adopted the Supermontage system. The structure proposed in Supermontage divides the order book into separate classes, and establishes price over time priority, thus threatening the ability of new entrants to compete. For example, as in Figure 2-3(a), an ECN (similar to an electronic limit order book), charged an access fee, enters an order in PDLI that betters the NBBO (National Best Bid and Offer). A market maker then enters a similarly priced order, as in Figure 2-3(b).

Figure 2-3(a)
Example of a Limit Order Book

Stock	Bid	Ask
PDLI	92	92-1/2
ECN1	92	95
MM1	91-1/2	93
MM2	91-1/2	93
ECN2	90	92-1/2

Figure 2-3(b)
Example of a Market Maker Posting Bids and Asks

Stock	Bid	Ask
PDLI	92	92-1/2
MM1	92	93-1/2
ECN1	92	95

Under the Supermontage algorithm, the market makers' order takes precedence (going to the top of the order book). This structure establishes prima facie that Nasdaq market makers are granted a right of first refusal in competition with ECNs and other markets.

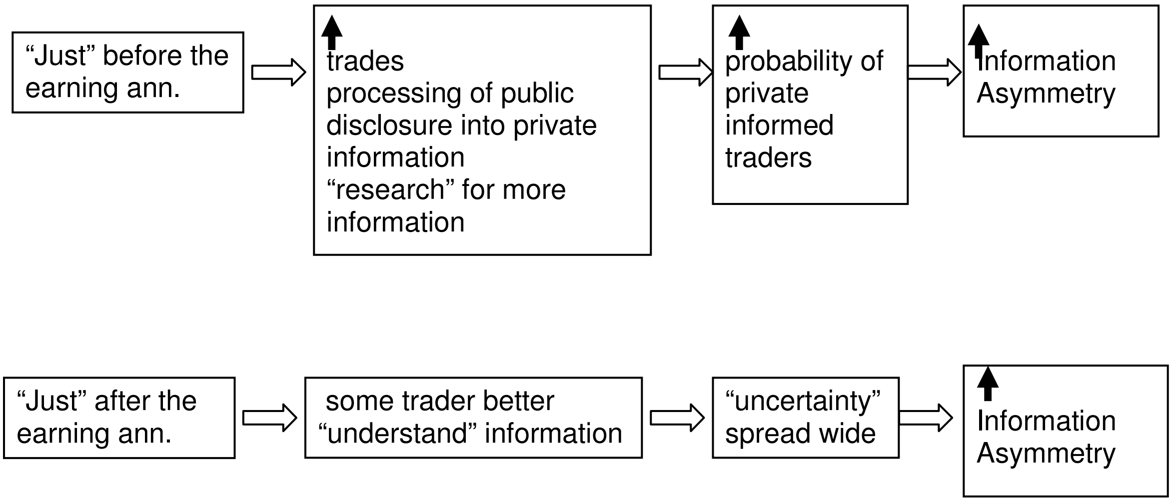
Further, the study of market reaction surrounding earnings announcements raises questions concerning information asymmetry and the relationship between private and public information in securities markets. Morse and Ushman (1983) and Bushman, Dutta, Hughes and Indjejikian (1997) support the "substitute" hypothesis where public announcements discourage private information gathering. Earnings announcements could coincide with lower information asymmetry, implying an increase in market liquidity surrounding the price-sensitive information. The decrease of liquidity in the market due to the presence of discretionary liquidity traders does not necessarily indicate evidence of price-sensitive information, creating more private information (i.e. more information asymmetry). However, some investors can quickly process public information, increasing the level of private information. This results in private and public information being complementary, increasing information asymmetry surrounding earnings announcements (see Indjejikian, 1991; Harris and Raviv, 1993).

Kim and Verrecchia (1994) argue that some market participants process earnings announcements into private information about a firm's performance. These traders are capable of informed judgments from public sources and can be thought of as market experts. Through their activities, information is quickly impounded into prices. Alternatively, an earnings release motivates informed judgments, creating or aggravating information asymmetry between traders and market makers. This implies a decline in liquidity as a direct consequence of increased disclosure. However, less liquidity does not necessarily result in decreased trading activity around earning announcements. This is depicted in Figure 2-4.

Direct analysis of market reactions surrounding earnings announcements has been studied extensively in the finance literature. Empirical tests, pioneered by Ball and Brown (1968), introduced the event study methodology for analyzing abnormal returns. They report significant abnormal returns around earnings surprises. Early studies also report abnormal trading volume surrounding earnings announcements (Beaver, 1968; Kiger, 1972; Morse, 1981). More recent empirical work has confirmed that the market reactions documented are robust to firm size and systematic risk (Ball and Kothari, 1991; Chopra, Lakonishok and Ritter, 1992). These findings suggest that earnings announcements have information content which is impounded into stock prices when information is released publicly. Information in earnings reports is also impounded before public announcements, suggesting the existence of privately informed traders.

Figure 2-4
Information Asymmetry Around Earning Announcements

To prevent the temporary information advantage held by processors of public information, market makers increase spreads, causing a decline in liquidity.



With the availability of quote data, a number of empirical studies have focused on bid-ask spreads as a proxy of information asymmetry. Morse and Ushman (1983) report no significant increase in spreads for over-the-counter securities surrounding earnings announcements. Venkatesh and Chiang (1986) corroborate this for NYSE securities, finding no evidence of an increase in spreads surrounding regular earnings announcements. However, Lee, Mucklow and Ready (1993) find evidence to the contrary using intraday data, reporting that spreads increase significantly surrounding earnings announcements.

Further examination of the issue through the study of bid-ask spread components provides some explanation. Brooks (1994), Krinsky and Lee (1996) and Affleck-Graves, Callahan and Chipalkatti (2002) all report significant increases in the asymmetric information component of spreads surrounding announcements. Krinsky and Lee (1996) also report significantly reduced inventory holding and order processing components, potentially explaining the insignificant reaction in posted spreads despite increased information asymmetry.

Based on this, two specific hypotheses will be tested in the first essay of this dissertation. Although most studies have documented no significant increase in bid-ask spreads surrounding earnings announcements, this could be driven by a myriad of factors including anti-competitive dealer behavior on Nasdaq, or the interaction between the specialist and the limit order book on the NYSE. The Blue Chip stocks on the Italian Bourse trade in a pure order-driven environment, absent of confounding factors. If spreads widen around earnings announcements, I will be able to detect this using a 'clean' experimental market. Thus the first hypothesis ($H_{3,1}$) conjectures that bid-ask spreads will be significantly wider surrounding earnings announcements on the Italian Bourse.

Hypothesis$_{3,1}$: Bid-ask spreads will be significantly wider surrounding earnings announcements for Blue Chip stocks on the Italian Bourse.

Extending the idea of wider spreads surrounding earnings announcements, the increase in information asymmetry is also likely to cause an increase in trading activity and thus volatility. The second hypothesis ($H_{3,2}$) thus conjectures that both volume and volatility will be significantly higher surrounding earnings announcements.

Hypothesis$_{3,2}$: Both volume and volatility will be significantly higher surrounding earnings announcements for Blue Chip stocks on the Italian Bourse.

2.2 Bid-Ask Spreads

While the previous section deals with bid-ask spreads surrounding earnings announcements, this section documents the extensive literature pertaining to bid-ask spreads both across markets and across the trading day. Section 2.2.1 addresses the variation in bid-ask spreads caused by a change in market structure. Section 2.2.2 documents the many studies which analyze the intraday pattern of bid-ask spreads.

2.2.1 Bid-Ask Spreads across Varying Market Structures

Previous studies have tested whether structurally-induced reductions in trading costs emerge when firms relocate from dealer markets to specialist markets. Generally, these studies rely on transaction data to document the liquidity gains that are realized immediately after firms begin trading on the new exchange.

Reinganum (1990) was one of the first to study the contrast between multiple-dealership markets, such as Nasdaq, and monopolistic specialist systems, such as the NYSE. He finds that the former has a liquidity advantage over the latter for small firms, but the advantage is reversed for large companies. Neal (1992) compares the costs of transacting in equity options between the AMEX specialist system and the CBOE competitive dealer system. He suggests that the AMEX specialist structure has lower transaction costs for low-volume options. This difference declines as liquidity increases.

Biais (1993) examines the difference between centralized and fragmented markets, where risk-averse agents compete for market orders. In centralized markets, these agents are specialists who compete against a limit order book, while in fragmented markets they are dealers competing against each other. The results show that the number of dealers increases with the frequency of trades and volatility. The spread is not significantly different in both markets, although the spread is more volatile in centralized rather than fragmented markets.

Christie and Huang (1994) analyze firms that switched from Nasdaq to either the NYSE or AMEX. They provide evidence of structurally induced changes in trading costs for firms that elect to move from the dealer market to a specialist system. The bid-ask spread declines significantly when securities move from Nasdaq to the NYSE / Amex. Affleck-Graves, Hedge and Miller (1994) document that the NYSE trading system lowers order processing costs, but is characterized by higher inventory holding costs as the specialist faces a larger cost of absorbing a given order imbalance. Pagano and Roell (1996) focus on the degree of transparency as the main difference between trading mechanisms. They confirm the finding that uninformed traders' transaction costs are higher in a dealer market than under an auction system.

Barclay (1997) also analyzed a sample of stocks that moved from Nasdaq to the NYSE / AMEX. While trading on Nasdaq, stocks for which dealers avoided odd-eight quotes have wider spreads than the stocks for which dealers use both odd and even eights. If Nasdaq spreads are competitive, then stocks for which dealers avoid odd-eight quotes should continue to have larger spreads when they move to the NYSE / Amex. His results indicate that effective bid-ask spreads decline with the move to the NYSE / Amex. He attributes this to either structural differences between the markets, or to differences in the behavior of the participants in the markets, and not to differences in the individual securities.

Bessembinder and Kaufman (1997) compare execution costs for NYSE and Nasdaq listed stocks. The Nasdaq market leaves dealers more vulnerable to losses incurred in trades with better informed investors. As such, quoted and effective spreads could be greater on Nasdaq to allow dealers to recover this large economic cost of market making. This possibility can be evaluated by decomposing effective half-spreads into two components: price impact and realized half-spreads. The price impact measures a trade's average information content, which comprises a market-making cost in the form of losses to better informed traders. Realized spreads measure average price reversals after trades and market-making revenue net of information costs, confirming that execution costs are, on average, greater for trades in Nasdaq issues compared to the matched NYSE issues.

Theissen (2000) reports results of several experiments that were conducted to compare continuous auction and dealer markets. Transaction prices in the auction market were found to be more efficient than prices in the dealer system. Bagliano, Brandolini and Dalmazzo (2000) analyze the co-existence of two markets for the same stocks; a quote-driven market (dealer) and an order-driven market (auction), on the London SEAQ International. The model proposed shows that investors who desire to trade in large quantities will prefer dealer markets. Trades of smaller size will be executed at lower cost in an auction market.

Recently, Nimalendran and Petrella (2003) find that specialist intervention improves liquidity for the most illiquid stocks on the Italian Stock Exchange, contrasting previous studies that show spreads are generally tighter in continuous auction markets (e.g. Lee, 1993; Christie and Huang, 1994; de Jong, Nijman and Roell, 1995; Pagano and Roell, 1996; Huang and Stoll, 1996; Keim and Madhavan, 1996; Bessembinder and Kaufman, 1997). Barclay, Christie, Harris, Kendal and Schultz (1999) and Bessembinder (1999) document that spreads on Nasdaq have fallen since the introduction of competition from limit orders in 1997. However, trade execution costs remain larger than those on the NYSE (Bessembinder, 1999).

While these studies are comparing liquidity across exchanges, the exact nature of the comparison is unclear. Nasdaq is a 'competitive' dealer market, employing several market makers for each security. The NYSE, however, is ambiguous. Brock and Kleidon (1992) describe specialists on the NYSE as monopolistic market makers. Huang and Stoll (1996) describe the NYSE as an auction market that employs a specialist for each security. Affleck-Graves, Hedge and Miller (1994, p1473) describe the specialist as "enjoying an exclusive franchise to make a market in a listed stock and to manage the book of public limit orders". The adoption of a limit order book to provide additional liquidity is considered as competition to the specialist (Glosten, 1994). Overall, the exact nature of trading on the NYSE cannot be classified as a single, definitive market structure.

An important caveat from Demsetz (1997) is the direct customer to customer interaction through limit orders. This interaction can obscure the link between observed bid-ask spreads and the costs of market making. Under this argument, bid-ask quotes on the NYSE may simply reflect the supply and demand conditions of investors rather than the inventory, order processing and adverse-selection costs of professional market makers.

This argument is important because if bid-ask spreads on NYSE / Amex bear no relation to the costs of market making, then comparing bid-ask spreads on Nasdaq with bid-ask spreads on the NYSE / Amex could provide misleading inferences about the competitiveness of Nasdaq bid-ask spreads. Thus comparing bid-ask spreads on the NYSE and Nasdaq can be misleading as spreads on the NYSE do not accurately represent the costs of making a market.

Based on this, two hypotheses are developed which will be subsequently tested in the second essay of this dissertation. While most studies document a reduction in spreads when stocks move from a dealer market (Nasdaq), to a specialist or hybrid market (NYSE), this hybrid nature of trading on the NYSE makes comparing liquidity across dealer and specialist markets ambiguous. As stocks on the Italian Bourse moved from a pure order-driven auction market to a specialist market, a clean test of specialist intervention on bid-ask spreads is possible. The first hypothesis ($H_{4,1}$) thus conjectures that bid-ask spreads will be tighter under a specialist market structure.

Hypothesis$_{4,1}$ *: Bid-ask spreads will be tighter after stocks switch from an auction market to a specialist market on the Italian Bourse.*

Directly leading from this first hypothesis, if bid-ask spreads are tighter after the switch to a specialist market, then trading activity is also likely to increase with the specialist. The second hypothesis ($H_{4,2}$) thus conjectures that trading activity will increase under a specialist market structure.

Hypothesis$_{4,2}$ *: Trading activity will increase after stocks switch from an auction market to a specialist market on the Italian Bourse.*

2.2.2 Intraday Analysis of Bid-Ask Spreads

One of the first papers in the area is Amihud and Mendelson (1980). The main issue addressed regarding intraday spreads is the impact of the market maker (especially if the market maker is a monopolist). The market maker's activity can be characterized as a stochastic flow of market buy and sell orders whose mean rate per unit of time is price-dependent. The specialist must pursue a policy of relating prices to inventories to avoid losses. This inventory-dependent policy is the main issue of the paper, and the analysis is dependant on the quoted bid and ask prices of the market maker. Price is a monotonically decreasing function of inventory, with a positive spread resulting.

Furthermore, the explicit behavior of the bid-ask spread with volume can be interpreted as a function of the inventory position, proving that the optimal pricing policy is consistent with the efficient market hypothesis (it is impossible to consistently profit by speculating in the market, except if the market maker is a monopolist). Market makers face two types of traders: liquidity traders and "insider" traders (with superior information). Market makers gain with the former and lose with the latter, and the tradeoff between the two determines the spread (Amihud and Mendelson, 1980).

A dealer's price adjustment depends largely on inventory. When inventory increases, both bid and ask prices decline. In an inactive stock, when the dealer is required to trade a minimum amount, the expected profit from trading may not be enough to offset the risk (Ho and Stoll, 1981). Given the behavior of liquidity and informed traders, dealers are required to offer an "out of the money" straddle option for a fixed number of shares in a fixed time period. The exercise price of the straddle determines the bid-ask spread. The dealers achieve profit maximizing spreads by balancing the expected total revenues from liquidity traders against the expected total losses from informed traders. A monopolistic dealer will establish a wider bid-ask spread than will perfectly competitive dealers.

Easley and O'Hara (1987) show that large trades are made at worse prices than small trades. Even if markets are efficient, trade size and quantity affect price. Possible explanations include the inventory imbalance resulting from block transactions. Because large trades force market makers away from their preferred inventory positions, prices for these transactions must compensate specialists for bearing this inventory risk. The problem, however, is in analyzing the price-quantity relation. Quantity affects spreads as it is correlated with private information about securities' true value. An adverse selection problem arises given that as they wish to trade, informed traders prefer to trade larger amounts at any given price. Since uninformed traders do not share this quantity bias, the larger the trade size, the more likely it is that the market maker is trading with an informed trader.

Easley and O'Hara (1987) also argue that the possibility of information-based trading can induce a spread between bid and ask quotes, compensating the market maker for the risk of doing business with informed traders who have superior information. Here traders always prefer to trade larger quantities. Although the market maker faces uncertainty about whether an individual trader is informed, there is also the uncertainty about whether any new information exists. The latter uncertainty dictates that both the size and sequence of trades influence the price-quantity relation. Whereas the first effect causes prices to worsen for a block trade, the second effect causes the partial price recovery that characterizes most block trading sequences. Information alone can explain the price behavior of block trades, without appealing to inventory adjustment costs.

Several studies show that both variance of price changes and the volatility of returns follow a U-shaped intraday pattern. Admati and Pfleiderer (1988) develop a model in which traders determine when to trade. Information and liquidity are the determinants of the model developed in the paper. Informed traders trade on the basis of the level of private information that is unknown to all other traders when the trade takes place. Liquidity traders, on the other hand, trade for reasons that are not directly related to the future payoffs of financial instruments.

Most models that involve liquidity trading (i.e. noise trading) assume that liquidity traders have no discretion with regard to the timing of their trades. Admati and Pfleiderer (1988) develop a more reasonable assumption that at least some liquidity traders can choose the timing of their trading strategically, especially when the market is thick. Thus, the introduction of 'more informed' liquidity traders generally intensifies the forces leading to the concentration of trading by discretionary liquidity traders. The interaction between liquidity and informed traders leads to a pronounced pattern of trading over time. However, if private signals are weakly correlated, then competition among informed traders can actually worsen the terms of the trade. An interesting finding made by Admati and Pfleiderer (1988) is the wider spreads caused by heavier trading at the beginning and end of the trading day, compared to the middle of the day.

The adverse selection component of the spread is also supported by Foster and Viswanathan (1990). Their paper analyzes this component for the inter-temporal behavior of trading volume, trading costs and price volatility, in relation to the information advantage held by informed traders in different periods. As prices contain important information for uninformed traders, informed traders have the important advantage when the market first opens. The longer the market is closed, the more significant is the advantage (i.e. on Mondays). This environment incorporates a single informed trader, a competitive market maker and a group of liquidity traders.

In the first instance, Foster and Viswanathan (1990) consider an individual with monopolistic access to information and show that, without public revelation, it is optimal for the individual to trade in such a way that the market depth (or the market maker's price response to new orders) is the same, and that prices are equally informative each day. When private information is to be publicly released at a later date, the informed individual must transact more intensely, causing the private information to be released more quickly.

Secondly, Foster and Viswanathan (1990) consider the effect of giving some liquidity traders discretion to delay their trades for one day without cost, so that they can avoid trading when the adverse selection problem is most severe. Without public information, informed traders act so as to keep constant the trading costs of these discretionary liquidity traders, rendering their delaying tactics futile. However, when some information is publicly released, the informed trader's optimal strategy no longer equalizes the costs of trading for the liquidity traders throughout the week. For example, there are higher trading costs and lower volume on Monday relative to Tuesday.

Easley and O'Hara (1992) analyze the stochastic process of prices. In many models, the timing of trades is irrelevant as stock prices have no information. This specification makes sense if time is exogenous to the price process. But if time can be correlated to any factor related to the value of the asset, then the presence or absence of trading may provide information to market participants. The authors show that traders learn from both trades and the lack of trades, because each could be correlated with different aspects of information. While trades provide evidence of the direction of any new information, the lack of trading still can signal the existence of new information. Spreads depend on the time between trades, encouraging spreads to decrease as time increases, and inducing a bias to the transaction price estimation.

Easley and O'Hara (1992) thus conclude that time affects prices. If two sell transactions occur contiguously in time rather than an hour apart, they can have very different information content. During the interval between trades, market makers can revise their beliefs about the value of the asset without it being reflected in trade prices. As prices depend on time, spreads are also time dependant. As the time between trades increases, bid-ask spreads generally decrease.

Several other studies model the response of bid and ask quotes to the changes in demand for transaction services. Under mild conditions, increased transaction demand at the open and close of trading will result in increased volume and wider bid-ask spreads, assuming a monopolistic market maker (Brock and Kleidon, 1992). Foster and Viswanathan (1994) are interested in how the existence of pivotal traders affect price determination in a market. Better informed traders realize that their actions are being followed closely, so they could alter their trading strategy (and trade away from the open and close) to keep their information from being revealed through trading too quickly.

Most models of strategic trading fail to account for this learning among informed traders, and focus only on how market makers learn from the order flow. While this may be appropriate for some markets, Foster and Viswanathan's (1994) model sheds some light on the complex, strategic interaction that occurs in markets such as the commodity future markets. They find intense trading by all informed traders on their common information in the early periods, and greater trading by the better informed traders (based on additional information) later in the trading day.

While the above studies are generally theoretical in nature, there is substantial empirical research motivated by the growing interest in the price formation process. Ho and Macris (1984) argues that while equilibrium returns follow a Brownian motion, transaction prices could be determined by the dealer's quotes relative to the equilibrium prices. They find that a dealer's percentage spread is positively related to the asset risk, and is larger than the percentage reservation spread. Dealers also adjust quotes in response to changes in inventory positions. Specifically, dealers will lower both bid and ask quotes when they have accumulated positive inventory; conversely dealers raise both bid and ask quotes when their inventory level is lower than optimal. Overall, percentage spreads depend on the risk of a security.

McInish, Ord and Wood's (1985) empirical analysis relies on minute by minute transaction data. A profile of the typical trading pattern throughout the day is obtained by averaging across trading days within each trading minute. The patterns indicate possible non-stationarity in the data, raising the issue of how the autocorrelation function varies over the trading day. Specifically, differences in return distribution are found across trading occurring over-night, during the first thirty minutes of the trading day, at the market close, and during the remainder of the day. The majority of positive returns are earned during the first thirty minutes of the trading day, and at the market close. Outside this range, market returns are found to be normally distributed, with the autocorrelation substantially reduced.

Hasbrouck (1988) attempts to address problems in previous studies. He presents an empirical framework which includes the simultaneous existence of inventory control and asymmetric-information effects. Using a sample of stocks from the NYSE, he finds that trades for low volume stocks exhibit the negative autocorrelation consistent with inventory-control effects. No such pattern, however, characterizes high-volume stocks. This is perhaps a consequence of the relatively greater importance for these stocks of public limit orders, and the relatively lesser importance of specialist transactions. For all stocks the persistent impact of trades on quote revisions is strongly positive. This is consistent with an information effect. He also finds that for high-volume stocks, a persistent order-size effect on quote-revisions exists. This is consistent with the view that large orders convey more information.

McInish and Wood (1992) examine both the intraday behavior and the determinants of time weighted percentage bid-ask spreads across a sample of NYSE stocks in 1989. On a minute by minute basis, spreads are shown to have a crude reverse J-pattern. While previous studies argue that the bid-ask spread is determined by activity, risk, information and competition, their research extends previous studies by using data for 13 intervals of the trading day. Specifically, the authors control for trade frequency, trade size, volatility, the stock price, regional dealer exchange ratio and dummy variables for inter- and intra- day effects.

The evidence garnered from their inter- and intra- day analysis shows that fixed trading costs exhibit minimal variation. However, the adverse selection component of the spread varies within the day, and across days. Adverse selection costs are highest in the first hour of trading, fall during the middle of the trading day, and then increase towards the close of trading. Adverse selection costs are generally higher on Monday than other days. Intraday trading volume is high when returns are most volatile.

In a vigorous competitive market such as the CBOE, George and Longstaff (1993) examine the relation between bid-ask spreads and the determinants of the cost of market making, as well as the relation between trading activity and bid-ask spreads. Determinants of market-making costs explain almost 70 percent of the cross-sectional variation in bid-ask spreads. Approximately 50 percent of the cross-sectional variation in trading activity is explained by bid-ask spreads and features of the option contract (maturity and proximity to in-the-money). Regression results suggest that the bid-ask spread is positively related to the option's time to maturity and its price, and negatively related to its delta and the level of trading activity. The institutional features of the trading mechanism affect the cost imposed by the market maker, who is bearing unsystematic risk associated with inventory positions.

Similar to Hasbrouck (1988), Madhavan and Smidt (1993) develop a model that incorporates the effect of both asymmetric information and inventory control, where the dynamic strategic behavior of a market maker and a representative informed trader are explicitly characterized. In their model, the market maker acts as both a dealer who provides liquidity on demand and an active investor, trading for their own account. The market maker's long-run optimal inventory is endogenously chosen, and is periodically revised due to changes in the risk profile of the underlying stock. The market maker's trades also reflect short-run speculative demands based on information of the impending order flow.

Empirical findings show mean reversion in inventory, assuming the specialist's desired stock holding is constant. It takes over 49 trading days, on average, for an inventory imbalance to be reduced by 50 percent. This slow adjustment is consistent with the weak inventory effects using intraday data. Further, the model predicts that quote revisions are inversely correlated to specialists' trades and positively related to the information content of the order flow. Interestingly, the non-block (unanticipated order imbalance) portion of order flow appears to have information content. The specialist's quotes anticipate future order imbalances, a result consistent with the specialist receiving information about the impending order flow (through leakage in the upstairs market).

Hasbrouck and Sofianos (1993) examine a comprehensive sample of quote, trade and inventory holdings for NYSE specialists. The most salient univariate characteristic of specialist holdings is the long persistence of deviations from mean values. If the mean is taken as a good estimate for the time-invariant optimum target level, this finding suggests that the conventional inventory control mechanisms operate with adjustment lags of days or weeks. The paper provides evidence that specialists are capable of rapidly adjusting their position. Moreover, the authors find no evidence that specialists react slowly to inventory shocks because they are hedged with offsetting positions in other stocks. Thus, specialists adjust inventory levels toward time-varying targets.

They also find that most of the specialists' profits arise from the bid-ask spread. When specialists' trades are assumed to take place at the midpoint of the prevailing quotes, the implied profits are sharply reduced. The presence of small positive components in the quote midpoint profits over the short and medium terms (under 100 transactions) does suggest, however, that specialists are able to anticipate price reversals over these horizons (although long term estimation is very difficult). Finally, analysis turns to dynamic modeling of the interaction among quotes, trades and inventories. Shocks to inventories lead (at least) to transient effects on quotes. The impact of a trade is higher if the specialist is the counterparty to the trade, as the specialist is obligated to participate in trades during times of high informational asymmetries.

A study by Chan, Christie and Schultz (1995) examines the intraday pattern of bid-ask spreads for a sample of Nasdaq stocks. Spreads are relatively stable throughout the day, but narrow significantly near the close, contrasting the U-shaped intraday pattern for NYSE stocks. The difference is attributed to the difference between specialist and dealer market structures. The wider spread at both the open and close on the NYSE may reflect the market power of the specialist. The decline in spreads near the close for Nasdaq stocks is consistent with inventory control by individual dealers.

Chan, Chung and Johnson (1995) study the intraday behavior of spreads for high liquidity CBOE options and their underlying stocks. They confirm the U-shaped spread pattern for stocks. However, the options display a very different intraday pattern, which declines sharply after the open and then levels off. This confirms that both the degree of competition in market making, and the extent of informed trading, are important for understanding the intraday behavior of spreads.

On the basis of this literature, two hypotheses are developed, which will be tested in the final essay of this dissertation. Most studies using NYSE data have found that volume, volatility and bid-ask spreads exhibit a U-shaped intraday pattern. As discussed previously, trading on the NYSE consists of both a specialist and a limit order book (i.e. an auction market). Several stocks on the Italian Bourse switched from an auction market to a specialist market. The first hypothesis ($H_{5,1}$) thus conjectures that the U-shaped intraday pattern in volume, volatility and bid-ask spreads will exist both before and after the structural change.

Hypothesis$_{5,1}$ *: Volume, volatility and bid-ask spreads will exhibit the classical U-shaped intraday pattern both in an auction market before the structural change, and in a specialist market after the structural change.*

Following on from this, specialists on the Italian Bourse are effectively monopolists. The market power they possess will allow them to charge higher spreads compared to the auction market, especially towards the start and end of a trading day. The second hypothesis ($H_{5,2}$) thus conjectures that specialists will use their market power to charge higher prices throughout the trading day.

Hypothesis$_{5,2}$ *: Specialist's will use their market power to charge higher prices, compared to the auction market throughout the trading day.*

2.3 Institutional Detail

Initially, the Milan exchange traded securities and commodities, and did not get its first corporate listing, a railroad company, until 1859. Other regional exchanges flourished throughout Italy, which became a unified nation in 1861. Genoa, a major port, was the main Italian financial market in the 19th century, but Milan took the lead after World War I. The fascist regime imposed a tight control on the economy and stifled capital markets. It was not until the 1980s that Italian markets received a boost from the introduction of mutual funds. Milan firmly established itself as the leading Italian market with 99 percent of overall volume, although nine other regional exchanges struggled while the open-outcry system survived. However, broad market reforms ushered in a national computerized order-driven trading system in 1991, and Italy's privatization program in the late 1990's paved the way for modern equity markets.

Since 1991, equity trading on the Italian Bourse has taken place on the Mercato Telematico Azionario (MTA), an electronic trading system which enables brokers to trade all securities in real-time from computer terminals linked to the Italian Bourse. During 2000, important changes were introduced to the operational environment of issuers and intermediaries. These changes encourage the qualitative growth, improve the services offered to market participants and expand access to the Italian market.

The system regarding common stock, before 2 April, 2001, was essentially formed by an order-driven market where ordinary and MIB30 stocks were traded. Two market segments were supported by a specialist: the New Market and the Less Liquid Financial Instruments. The order-driven form of the market offered greater opportunities for market expansion because it guaranteed impartial treatment with regard to operators who can freely enter trading orders. This had positive effects on the competitive level of the market, enhancing the quality of prices, trading volume, and thereby, market liquidity.

The combination of this type of market and the presence of a specialist responsible for supporting liquidity derives from the need to ensure maintenance of a sufficient level of liquidity for stocks which, alongside greater yield potential, imply a higher risk level. These specialists are required to expose all orders until a minimum daily quantity is transacted. However, the specialist has monopolistic powers for institutional block orders, where they can hold the order for five minutes before deciding to either transact the order, or post it in the electronic limit order book (Handbook of World Stock Exchanges, 2001).

The thinly-traded shares project, which became operative on 19 May, 1997, was set the goal of developing the liquidity of less liquid financial instruments. To this end, the Stock Exchange official list was segmented to show shares where intervention was required to increase volume, frequency of trading and significance of price. The reduction in the number of less liquid shares indicates the increase in market liquidity generally, and in particular securities previously characterized as lower liquidity. The intervention to improve the liquidity of thinly-traded stocks included reduced trading hours.

The New Market commenced trading in 1999. It is dedicated to small and medium sized companies with high growth potential. In view of the higher risk associated with these securities, and therefore of the liquidity support function, the specialist enjoys an information monopoly of five minutes during which they have exclusive viewing rights of orders above €50,000.

On 2 April, 2001, the new segmentation of the Electronic Share Market (MTA) came into effect, defined with a view to make the official Stock Exchange market list more representative of the country's economic reality. Based on the capitalization of the main shares, and in order to give full value to small and medium sized stocks, three segments were created. The first, the Blue Chip segment, includes the largest companies with market capitalization in excess of €800 million. For the remaining stocks with market capitalizations below €800 million, the issuer decided to be included in one of two segments: the Star market or the Ordinary (SBO) market.

The Star segment (Segmento Titoli con Alti Requisiti) includes shares of medium-sized companies wishing to maximize the value of their listing on the market by observing more stringent requirements in terms of diffusion of shares, transparency, corporate governance and trading procedures. The additional requisites (beyond market capitalization) ascribe to the companies possessing high qualitative standards, and increasing the image and visibility with institutional investors and the general market.

The Star issuer must appoint a specialist who, for the entire period during which the shares are traded in the segment, undertakes to perform a dual role. The first is to support the shares' liquidity, whilst the second relates to assisting in the diffusion of reliable information about the company. From a liquidity standpoint, the specialist assures his or her presence in the market by displaying continuous bids and asks satisfying some parameters established by the Italian Bourse. These obligations are grouped under three classes and defined in terms of minimum daily quantity; obliging the specialist to remain in the order book, the minimum size of each single order and the maximum spread within which orders must be entered.

Finally, the ordinary segment (SBO) includes the securities of medium and small capitalization companies not wishing to acquire the Star status, although wanting to enjoy the advantage of being listed on the Stock Exchange. The companies belonging to the segment satisfy the requisites for admission and continued inclusion established for Blue Chip companies, however the securities are traded according to procedures and hours that are differentiated by liquidity.

The procedures that companies must follow when releasing earnings information are described in regulations set by the Italian corporate regulator, CONSOB.[4] These regulations provide a framework for the timely release of price-sensitive information to the market. Blue Chip and SBO companies are recommended to transmit price-sensitive information to CONSOB, the Italian Bourse (which reports the announcement through MTA and its web site), and at least two international press agencies. The information release procedure is compulsory for Star listed companies.

From 1 September, 1999 to 2 April, 2001, liquid stocks were continuously traded from 9:30 a.m. to 5:30 p.m., after a pre-opening phase and a validation phase between 8:00 a.m. and 9:30 a.m. Since 2 April, 2001, liquid stocks on the first segment of the SBO market have traded continuously between 11:00 a.m. and 4:25 p.m. Blue-Chip and Star stocks trade continuously from 9:30 a.m. to 5:25 p.m. A closing auction phase was introduced to improve the price formation process during the final phase of the trading session. Through the concentration of buying and selling interests present in the market at the end of the trading session, it is possible to establish a more accurate closing price.

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[4] See CONSOB regulation number 11971/99.

2.4 Summary

This chapter has reviewed previous literature pertaining to bid-ask spreads across various market structures. This dissertation extends the bid-ask spread literature in several ways. The first essay explores the bid-ask spread surrounding earnings announcements for pure order driven markets as described in Section 2.1. The second essay of this dissertation compares bid-ask spreads across auction and specialist market structures, brought about by the structural change implemented by the Italian Bourse, as described in Section 2.2.1. The final essay in this dissertation analyzes the intraday pattern in bid-ask spreads across auction markets, and tests the market power of the specialist across the trading day, as described in Section 2.2.2.

Chapter 3: Bid-Ask Spreads Around Earnings Announcements

3.1 Introduction

This chapter analyzes market reactions surrounding earnings announcements on the Italian Bourse. The literature reviewed in Chapter 2 raises questions concerning information asymmetry and the relationship between private and public information in securities markets. If public announcements discourage private information gathering, earnings announcements could coincide with lower information asymmetry. However, if some investors can acquire private information by processing public announcements, private and public information could be complementary, increasing information asymmetry surrounding earnings announcements.

Based on this, and the literature in Section 2.1, two hypotheses were developed, which will subsequently be tested in this Chapter. The first hypothesis conjectures that bid-ask spreads will increase significantly around earnings announcements. The second hypothesis conjectures that both volume and volatility will be significantly higher surrounding earnings announcements.

The remainder of this chapter is organized as follows. Section 3.2 describes the dataset and subsequent sample used. Section 3.3 sets out the research design and Section 3.4 presents the empirical results. Section 3.5 summarizes the chapter.

3.2 Data and Sample

Since 1991, equity trading on the Italian Bourse has taken place on the Mercato Telematico Azionario (MTA). MTA is an electronic trading system that enables brokers to trade all securities in real-time from computer terminals linked to the Italian Bourse. Similar to other European markets such as Euronext, Deutsche Börse and the London Stock Exchange, the Italian Bourse uses a segmented market structure. Stocks are grouped according to market capitalization, each group using a different trading mechanism within MTA. The Blue Chip segment comprises the largest stocks, with market capitalization greater than €800 million. Mid-cap stocks trade in the Segmento Titoli con Alti Requesti (STAR) segment. Technology stocks trade in the Nuovo Mercato (NM). All other stocks trade in the Ordinary segment (SBO).

This chapter focuses on the stocks in the Blue Chip segment. Blue Chip stocks are traded in a continuous auction from 9:30 a.m. to 5:25 p.m. each trading day, using an open electronic limit order book. Liquidity is supplied by public limit orders without any official market makers. For reasons discussed in Chapter 2, this enables a cleaner test of asymmetric information surrounding earnings announcements. The procedures that companies must follow when releasing earnings information are described in regulations set by the Italian corporate regulator, CONSOB.[5] These regulations provide a framework for the timely release of price-sensitive information to the market. Blue Chip companies must transmit price-sensitive information to CONSOB, the Italian Bourse (which reports the announcement through MTA and its web site), and at least two international press agencies.

Earnings announcement data for this chapter are obtained from the Italian Bourse. The earnings announcement file describes the stock code, announcement date and the announcement type. Announcements are recorded as quarterly, half-yearly or annual. There are 95 stocks in the earnings announcement file, and eight announcements per stock from February 14, 2000 to October 29, 2003, comprising 568 separate announcements.[6] Daily price and volume data for each stock in the earnings announcement file are gathered from Bloomberg. The Bloomberg file describes the last transaction price, last bid quote, last ask quote and daily volume for each stock on each trading day. Data are captured for each stock from 50 trading days prior to the first announcement date (December 2, 1999) to 50 days after the last announcement date (February 19, 2004).

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[5] See CONSOB regulation number 11971/99.

[6] The original sample consisted of 832 separate earnings announcements. Due to missing data, I collected all stocks with 8 earnings announcements (two per year from 2000 to 2003), resulting in a sample size of 568.

A daily time-series is created for each stock on each trading day. The following variables are calculated using the Bloomberg data:

$$BAS_{i,t} = ASK_{i,t} - BID_{i.t}$$

$$PBAS_{i,t} = \frac{BAS_{i.t}}{MIDQUOTE_{i.t}}$$

$$VOLATILITY_{i.t} = \ln\left(\frac{HIGH_{i,t}}{LOW_{i.t}}\right)$$

$$SVOL_{i.t} = \frac{VOLUME_{i,t}}{SHARES_{i}}$$

These variables are defined as follows: $BAS_{i,t}$ is the observed bid-ask spread (in €) for stock *i* on day *t*, measured as the difference between the respective end-of-day ask and bid quotes. $PBAS_{i,t}$ is the proportional bid-ask spread for stock *i* on day *t*. This is defined as $BAS_{i,t}$ divided by the mid-quote $(ASK_{i,t} + BID_{i.t})/2$. The volatility metric used is the log difference between the high price and low price for stock *i* on day *t*. A volume metric referred to as $SVOL_{i.t}$ is also constructed, measured as daily volume in shares for stock *i* on day *t* divided by the number of shares on issue for stock *i* as at December 1, 1999. Shares on issue are obtained from DataStream.

If on a given day, the stock did not trade, missing values are recorded for the stock on that day. Equally-weighted cross-sectional averages of individual stock, volume and volatility measures are constructed each day to proxy for market-wide measures. Missing values for some stocks on certain days causes the number of stocks included in the sample to vary each day. However, the average daily variation is only one percent.

A time-series around each announcement is constructed by linking the time-series data to the earnings announcement file. A date relative variable indicating the position of an observation from its respective announcement date is added. The number zero is attached to all observations that are recorded on an announcement date. All non-announcement days are then expressed relative to the relevant announcement day. For example, -25 is attached to all observations that are recorded 25 days prior to an announcement date. The final sample consists of a daily time-series for each announcement that records the measures outlined above for the announcement date, as well as contemporaneous market-wide measures, from -50 to +50 days around each announcement.

3.3 Research Design

3.3.1 Control and Experimental Samples

The method outlined in Morse and Ushman (1983) is used to construct experimental and control samples for the bid-ask spread measures, to test for significant changes in bid-ask spreads surrounding earnings announcements.

Increased bid-ask spreads surrounding earnings announcements are consistent with increased information asymmetry. The volume and volatility measures are also examined using the same method to test whether trading activity and price informativeness change surrounding earnings announcements.

The experimental sample consists of all observations that are within -25 to +25 days surrounding each announcement date (denoted as day zero). Within the experimental sample, cross-sectional averages of individual stock measures are constructed for each day. For example, all observations on proportional spreads on day -25 are pooled, and then averaged. This process is repeated each day, with the time-series of cross-sectional averages forming the experimental sample. To construct the control sample, time-series for each stock from days -50 to -26 and from days +26 to +50 are joined and a cross-sectional average is constructed for each day, similar to the experimental sample. The time-series average of these cross-sectional measures is then calculated to arrive at a single number which represents the control.

3.3.2 Statistical Tests

To examine whether bid-ask spreads, volume and volatility are significantly different surrounding earnings announcements relative to the control period, a difference of means test is used. A Student *t*-statistic is calculated for each metric on each day in the experimental sample to test whether the experimental value for that day is greater than the control value. The difference of means test assumes that the variance of the experimental sample is not necessarily equal to the variance of the control sample. Significance of *t*-statistics is assessed using one-tailed critical values. To gauge the prevalence of increases in bid-ask spreads, volume and volatility across the sample of earnings announcements, the frequency of increases in each metric is recorded for each day (from -25 to +25). Relative frequencies are then calculated by dividing the frequency of increases by the total number of observations on that day. Significance of the relative frequency of increases on each day is assessed using a binomial test of whether the sample proportion exceeds fifty percent.

3.4 Empirical Results

3.4.1 Bid-Ask Spreads

Table 3-1 reports the results for bid-ask spreads surrounding earnings announcements. Figure 3-1 shows that bid-ask spreads are generally higher than the control throughout the experimental window, with the exception of a few days. The *t*-statistics reported in Table 3-1 indicate that the difference is statistically significant at the 5 percent level on days -5, 0 (the announcement day) and +14.[7] These results suggest increased information asymmetry surrounding earnings announcements in contrast to previous studies that

[7] Due to a lack of significant results further away from the announcement date, only days -10 to +20 are included in each table.

examine dealer spreads (Morse and Ushman, 1983; Venkatesh and Chiang, 1986). The results are consistent with the proposition that public earnings announcements are associated with private information gathering, and that market participants anticipate informed trading before earnings announcements. In summary, the results support the argument that private and public information are complements (see Indjejikian, 1991; Harris and Raviv, 1993; Kim and Verrecchia, 1991, 1994).

Figure 3-1
Bid-Ask Spreads Surrounding Earnings Announcements

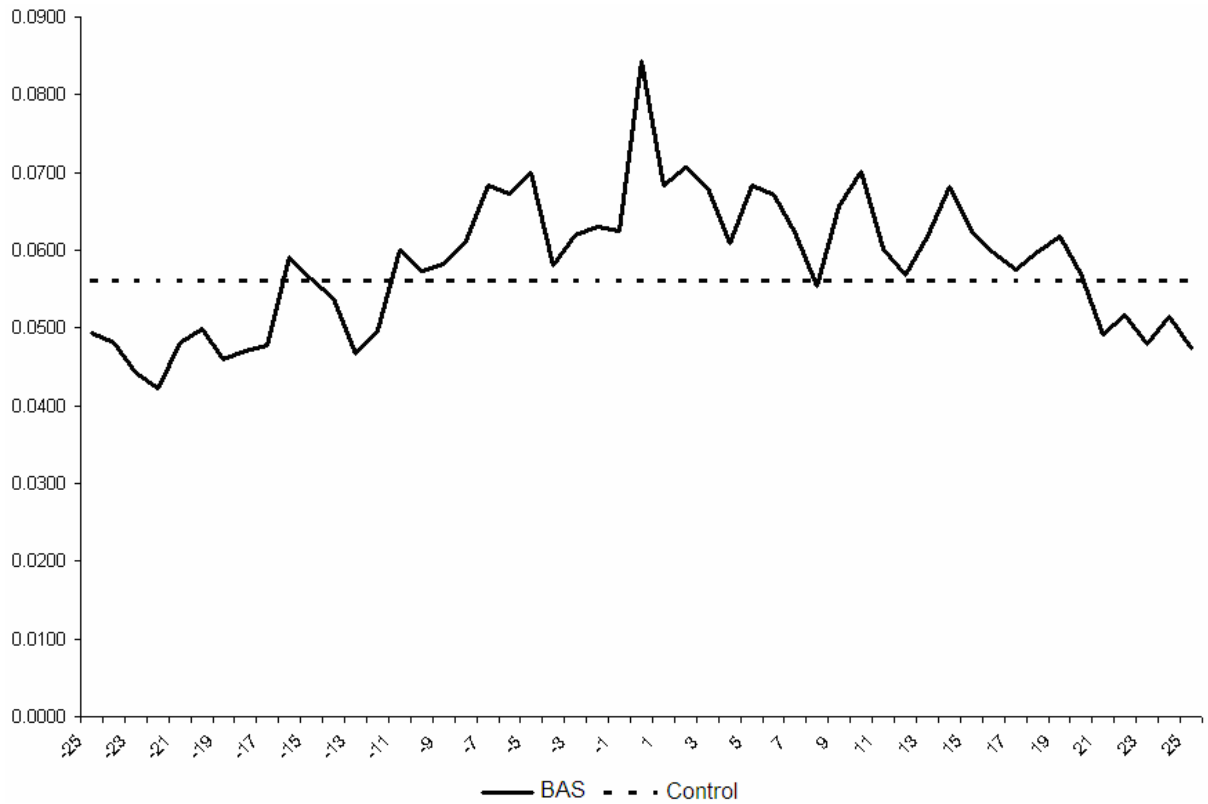


Table 3-1
Bid-Ask Spreads Surrounding Earnings Announcements

This table reports bid-ask spreads surrounding earnings announcements for a sample of 95 stocks listed on the Italian Bourse Blue Chip segment. 570 individual earnings announcements are examined for the period February 14, 2000 to October 29, 2003. Bid-ask spreads are the difference between end-of-day ask and bid prices. The experimental sample comprises a time-series of cross-sectional average bid-ask spreads from -25 to +25 days surrounding each announcement. Days -50 to -26 and +26 to +50 are used to construct the control sample using a similar procedure. A control value is calculated as the time-series average across the control sample. Significance of experimental values is assessed using a one-tailed *t*-test of whether the experimental value is greater than the control. The number of increases in bid-ask spreads each day is also reported, with a p-value from a binomial test of whether the proportion of increases each day exceeds fifty percent.

Day	Sample Size	Experimental	Control	Increases	p-value
- 10	568	0.0573	0.0561	243	0.531
- 9	568	0.0582	0.0561	240	0.630
- 8	568	0.0613	0.0561	243	0.531
- 7	568	0.0684	0.0561	244	0.497
- 6	568	0.0673	0.0561	256	0.154
- 5	568	0.0700*	0.0561	225	0.946
- 4	568	0.0581	0.0561	249	0.334
- 3	568	0.0619	0.0561	246	0.430
- 2	568	0.0631	0.0561	235	0.775
- 1	568	0.0624	0.0561	248	0.365
0	568	0.0843*	0.0561	239	0.661
+ 1	568	0.0683	0.0561	239	0.661
+ 2	568	0.0706	0.0561	241	0.598
+ 3	568	0.0680	0.0561	238	0.692
+ 4	568	0.0608	0.0561	268	0.021
+ 5	568	0.0684	0.0561	244	0.497
+ 6	568	0.0671	0.0561	238	0.692
+ 7	568	0.0623	0.0561	210	0.998
+ 8	568	0.0554	0.0561	261	0.075
+ 9	568	0.0656	0.0561	258	0.117
+ 10	568	0.0701	0.0561	264	0.045
+ 11	568	0.0602	0.0561	236	0.749
+ 12	568	0.0568	0.0561	247	0.397
+ 13	568	0.0617	0.0561	260	0.087
+ 14	568	0.0682*	0.0561	240	0.630
+ 15	568	0.0625	0.0561	227	0.925
+ 16	568	0.0597	0.0561	236	0.749
+ 17	568	0.0575	0.0561	242	0.564
+ 18	568	0.0598	0.0561	249	0.334
+ 19	568	0.0618	0.0561	253	0.221
+ 20	568	0.0569	0.0561	232	0.844

*Significant at 5% level

The results for proportional bid-ask spreads are reported in Table 3-2 and Figure 3-2, corroborating the euro bid-ask spread. A number of additional days both before and after announcements exhibit significantly higher proportional spreads relative to the control period. This is consistent with increased information asymmetry on a greater number of days when spreads are expressed in proportional terms. Overall, the first hypothesis ($H_{3,1}$) is accepted. Bid-ask spreads increase around earnings announcements.

Figure 3-2
Proportional Bid-Ask Spreads Surrounding Earnings Announcements

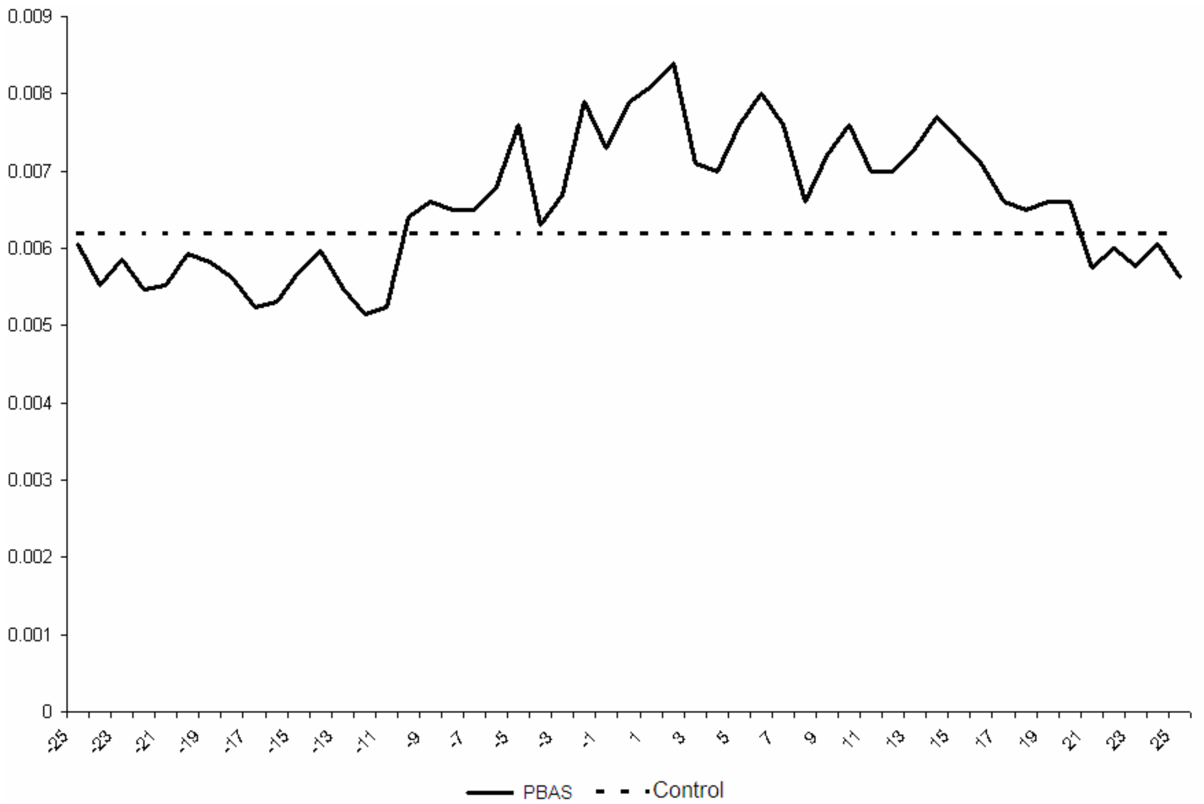


Table 3-2
Proportional Bid-Ask Spreads Surrounding Earnings Announcements

This table reports proportional bid-ask spreads surrounding earnings announcements for a sample of 95 stocks listed on the Italian Bourse Blue Chip segment. 570 individual earnings announcements are examined for the period February 14, 2000 to October 29, 2003. Proportional bid-ask spreads are the difference between end-of-day ask and bid prices, divided by the midpoint of the bid-ask spread. The experimental sample comprises a time-series of cross-sectional average bid-ask spreads from -25 to +25 days surrounding each announcement. Days -50 to -26 and +26 to +50 are used to construct the control sample using a similar procedure. A control value is calculated as the time-series average across the control sample. Significance of experimental values is assessed using a one-tailed *t*-test of whether the experimental value is greater than the control. The number of increases in proportional bid-ask spreads each day is also reported, with a p-value from a binomial test of whether the proportion of increases each day exceeds fifty percent.

Day	Sample Size	Experimental	Control	Increases	p-value
- 10	568	0.0064	0.0062	273	0.484
- 9	568	0.0066	0.0062	270	0.584
- 8	568	0.0065	0.0062	267	0.679
- 7	568	0.0065	0.0062	270	0.584
- 6	568	0.0068	0.0062	295	0.030
- 5	568	0.0076*	0.0062	262	0.812
- 4	568	0.0063	0.0062	289	0.084
- 3	568	0.0067	0.0062	276	0.386
- 2	568	0.0079*	0.0062	270	0.584
- 1	568	0.0073*	0.0062	281	0.239
0	568	0.0079*	0.0062	273	0.484
+ 1	568	0.0081*	0.0062	284	0.168
+ 2	568	0.0084*	0.0062	253	0.949
+ 3	568	0.0071	0.0062	268	0.648
+ 4	568	0.0070	0.0062	294	0.036
+ 5	568	0.0076*	0.0062	294	0.036
+ 6	568	0.0080*	0.0062	253	0.949
+ 7	568	0.0076*	0.0062	237	0.999
+ 8	568	0.0066	0.0062	286	0.130
+ 9	568	0.0072*	0.0062	276	0.386
+ 10	568	0.0076*	0.0062	300	0.011
+ 11	568	0.0070	0.0062	258	0.889
+ 12	568	0.0070	0.0062	273	0.484
+ 13	568	0.0073	0.0062	263	0.788
+ 14	568	0.0077*	0.0062	260	0.853
+ 15	568	0.0074	0.0062	258	0.889
+ 16	568	0.0071*	0.0062	258	0.889
+ 17	568	0.0066	0.0062	265	0.736
+ 18	568	0.0065	0.0062	284	0.168
+ 19	568	0.0066	0.0062	276	0.386
+ 20	568	0.0066	0.0062	263	0.788

* Significant at the 5% level

3.4.2 Volume and Volatility

The results for volume (adjusted for shares on issue) are reported in Table 3-3. Volume is significantly higher from day 0 to day +8, suggesting increased trading activity at the time of and after the announcement of earnings. This is evident in Figure 3-3, which shows a large spike in volume at the time of the announcement.

Figure 3-3
Volume Surrounding Earnings Announcements

Table 3-3
Volume Surrounding Earnings Announcements

This table reports volume (adjusted for shares on issue) surrounding earnings announcements for a sample of 95 stocks listed on the Italian Bourse Blue Chip segment. 570 individual earnings announcements are examined for the period February 14, 2000 to October 29, 2003. The experimental sample comprises a time-series of cross-sectional average volumes from -25 to +25 days surrounding each announcement. Days -50 to -26 and +26 to +50 are used to construct the control sample using a similar procedure. A control value is calculated as the time-series average across the control sample. Significance of experimental values is assessed using a one-tailed *t*-test of whether the experimental value is greater than the control. The number of increases in volume each day is also reported, with a p-value from a binomial test of whether the proportion of increases each day exceeds fifty percent.

Day	Sample Size	Experimental	Control	Increases	p-value
- 10	568	2.9723	3.2395	338	0.040
- 9	568	3.0848	3.2395	317	0.508
- 8	568	3.2335	3.2395	359	0.000
- 7	568	3.5402	3.2395	317	0.508
- 6	568	3.4761	3.2395	322	0.344
- 5	568	3.3384	3.2395	327	0.205
- 4	568	3.2175	3.2395	332	0.106
- 3	568	3.2470	3.2395	331	0.122
- 2	568	3.5954	3.2395	332	0.106
- 1	568	3.4241	3.2395	380	0.000
0	568	4.4698*	3.2395	366	0.000
+ 1	568	4.8074*	3.2395	251	1.000
+ 2	568	4.2131*	3.2395	298	0.947
+ 3	568	4.0801*	3.2395	309	0.756
+ 4	568	3.9688*	3.2395	322	0.344
+ 5	568	3.7421*	3.2395	336	0.056
+ 6	568	3.8625*	3.2395	303	0.885
+ 7	568	3.7480*	3.2395	325	0.256
+ 8	568	3.7928*	3.2395	281	0.999
+ 9	568	3.7348	3.2395	303	0.885
+ 10	568	3.5410	3.2395	312	0.671
+ 11	568	3.6738	3.2395	300	0.927
+ 12	568	3.3889	3.2395	324	0.284
+ 13	568	3.5719	3.2395	314	0.608
+ 14	568	3.5742	3.2395	307	0.806
+ 15	568	3.1866	3.2395	308	0.782
+ 16	568	3.0851	3.2395	286	0.996
+ 17	568	3.1906	3.2395	309	0.756
+ 18	568	3.0162	3.2395	300	0.927
+ 19	568	3.2357	3.2395	341	0.022
+ 20	568	2.9723	3.2395	317	0.508

* Significant at the 5% level

Stock price volatility surrounding earnings announcements is reported in Table 3-4. As Figure 3-4 shows, volatility is higher at the time of, and immediately following, the announcement. The *t*-statistics reported in Table 3-4 indicate that volatility is significantly higher than the control from day -4 to day +7. Given that volatility is a proxy for stock price informativeness, the results for volatility and volume are consistent with informed trading on earnings information at announcement, and up to seven trading days after the announcement. Based on these results, the second hypothesis ($H_{3,2}$) is also accepted. Both volume and volatility are significantly higher around earnings announcements.

Figure 3-4
Stock Price Volatility Surrounding Earnings Announcements

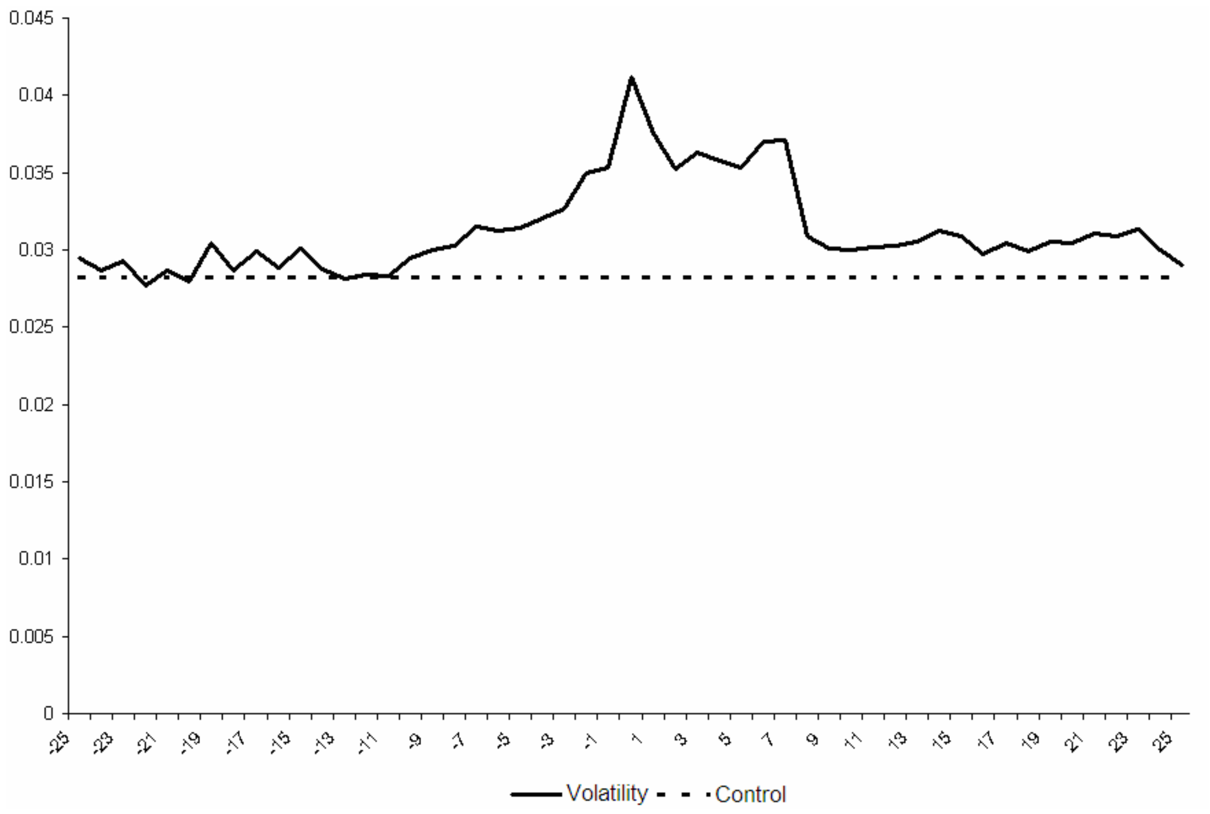


Table 3-4
Stock Price Volatility Surrounding Earnings Announcements

This table reports stock price volatility surrounding earnings announcements for a sample of 95 stocks listed on the Italian Bourse Blue Chip segment. 570 individual earnings announcements are examined for the period February 14, 2000 to October 29, 2003. Stock price volatility is the log difference between high and low prices on a trading day. The experimental sample comprises a time-series of cross-sectional average volatilities from -25 to +25 days surrounding each announcement. Days -50 to -26 and +26 to +50 are used to construct the control sample using a similar procedure. A control value is calculated as the time-series average across the control sample. Significance of experimental values is assessed using a one-tailed *t*-test of whether the experimental value is greater than the control. The number of increases in volatility each day is also reported, with a p-value from a binomial test of whether the proportion of increases each day exceeds fifty percent.

Day	Sample Size	Experimental	Control	Increases	p-value
- 10	568	0.0295	0.0282	338	0.223
- 9	568	0.0300	0.0282	317	0.463
- 8	568	0.0303	0.0282	359	0.596
- 7	568	0.0315	0.0282	317	0.398
- 6	568	0.0312	0.0282	322	0.596
- 5	568	0.0314	0.0282	327	0.076
- 4	568	0.0320*	0.0282	332	0.596
- 3	568	0.0327*	0.0282	331	0.009
- 2	568	0.0350*	0.0282	332	0.773
- 1	568	0.0353*	0.0282	380	0.719
0	568	0.0412*	0.0282	366	0.176
+ 1	568	0.0375*	0.0282	251	0.820
+ 2	568	0.0352*	0.0282	298	0.176
+ 3	568	0.0363*	0.0282	309	0.136
+ 4	568	0.0358*	0.0282	322	0.276
+ 5	568	0.0353*	0.0282	336	0.366
+ 6	568	0.0370*	0.0282	303	0.176
+ 7	568	0.0371*	0.0282	325	0.690
+ 8	568	0.0309	0.0282	281	0.923
+ 9	568	0.0301	0.0282	303	0.934
+ 10	568	0.0300	0.0282	312	0.879
+ 11	568	0.0302	0.0282	300	0.463
+ 12	568	0.0303	0.0282	324	0.305
+ 13	568	0.0305	0.0282	314	0.773
+ 14	568	0.0312	0.0282	307	0.961
+ 15	568	0.0309	0.0282	308	0.305
+ 16	568	0.0297	0.0282	286	0.430
+ 17	568	0.0304	0.0282	309	0.335
+ 18	568	0.0299	0.0282	300	0.998
+ 19	568	0.0305	0.0282	341	0.012
+ 20	568	0.0304	0.0282	317	0.953

* Significant at the 5% level

3.5 Summary

This chapter provides new evidence that bid-ask spreads increase significantly surrounding earnings announcements, in contrast to prior evidence from US markets which is inconclusive. The use of bid-ask spreads from a purely order-driven environment mitigates the problems inherent in prior studies that use dealer spreads, enabling a cleaner test of information asymmetry surrounding earnings announcements. The results are consistent with an increase in information surrounding earnings announcements, suggesting that private and public information are complements. Both the first hypothesis that bid-ask spreads are wider, and the second hypothesis that volume and volatility is higher around earnings announcements, are accepted.

Chapter 4: Bid-Ask Spreads Under Auction and Specialist Market Structures

4.1 Introduction

This chapter analyzes bid-ask spreads under specialist and auction market structures on the Italian Bourse. The institutional detail discussed in Section 2.3 described how several stocks that originally traded in an order-driven auction market switched to a specialist market structure. The literature reviewed in Chapter 2 also highlighted the many studies that have attempted to compare spreads (and thus liquidity) across various market structures. However, the hybrid nature of trading on the NYSE (which combines a specialist with a limit order book) complicates the comparison, making results ambiguous. The switch from an auction to a specialist market on the Italian Bourse thus provides a natural experiment to compare the benefits / costs of a specialist market structure.

Based on this, and the literature in Section 2.2.1, two hypotheses were developed, which will be subsequently tested in this chapter. The first hypothesis conjectures that bid-ask spreads will decrease significantly under a specialist market structure. The second hypothesis conjectures that trading activity will increase with specialist intervention.

The remainder of this chapter is organized as follows. Section 4.2 describes the dataset and subsequent sample used. Section 4.3 sets out the research design, Section 4.4 presents the empirical results, while Section 4.5 presents several additional tests. Section 4.6 summarizes the chapter. Section 4.7 then provides a list of ticker symbols of Star and SBO stocks used throughout this chapter.

4.2 Data and Sample

To test the effect of moving from an auction market to a specialist market, I 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.[8] From the remaining stocks, I select 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 20 commenced trading in the new Star market.

For these 77 stocks, I collect daily closing bid, ask and transaction prices, both one year before and after the 2 April, 2001 structural change. Also collected are daily high and low prices, and daily turnover for each stock. Market

[8] Also excluded are foreign listed companies.

capitalization of all 77 firms on the trading day prior to the structural change is also available. The data is sourced from a Bloomberg database.

4.3 Research Design

In order to explore the impact on the bid-ask spread of the change from an auction market to a specialist market, and to test the first hypothesis, two measures are examined.[9] The first is the quoted spread (in €), defined as:

Quoted Spread = Ask – Bid

To control for stock price variations, both over time and across stocks, I also examine the proportional quoted spread, defined as:

Proportional Spread = (Ask – Bid) / [(Ask + Bid) / 2]

Also, other stock factors, including turnover and volatility could vary with the switch, for both the Star and SBO markets. Changes in these other factors could drive variation in spreads. To control for the impact that these additional factors have on the spread, and to test the second hypothesis, four regressions are estimated. The first two control for variation (both over time and across stocks) in the spreads of stocks that remain in the auction market segment. Specifically, the following two regressions are estimated:

[9] Prior literature also examines the effective spread, which takes into account trading within the best bid and ask quotes. As the pre-period in the experiment utilized only an auction market, no trading occurred within the best quotes. Thus, the effective spread is equal to the quoted spread. However, for stocks that moved to the Star market, trading inside the spread can be facilitated by the specialist. To examine this possibility, an additional test comparing the quoted and effective spreads for the Star stocks after the structural change is reported later in the chapter.

$$\text{Star\_QS}_t = \beta_0 + \beta_1 \text{ Change}_t + \beta_2 \text{ SBO\_QS}_t + \varepsilon_t \quad (4\text{-}1)$$

$$\text{Star\_PS}_t = \beta_0 + \beta_1 \text{ Change}_t + \beta_2 \text{ SBO\_PS}_t + \varepsilon_t, \quad (4\text{-}2)$$

where Change_t is a dummy variable that takes the value of one after the structural change, zero otherwise. Star_QS_t is the quoted spread (in €) for stocks that moved to the specialist Star market and Star_PS_t is the proportional quoted spread for the same stocks. SBO_QS_t is the quoted spread (in €) for stocks that remained in the SBO auction market and SBO_PS_t is the proportional quoted spread for the same stocks.

As the bid-ask spread is dependant on several factors including turnover and volatility, I also control for these factors. The next two regressions examine the change in spread for Star stocks after controlling for changes in turnover and volatility in both the Star and SBO markets.[10] Specifically, the following two regressions are estimated:

$$\text{Star\_QS}_t = \beta_0 + \beta_1 \text{ Change}_t + \beta_2 \ln(\text{SBO\_Turn}_t) + \beta_3 \text{ SBO\_Vol}_t + \beta_4 \ln(\text{Star\_Turn}_t) + \beta_5 \text{ Star\_Vol}_t + \varepsilon_t \quad (4\text{-}3)$$

---

[10] Specifically, the quoted spread for Star stocks is estimated using the following regression:

$$\text{Star\_QS}_t = \beta_0' + \beta_1' \text{ Star\_Turn}_t + \beta_2' \text{ Star\_Vol}_t + \varepsilon_t' \quad (4\text{-}3')$$

Similarly, the quoted spread for SBO stocks is estimated using the following regression:

$$\text{SBO\_QS}_t = \beta_0'' + \beta_1'' \text{ SBO\_Turn}_t + \beta_2'' \text{ SBO\_Vol}_t + \varepsilon_t'' \quad (4\text{-}3'')$$

Substituting (4-3') and (4-3'') into (4-1) leads to (4-3). Similar calculations are used for the proportional spread, resulting in (4-4).

$$Star\_PS_t = \beta_0 + \beta_1 \, Change_t + \beta_2 \ln(SBO\_Turn_t) + \beta_3 \, SBO\_Vol_t + \beta_4 \ln(Star\_Turn_t) + \beta_5 \, Star\_Vol_t + \varepsilon_t \qquad (4\text{-}4)$$

where $\ln(SBO\_Turn_t)$ is calculated as the natural logarithm of daily stock turnover (in €) for SBO stocks and SBO_Vol_t is the daily volatility, calculated as the log difference between the high price and low price on each trading day for SBO stocks. Both $\ln(Star\_Turn_t)$ and $Star\_Vol_t$ are calculated similarly for Star stocks. $Change_t$ is again a dummy variable that takes the value of one after the structural change, zero otherwise.[11] All variables are calculated using data from 12 months prior to and after the structural change.

4.4 Empirical Results

4.4.1 Univariate Results

Table 4-1 provides descriptive statistics for the two spread measures, as well as other stock characteristics, for stocks that moved from the auction market to the Star market, and for stocks remaining in the auction (SBO) market. Statistics are calculated using data from 12 months prior to and after the structural change.

[11] Dependant variables are as described for the first two regressions.

For the 20 stocks that switched to the specialist Star market, the quoted spread falls from €0.059 to €0.043, a significant reduction of €0.016. After adjusting for the stock price, the proportional spread falls from 1.122 percent to 1.039 percent; a significant reduction of 0.083 percent. Over the same period, stocks that remained in the auction market show a reduction in quoted spread of €0.014. However, the proportional spread increased by the insignificant amount of 0.024 percent.

Overall, univariate results indicate a reduction in bid-ask spreads when stocks move from an auction market to a specialist market. This reduction is evident in Figures 4-1 and 4-2. The reduction in both quoted and proportional spreads occurs on the day of the structural change (day zero), after which a new equilibrium bid-ask spread level is attained. Overall, I accept the first hypothesis ($H_{4,1}$). Bid-ask spreads are significantly tighter under a specialist market structure.

Table 4-1 also presents descriptive statistics for several stock characteristics. Closing prices for stocks that switched to the Star market have fallen. Prior to the move, the average closing price is €5.35, whilst after the move the average falls to €4.43. The average daily volume also falls by 17,578 shares (insignificantly different from zero). Given the significant reduction in stock price, and the minor reduction in volume, stock turnover also falls, from an average of €555,827 in the 12 months prior, to an average of €363,457 in the 12 months after the switch. However, stock volatility is significantly reduced under the specialist system, with a reduction of 0.156 percent.

Figure 4-1
Quoted Euro Spreads

This figure depicts the average quoted euro spread for the 20 stocks that moved from the auction market to the Star specialist market on 2 April, 2001. Day zero is the first day of trading in the Star market.

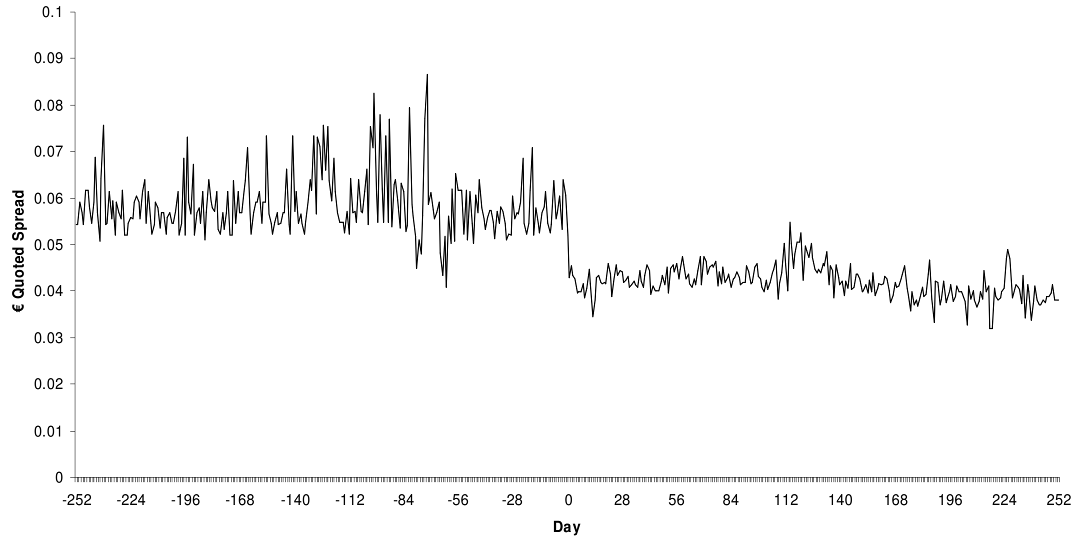
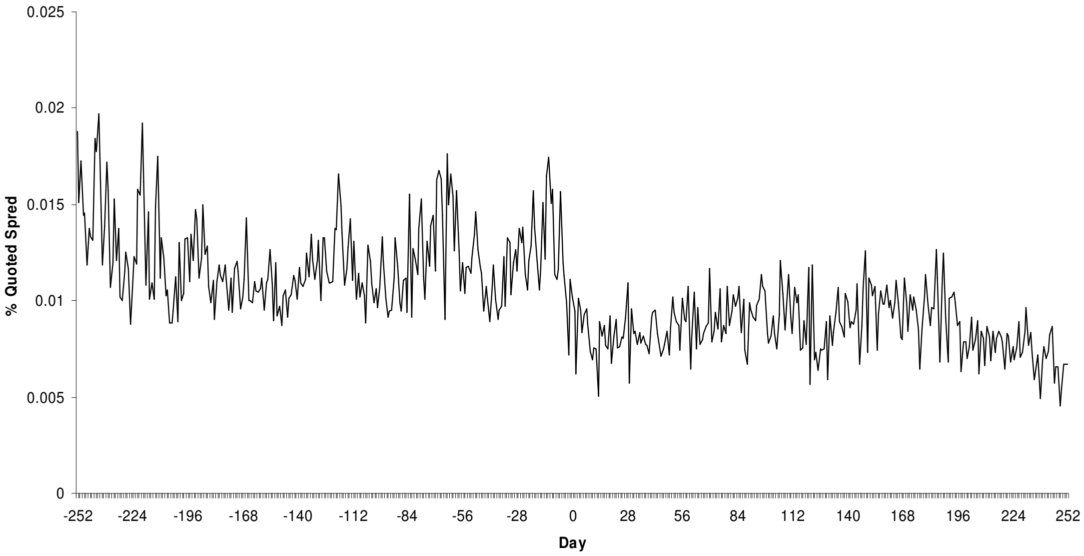


Figure 4-2
Proportional Quoted Spreads

This figure depicts the average proportional quoted spread for the 20 stocks that moved from the auction market to the Star specialist market on 2 April, 2001. Day zero is the first day of trading in the Star market.



Over the same period, stocks remaining in the auction market (SBO stocks) also exhibit variation. The average stock price falls from €4.43 to €3.47, whilst average volume falls from 275,645 to 234,402. Together, this leads to a reduction in turnover of €161,017, similar to the Star market. However, the volatility of the SBO stocks remains constant after the structural change. Overall, trading activity for Star and SBO stocks falls after the switch, although the reduction in spreads is localized to Star stocks. Based on this, the second hypothesis ($H_{4,2}$) is rejected. Trading activity is not significantly higher under a specialist market structure.

4.4.2 Regression Results

The univariate results indicate a significant reduction in bid-ask spreads when stocks move to a specialist market. Table 4-2 presents coefficient estimates and adjusted R-squared values for the four regressions. The first two regressions indicate that after controlling for variation in SBO stock spreads (which have a positive effect on Star stock spreads), both the quoted and proportional spreads are reduced after the structural change. Both dummy variables have negative coefficients which are significant at all conventional levels.

Table 4-1
Descriptive Statistics

This table reports descriptive statistics (number of stocks, quoted and proportional spread, closing price, daily volume, daily turnover and daily volatility) for the 20 Star and 57 SBO stocks. Stocks are included if they traded continuously for 12 months prior to and after the 2 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, median and change in mean for the 12 months before and after the structural change. Statistical significance emanates from the test of whether the mean change is significantly different from zero.

	Star market		SBO market	
	Before	After	Before	After
Number of stocks	20		57	
Quoted spread (€)				
Mean	0.059	0.043	0.052	0.038
Median	0.055	0.042	0.051	0.038
Mean change	-0.016**		-0.014**	
Proportional spread (%)				
Mean	1.122	1.039	1.320	1.344
Median	1.062	1.016	1.276	1.307
Mean change	-0.0830**		0.0240	
Closing price (€)				
Mean	5.35	4.43	4.43	3.47
Median	5.38	4.36	4.45	3.22
Mean change	-0.92**		-0.96**	
Daily volume (shares)				
Mean	111,612	94,034	275,645	234,402
Median	107,328	89,034	211,717	189,742
Mean change	-17,578		-41,243	
Daily turnover (€)				
Mean	555,827	363,457	845,462	684,445
Median	422,429	319,842	617,682	519,683
Mean change	-192,370**		-161,017**	
Daily volatility (%)				
Mean	2.810	2.654	3.058	3.029
Median	2.730	2.493	2.891	2.829
Mean change	-0.1560*		-0.0290	

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

The next two regressions, after controlling for turnover and volatility in both the Star and SBO markets, indicate that both the quoted and proportional spreads decline after the structural change. The coefficients for the dummy variables are significantly negative (at all conventional levels). Coefficient estimates for the four explanatory variables are as expected. An increase in turnover in both the Star and SBO markets reduces spreads, although the univariate results indicate that both turnover and spreads decline for Star stocks. An increase in volatility widens spreads. Overall, after controlling for spreads in the SBO market, and other factors affecting spreads in both the Star and SBO markets, both the quoted and proportional spreads are significantly tighter under a specialist rather than auction market structure. I thus confirm the acceptance of the first hypothesis ($H_{4,1}$).

4.5 Additional Tests

This section provides several additional tests to examine the robustness of the reduced spread for the specialist market stocks.

Table 4-2
Multiple Regression Results

This table reports results from the four regressions for the 20 stocks that moved from an auction market to the specialist Star market on 2 April, 2001. Stocks are included if they traded continuously for 12 months prior to and after the structural change. The dependant variable is measured as the quoted euro spread for the Star stocks in the first and third regressions, while it is measured as the proportional quoted spread in the second and fourth regressions. The change dummy variable takes the value of one after the structural change, zero otherwise. The SBO spread variable is the quoted euro spread for the first regression, and the proportional quoted spread for the second regression. The third and fourth regressions include the natural logarithm of the euro turnover for Star and SBO stocks, as well as the percentage volatility, measured as the natural logarithm of the ratio of daily high to low stock prices, again for Star and SBO stocks. All variables are calculated using data from 12 months prior to and after the structural change. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

Dependant variable	Intercept	Change	SBO spread	SBO turnover ln(€)	SBO volatility (%)	Star turnover ln(€)	Star volatility (%)	Adj. R^2
Star quoted spread (€)	0.0281**	-0.0072**	0.5884**					0.3660
Star proportional spread (%)	0.0041**	-0.0009**	0.5350**					0.4060
Star quoted spread (€)	0.0430**	-0.0170**	--	-0.0050*	0.5492**	-0.0047*	0.3551*	0.3560
Star proportional spread (%)	0.0084**	-0.0011**	--	-0.0011**	0.0870**	-0.0012**	0.1327**	0.3833

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

4.5.1 Effect of Firm Size and Industry Affiliation

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" (which are analyzed in the previous chapter), the stocks remaining in the SBO and Star markets are medium to small capitalization stocks. To examine the impact of firm size, I divide the samples of SBO and Star stocks into two groups.

As the average market capitalization of both the Star and SBO samples is approximately €300 million, all stocks with market capitalizations greater than €300 million are considered medium capitalization stocks, while all stocks less than €300 million in capitalization are considered small capitalization stocks. The analysis around the structural change is then completed separately for small and medium capitalization stocks. The results are presented in Table 4-3 (market capitalization details), Table 4-4 (small capitalization stocks) and Table 4-5 (medium capitalization stocks).

Descriptive market capitalization statistics are presented in Table 4-3 for all stocks, small capitalization stocks and medium capitalization stocks. The average market capitalization of small stocks is €146.9 million for Star stocks and €142.1 million for SBO stocks. The medium capitalization stocks have an average of €513.7 million for Star stocks and €493.7 million for SBO stocks. The median results also indicate that the within the small and medium groups, there is minimal difference between the market capitalization of Star and SBO stocks. There is minimal difference in the size of firms that moved to the specialist market or remained in the auction market.

Descriptive spread and stock statistics are presented in Panel A of both Table 4-4 and Table 4-5. The reduction in spreads for small capitalization stocks averages €0.018 (proportional spread falls by 0.1000 percent), while the reduction averages €0.016 (0.1078 percent in proportional spreads) for medium capitalization stocks. Regression results, in Panel B of both tables, are also consistent. All dummy variables are significantly negative across all eight regressions. All turnover variables have negative coefficients, while volatility variables have positive coefficients. The reduction in spreads occurs for both small and medium capitalization stocks.

Extending the role of firm size, a large firm in a particular industry sector may be considered a small firm in another industry sector. To examine if the market capitalization of a firm within a particular industry sector affects spreads, I perform a matching procedure with the two samples. For each Star stock, I find all SBO stocks in the same industry sector. From all possible matches, I select the SBO stock with a market capitalization closest to the capitalization of the

Star stock. I do this for all 20 Star stocks. The regression results are presented in Table 4-6.

Table 4-3
Market Capitalization

This table reports descriptive market capitalization statistics for the 20 stocks that moved from an auction market to the Star specialist market on 2 April, 2001, and the 57 stocks which remained in the ordinary SBO auction market. Stocks are included if they traded continuously for 12 months prior to and after the structural change. Stocks with market capitalizations below the overall mean are moved into the small stock segment, while stocks with market capitalizations above the overall mean are moved into the medium stock segment. For each Star and SBO sample, the table reports the mean, minimum, median and maximum value, calculated on the trading day prior to the structural change. All amounts shown are in millions of euros.

	Mean	Minimum	Median	Maximum
All stocks *(20 Star, 57 SBO)*				
Star	296.9	37.08	258.8	724.5
SBO	277.9	16.73	146.0	798.5
Small stocks *(12 Star, 42 SBO)*				
Star	146.9	37.08	135.0	293.2
SBO	142.1	16.73	125.4	286.8
Medium stocks *(8 Star, 15 SBO)*				
Star	513.7	305.5	556.8	724.5
SBO	493.7	309.8	491.6	798.5

The results in Table 4-6 are consistent with the full sample results. After controlling for spread changes in the matched SBO stocks, spreads for the Star stocks still show considerable reductions, with both dummy variables significantly negative. The last two regressions, after controlling for turnover and volatility of both the SBO and Star matched stocks, again indicates a reduction in spreads, with both dummy variables significantly negative. The reduction in spreads when stocks move from an auction market to a specialist market is thus robust to both the size and industry affiliation of the firm.

4.5.2 Length of Event Window

Over time, a stock's characteristics vary. Thus, the event window in which variables are measured is important. A 12 month pre- and post- event window could include significant variation in turnover and volatility. To examine the sensitivity of results to the length of the event window, I calculate all variables for both three and six months before and after the structural change. I then re-estimate all four regressions separately for the three month and six month event windows. The results are presented in Table 4-7.

The three month results are presented in Panel A. Consistent with earlier findings, all four regressions have significantly negative coefficients for the dummy variable. Unlike with the previous regressions though, all turnover explanatory variables are insignificantly negative, while only the Star volatility variables are significantly positive (the SBO volatility variables are positive, but not significantly different from zero).

Table 4-4
Small Stock Segment

This table reports descriptive statistics, including quoted and proportional spread, turnover and volatility (Panel A) and regression results (Panel B) for small Star and SBO stocks, as classified in Table 4-3. Stocks are included if they traded continuously for 12 months prior to and after the 2 April, 2001 structural change. For each variable, the table reports the mean and median (in parentheses) for the 12 months before and after the structural change, and the change in mean values. Statistical significance emanates from the test of whether the mean change is significantly different from zero. In the regressions, the dependant variable is measured as the quoted euro spread for the Star stocks in the first and third regressions, while it is measured as the proportional quoted spread in the second and fourth regressions. The change dummy variable takes the value of one after the structural change, zero otherwise. The SBO spread variable is the quoted euro spread for the first regression, and the proportional quoted spread for the second regression. The third and fourth regressions include the natural logarithm of the euro turnover and percentage volatility for Star and SBO stocks. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

A. Descriptive statistics	Mean before (Median before)	Mean after (Median after)	Mean change
Quoted spread (€)	0.068 (0.04)	0.050 (0.03)	-0.018**
Proportional spread (%)	1.254 (1.046)	1.154 (1.016)	-0.1000**
Turnover (€)	281,528 (139,162)	224,888 (104,480)	-56,639**
Volatility (%)	2.514 (2.207)	2.309 (2.074)	-0.2050**

Table 4-4, continued

B. Regressions	Intercept	Change	SBO spread	SBO turnover ln(€)	SBO volatility (%)	Star turnover ln(€)	Star volatility (%)	Adj. R^2
Star quoted spread (€)	0.0376**	-0.0134**	0.4072**					0.3565
Star proportional spread (%)	0.0030**	-0.0004*	0.6157**					0.4448
Star quoted spread (€)	0.1598**	-0.0194**	--	-0.0050**	0.4447**	-0.0046*	0.3604*	0.3688
Star proportional spread (%)	0.0346**	-0.0010**	--	-0.0013**	0.0788**	-0.0015*	0.1633*	0.4260

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

Table 4-5
Medium Stock Segment

This table reports descriptive statistics, including quoted and proportional spread, turnover and volatility (Panel A) and regression results (Panel B) for medium Star and SBO stocks, as classified in Table 4-3. Stocks are included if they traded continuously for 12 months prior to and after the 2 April, 2001 structural change. For each variable, the table reports the mean and median (in parentheses) for the 12 months before and after the structural change, and the change in mean values. Statistical significance emanates from the test of whether the mean change is significantly different from zero. In the regressions, the dependant variable is measured as the quoted euro spread for the Star stocks in the first and third regressions, while it is measured as the proportional quoted spread in the second and fourth regressions. The change dummy variable takes the value of one after the structural change, zero otherwise. The SBO spread variable is the quoted euro spread for the first regression, and the proportional quoted spread for the second regression. The third and fourth regressions include the natural logarithm of the euro turnover and percentage volatility for Star and SBO stocks. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

A. Descriptive statistics	Mean before (Median before)	Mean after (Median after)	Mean change
Quoted spread (€)	0.045 (0.023)	0.029 (0.019)	-0.016**
Proportional spread (%)	0.9553 (0.7269)	0.8475 (0.7014)	-0.1078**
Turnover (€)	739,680 (471,567)	523,544 (369,314)	-216,136**
Volatility (%)	3.065 (2.541)	2.754 (2.221)	-0.3115**

Table 4-5, continued

B. Regressions	Intercept	Change	SBO spread	SBO turnover ln(€)	SBO volatility (%)	Star turnover ln(€)	Star volatility (%)	Adj. R^2
Star quoted spread (€)	0.0181**	-0.0032*	0.3573**					0.3220
Star proportional spread (%)	0.0053**	-0.0007**	0.4436**					0.2464
Star quoted spread (€)	0.0593	-0.0092**	--	-0.0025	0.3264*	-0.0010	0.7721**	0.2389
Star proportional spread (%)	0.0245**	-0.0013**	--	-0.0010**	0.0838**	-0.0005	0.0946**	0.2890

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

Table 4-6
Size and Industry Matched Sample

This table reports results from the four regressions for the 20 stocks that moved from an auction market to the specialist Star market on the 2 April, 2001. Stocks are included if they traded continuously for 12 months prior to and after the structural change. The SBO sample is based on a matching procedure with the 20 Star stocks. First all SBO stocks are grouped according to industry affiliation. Then for each Star stock, the SBO stock from the same industry group, with a market capitalization as close as possible to the Star stock, is selected. This results in a matched Star – SBO sample of 20 stocks. From this sample, the dependant variable is measured as the quoted euro spread for the Star stocks in the first and third regressions, while it is measured as the proportional quoted spread in the second and fourth regressions. The Change dummy variable takes the value of one after the structural change, zero otherwise. The SBO spread variable is the quoted euro spread for the first regression, and the proportional quoted spread for the second regression. The third and fourth regressions include the natural logarithm of the euro turnover and percentage volatility for Star and SBO stocks. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

Dependant variable	Intercept	Change	SBO spread	SBO turnover ln(€)	SBO volatility (%)	Star turnover ln(€)	Star volatility (%)	Adj. R^2
Star quoted spread (€)	0.0326**	-0.0078**	0.5835**					0.2564
Star proportional spread (%)	0.0048**	-0.0012**	0.5590**					0.4415
Star quoted spread (€)	0.1595**	-0.0203**	--	-0.0030*	0.7942**	-0.0076**	0.5631**	0.2687
Star proportional spread (%)	0.0344**	-0.0016**	--	-0.0013**	0.1324**	-0.0011**	0.1774**	0.3974

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

The six month results are presented in Panel B of Table 4-7. As with the three month results, all dummy variables are significantly negative, indicating a reduction in spreads around the structural change. All explanatory variables are significantly different from zero in their proposed directions, except for the SBO variables in the third regression, which are insignificantly different from zero (although in their expected direction). I conclude that the finding of a reduction in spreads when stocks switch to a specialist market is robust to the length of the event window.

4.5.3 Control with the 'New Market'

It is possible that market wide events are narrowing spreads. Over the transition period, trading in the New Market continued normally. Although New Market stocks are generally high-growth, high-volatility stocks, if spreads and other stock characteristics exhibit systematic changes over the same event window, overall market forces could be driving the decline in spreads for Star stocks. To examine this possibility, I analyze a sample of stocks trading on the New Market over the same time period. The results are presented in Table 4-8.

Table 4-7
Sensitivity to Event Window

This table reports results from the four regressions for the 20 stocks that moved from an auction market to the specialist Star market on 2 April, 2001. Stocks are included if they traded continuously for 12 months prior to and after the structural change. The dependant variable is measured as the quoted euro spread for the 20 Star stocks in the first and third regressions, while it is measured as the proportional quoted spread in the second and fourth regressions. The change dummy variable takes the value of one after the structural change, zero otherwise. The SBO spread variable is the quoted euro spread for the first regression, and the proportional quoted spread for the second regression. The third and fourth regressions include the natural logarithm of the euro turnover and percentage volatility for Star and SBO stocks. All variables are calculated using data from three months (Panel A) and six months (Panel B) around the structural change. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

Dependant variable	Intercept	Change	SBO spread	SBO turnover ln(€)	SBO volatility (%)	Star turnover ln(€)	Star volatility (%)	Adj. R^2
Panel A: 3 month window								
Star quoted spread (€)	0.0332**	-0.0080**	0.3864**					0.2087
Star proportional spread (%)	0.0064**	-0.0013**	0.3607**					0.4215
Star quoted spread (€)	0.0645	-0.0070*	--	0.0009	0.0314	-0.0036	0.7995*	0.1734
Star proportional spread (%)	0.0187*	-0.0007*	--	-0.0004	0.0635	-0.0007	0.1615**	0.4273

Table 4-7, continued

Panel B: 6 month window

Star quoted spread (€)	0.0331**	-0.0107**	0.4862**					0.2606
Star proportional spread (%)	0.0047**	-0.0009**	0.4841**					0.2871
Star quoted spread (€)	0.1308**	-0.0121**	--	-0.0009	0.2600	-0.0071*	0.8344*	0.2582
Star proportional spread (%)	0.0279**	-0.0007*	--	-0.0011*	0.1018**	-0.0009*	0.2102*	0.4178

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

As the New Market commenced trading in June 1999, only six stocks traded for the full two year period around the structural change. As the previous section shows that results are robust over both three and six month event windows, to increase the number of stocks included, I present results for the 13 stocks that traded for the entire six months prior to and after the change. Descriptive statistics are presented in Panel A of Table 4-8. Similar to Star and SBO stocks, the quoted spread declines over the period (with a reduction of €0.15). After adjusting for the stock price, results indicate an increase in proportional spread, although this increase is not significantly different from zero. Both turnover and volatility experience minimal variation around the structural change.

The four regressions used previously are estimated, with New Market variables replacing SBO variables. The results from all four regressions indicate that spreads in Star stocks decline after they commence trading in the specialist market. Unlike with the SBO variables, the New Market turnover and volatility variables have coefficients insignificantly different from zero for the final two regressions. I thus confidently conclude that factors affecting the market overall are not driving the reduction in spreads for Star stocks.[12]

[12] I also test the impact of the New Market over three and 12 month periods around the structural change. With the three month period, 18 stocks are included, whilst there are only six stocks for the 12 month period. Under both alternatives, results are qualitatively similar. There is strong evidence that the quoted and proportional spreads decline when stocks commence trading in the specialist Star market.

4.5.4 The Role of Effective Spreads

Much of the previous literature has calculated effective spreads. Effective spreads capture the actual cost of executing trades when some transactions occur inside the best bid and ask quotes. Prior to the structural change, all trading took place on an electronic auction market. Thus, no transactions occurred within the best quotes, and the effective spread equaled the quoted spread. Before and after comparisons of the effective spread are meaningless. However, the results indicate that quoted spreads (both euro and proportional) are reduced when stocks move to the specialist market. If the specialist allows trades to occur inside the spread, the effective spreads will be lower than the quoted spreads after the structural change, providing further evidence of the benefits of a specialist market structure.

To examine this issue, I calculate the effective quoted half spread as [Transaction Price – (Ask + Bid) / 2], and compare this to the quoted half spread, calculated as (Ask – Bid) / 2, for the 20 Star stocks in the 12 months after the structural change. I also calculate the effective percentage half spread as [Transaction Price – (Ask + Bid) / 2] / (Ask + Bid) / 2, and compare this to the proportional quoted half spread calculated as [(Ask – Bid) / 2] / (Ask + Bid) / 2, again for the 20 Star stocks. The results are presented in Table 4-9.

Table 4-8
Control with the New Market

This table reports descriptive statistics, including quoted and proportional spread, turnover and volatility (Panel A) and regression results (Panel B) for Star and New Market stocks. Star stocks are included if they traded continuously for 12 months prior to and after the 2 April, 2001 structural change, while New Market stocks traded continuously for six months prior to and after the change. For each variable, the table reports the mean, median (in parentheses) and change in mean for the six months around the structural change. Statistical significance emanates from the test of whether the mean change is significantly different from zero. In the regressions, the dependant variable is measured as the quoted euro spread for the Star stocks in the first and third regressions, while it is measured as the proportional quoted spread in the second and fourth regressions. The change dummy variable takes the value of one after the structural change, zero otherwise. The New Market spread variable is the quoted euro spread for the first regression, and the proportional quoted spread for the second regression. The third and fourth regressions include the natural logarithm of the euro turnover and percentage volatility for Star and New Market stocks. All variables are calculated using data from six months around the structural change. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

A. Descriptive statistics	Mean before (Median before)	Mean after (Median after)	Mean change
Quoted spread (€)	0.434 (0.41)	0.284 (0.27)	-0.150**
Proportional spread (%)	0.5342 (0.4971)	0.6136 (0.5868)	0.0794
Turnover (€)	1,131,166 (851,067)	1,167,845 (792,485)	36,679
Volatility (%)	3.918 (3.657)	4.172 (4.078)	0.2540

Table 4-8, continued

B. Regressions	Intercept	Change	New Market spread	New Market turnover ln(€)	New Market volatility (%)	Star turnover ln(€)	Star volatility (%)	Adj. R^2
Star quoted spread (€)	0.0496**	-0.0078*	0.0283*					0.1527
Star proportional spread (%)	0.0089**	-0.0018**	0.4039**					0.3115
Star quoted spread (€)	0.0893*	-0.0061*	--	-0.0012	0.2228	-0.0041	1.108**	0.2658
Star proportional spread (%)	0.0050**	-0.0010**	--	-0.0007	0.0123	-0.0006	0.2424**	0.4639

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

The comparison of the quoted half spread with the effective half spread indicates that effective spreads are lower than quoted spreads. The half spread averages €0.022, while the effective spread averages €0.018. The difference of €0.0034 is significantly different from zero. Percentage spread results are consistent. The difference between proportional and effective spreads of 0.0863 percent is significantly different from zero. Thus the specialist's ability to offer price improvement over the best quotes provides an even lower cost of trading than was attainable in the auction market.[13]

Table 4-9
Effective Spreads

This table reports quoted and effective half spreads (both euro and percentage) for the 20 stocks that moved from an auction market to the Star specialist market. Stocks are included if they traded continuously for 12 months prior to and after the 2 April, 2001 structural change. For each measure, the mean, median and mean difference is reported. Statistical significance emanates from the test of whether the mean difference between the effective and quoted spread is different from zero.

	Half spreads (€)		Half spreads (%)	
	Quoted	Effective	Quoted	Effective
Mean	0.022	0.018	0.5537	0.4674
Median	0.014	0.009	0.4380	0.3114
Mean difference	-0.004**		-0.0863**	

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

[13] I also compare effective and quoted spreads using three and six month event windows after the structural change. The results from this are consistent with the 12 month results.

4.6 Summary

Several studies have compared the differences in bid-ask spreads for stocks listed on the NYSE and Nasdaq. On 2 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 provides a 'natural' experiment where the impact of a specialist on the bid-ask spread can be ascertained.

Results indicate that spreads tighten when stocks move from an auction market to a specialist market, although trading activity is slightly reduced. After controlling for the bid-ask spread, the turnover and the volatility in the SBO and Star markets, both the quoted and proportional Star spreads exhibit considerable reductions after the structural change. The first hypothesis that bid-ask spreads are lower under a specialist market structure is thus accepted. However, the second hypothesis that trading activity will increase with specialist intervention is rejected.

4.7 Appendix

Table 4-10
Ticker Symbols for Star and SBO Stocks

This table lists the ticker symbols for the 20 stocks that switched to the Star market on 2 April, 2001 (Panel A) and the 57 stocks which remained in the ordinary SBO market (Panel B).

Panel A: Star stocks				
AMG	CMB	IMA	MRT	RG
BFE	CRM	IP	NM	RM
BRE	CSP	JH	PEL	SG
CEM	DMH	LD	PIN	STEF
Panel B: SBO stocks				
ACS	ENR	IZ	RIC	TFI
ARN	FDP	MCL	RON	VEM
ASR	GC	MF	SAD	VIN
B	GEM	MFNC	SCH	VLA
BAN	GI	MON	SIT	ZUC
BDB	GNV	OLI	SMI	
BE	IFP	PAG	SMU	
BRI	IGV	PF	SN	
CARR	IML	PINF	SNA	
CLE	IMS	PMS	SOL	
COF	IPG	POL	SPF	
CRA	ITH	PRO	SPO	
DAN	ITK	RAT	SSL	

Chapter 5: The Intraday Behavior of Bid-Ask Spreads Across Auction and Specialist Market Structures

5.1 Introduction

This chapter analyzes the intraday pattern in bid-ask spreads for Star stocks on the Italian Bourse. The literature reviewed in Chapter 2 highlighted the many studies that have analyzed spreads across the trading day, and have documented a U-shaped intraday pattern. This phenomenon has been attributed to inventory holding costs, specialist market power and adverse selection risk. However, the hybrid nature of trading on the NYSE (which combines a specialist with a limit order book) makes it difficult to determine the exact nature of spreads dictated by a specialist. The stocks that switched from an auction to a specialist market on the Italian Bourse thus provide a natural experiment to compare intraday spreads across the two market structures.

Based on this and the literature in Section 2.2.2, two hypotheses were developed, which will be subsequently tested in this Chapter. 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 their market powers to consistently charge higher prices.

The remainder of this chapter is organized as follows. Section 5.2 describes the dataset and subsequent sample used. Section 5.3 sets out the research design, Section 5.4 presents the empirical results, while Section 5.5 reports several additional tests. Section 5.6 summarizes the chapter.

5.2 Data and Sample

As with the previous chapter, I 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.[14] From the remaining stocks, I select 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 20 commenced trading in the new Star market.[15]

For these 20 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

[14] Also excluded are foreign listed companies.
[15] A list of all Star ticker symbols is provided in Section 4.7.

turnover for each stock. Market capitalization of all 20 firms on the trading day prior to the structural change is also available. The data is sourced from a Reuters database.

Table 5-1 provides summary statistics for the 20 Star stocks included in the sample. The average proportional spread prior to the structural change is 0.627 percent, whilst after the change the average has risen to 0.665 percent. The average price has fallen, from €5.03 before to €4.16 after. Average daily volume prior to 2 April, 2001 is 111,612 shares, whilst after the event date the average has fallen to 94,034 shares. The reduction in price and volume has lead to a reduction in average daily turnover, from €555,827 to €363,457. Average daily volatility, calculated as the log difference between the high price and low price on each trading day, 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 €296.9 million.

5.3 Research Design

To analyze the intraday behavior of bid-ask spreads and to test the first hypothesis for this chapter ($H_{5,1}$), I partition each trading day into 32 15-minute intervals.[16] Following the leads of both McInish and Wood (1992) and Chan, Chung and Johnson (1995), I calculate time-weighted absolute bid-ask spreads

[16] Same partitioning as used by Chan, Chung and Johnson (1995).

in each time interval. The weighting method is based on the number of seconds the quotation is outstanding during the 15-minute interval. I also calculate the midpoint of the bid-ask spread at the end of each 15-minute interval. The volatility for each 15-minute interval is calculated as the absolute midpoint-to-midpoint stock return. The use of quote midpoints is motivated by Chan, Chung and Johnson (1995) who claim that the use of transaction prices is noisy due to bid-ask bounce. Volume is simply the total number of shares transacted in each 15-minute interval.

It is possible that 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-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, I include only bid-ask spreads that lead directly to trades. Essentially this involves using the bid-ask spread immediately prior to each transaction.[17] Thus for each 15-minute interval, I calculate the volume-weighted effective percentage half spread as [Transaction Price – (Ask + Bid) / 2] / (Ask + Bid) / 2.[18]

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[17] Bessembinder (2003) and Peterson and Sirri (2003) show that estimates are least biased when measured using contemporaneous bid-ask quotes.

[18] During the pre-period in which Star stocks traded in an auction market, the effective percentage spread is equal to the proportional bid-ask spread as no transactions occurred within the quotes.

Table 5-1
Descriptive Statistics

This table reports descriptive statistics (number of stocks, proportional spread, closing price, daily volume, daily turnover, daily volatility and market capitalization) for the 20 Star stocks. Stocks are included if they traded continuously 12 months prior to and after the 2 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. Market capitalization is calculated on the trading day prior to the structural change.

		Star market	
		Before	After
Number of stocks		20	
Time-Weighted spread (%)			
	Mean	0.627	0.665
	Median	0.581	0.643
Closing price (€)			
	Mean	5.03	4.16
	Median	4.47	3.53
Daily volume (shares)			
	Mean	111,612	94,034
	Median	107,328	89,034
Daily turnover (€)			
	Mean	555,827	363,457
	Median	422,429	319,842
Daily volatility (%)			
	Mean	2.810	2.654
	Median	2.730	2.493
Market capitalization (€ million)			
	Mean	296.9	
	Median	258.8	

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

$$\mathrm{BAS}_{\mathrm{t}} = \beta_0 + \beta_1 Vol_t + \beta_2 Volume_t + \sum_{n=1}^{32} \beta_{3,\mathrm{n}} D_n + \sum_{d=1}^{4} \beta_{4,\mathrm{d}} Day_d + \varepsilon_t \qquad (5\text{-}1)$$

$$\mathrm{EBAS_t} = \beta_0 + \beta_1 Vol_t + \beta_2 Volume_t + \sum_{n=1}^{32} \beta_{3,\mathrm{n}} D_n + \sum_{d=1}^{4} \beta_{4,\mathrm{d}} Day_d + \varepsilon_t \qquad (5\text{-}2)$$

In the first regression, $\mathrm{BAS_t}$ represents the time-weighted bid-ask spread in each 15-minute interval, while in the second regression, $\mathrm{EBAS_t}$ 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, Vol_t, is the absolute midpoint-to-midpoint stock return for each 15-minute interval. The volume variable, $Volume_t$, is the total number of shares transacted in each 15 minute interval. Following the lead of McInish and Wood (1992), I include four dummy variables, Day_d, that equal one if the observations occur on Tuesday, Wednesday, Thursday, or Friday respectively, zero otherwise. This should capture any day-of-the-week effects.

To analyze the intraday behavior 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 chapter ($H_{5,2}$), I include 32 time-interval dummy variables for the entire two-year period. For example, if an observation falls into the first 15-minute interval and occurred after the 2 April, 2001 structural change, then the D_1 dummy variable takes the value of one, zero otherwise. Thus if D_1 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), I exclude the middle three 15-minute intervals from the specialist structure period.

5.4 Empirical Results

5.4.1 Intraday Pattern Results

Tables 5-2 and 5-3 present 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 for the 12 months before and after the 2 April, 2001 structural change. First, volume shows a U-shaped pattern both before and after the structural change, consistent with the findings of McInish and Wood (1992) and Chan, Chung and Johnson (1995). Volume is lower in each 15-minute interval after the structural change (which is consistent with the findings in the previous chapter). This U-shaped pattern, and the differences between the before and after periods, are also evident in Figure 5-1.

Secondly, return volatility is highest at the start of the trading day, both before and after the structural change. However, unlike with Chan, Chung and Johnson (1995), volatility does not begin to rise again at the end of the trading day. Interestingly, there is a spike in volatility around 3 p.m. under the specialist market structure, which lasts approximately 30 minutes, and then reverts back to prior levels. The spike and lack of U-shaped pattern is clearly illustrated in Figure 5-2.

Table 5-2
Intraday Patterns Prior to Structural Change

This table reports the mean values for volume, volatility, time-weighted percentage bid-ask spread (TWBAS) and volume-weighted effective percentage half spread (EBAS) in each 15-minute interval of the trading day for the 20 Star stocks prior to the 2001 structural change. Stocks are included if they traded continuously for 12 months prior to and after the structural change.

Time	Volume	Volatility	TWBAS (%)	EBAS (%)
9:30AM	1965	0.0053	1.497	0.5931
9:45AM	1961	0.0055	1.258	0.4978
10:00AM	2067	0.0061	1.139	0.3899
10:15AM	2005	0.0052	1.070	0.3464
10:30AM	2029	0.0043	1.022	0.3425
10:45AM	2018	0.0033	0.9853	0.3244
11:00AM	2087	0.0032	0.9507	0.3217
11:15AM	2032	0.0034	0.9208	0.3105
11:30AM	1949	0.0028	0.9017	0.3050
11:45AM	2092	0.0031	0.8833	0.2972
12:00PM	1957	0.0026	0.8718	0.2889
12:15PM	1992	0.0029	0.8724	0.2912
12:30PM	1948	0.0026	0.8518	0.2982
12:45PM	1928	0.0024	0.8342	0.2804
1:00PM	1854	0.0025	0.8236	0.2851
1:15PM	1841	0.0025	0.8108	0.2771
1:30PM	1764	0.0026	0.8075	0.2847
1:45PM	1456	0.0027	0.8037	0.2756
2:00PM	1122	0.0023	0.8008	0.2905
2:15PM	1338	0.0025	0.8012	0.2884
2:30PM	1337	0.0025	0.803	0.3429
2:45PM	1735	0.0024	0.7919	0.2840
3:00PM	1982	0.0024	0.7886	0.2776
3:15PM	2029	0.0024	0.7897	0.2761
3:30PM	2050	0.0027	0.7909	0.2738
3:45PM	2165	0.0026	0.7916	0.2741
4:00PM	2160	0.0025	0.795	0.2731
4:15PM	2301	0.0026	0.7924	0.2763
4:30PM	2271	0.0024	0.8023	0.2780
4:45PM	2376	0.0029	0.8062	0.2841
5:00PM	2430	0.0025	0.8224	0.2926
5:15PM	2737	0.0026	0.8616	0.2961
5:30PM	2697	0.0025	0.9880	0.3329

Table 5-3
Intraday Patterns After the Structural Change

This table reports the mean values for volume, volatility, time-weighted percentage bid-ask spread (TWBAS) and volume-weighted effective percentage half spread (EBAS) in each 15-minute interval of the trading day for the 20 Star stocks after the 2001 structural change. Stocks are included if they traded continuously for 12 months prior to and after the structural change.

Time	Volume	Volatility	TWBAS (%)	EBAS (%)
9:30AM	1761	0.0070	1.483	0.5846
9:45AM	1705	0.0067	1.325	0.4545
10:00AM	1272	0.0044	1.235	0.3795
10:15AM	1312	0.0036	1.184	0.3468
10:30AM	1326	0.0040	1.138	0.3261
10:45AM	1329	0.0030	1.093	0.3352
11:00AM	1257	0.0037	1.061	0.3221
11:15AM	1215	0.0037	1.065	0.3151
11:30AM	1296	0.0041	1.039	0.3207
11:45AM	1278	0.0030	1.026	0.3135
12:00PM	1296	0.0028	1.013	0.3229
12:15PM	1316	0.0033	0.9943	0.3182
12:30PM	1220	0.0031	0.9865	0.3134
12:45PM	1285	0.0034	0.9843	0.3125
1:00PM	1191	0.0032	0.9730	0.3133
1:15PM	1178	0.0031	0.9648	0.3156
1:30PM	986	0.0026	0.9564	0.2855
1:45PM	840	0.0021	0.9499	0.2483
2:00PM	741	0.0017	0.9447	0.2279
2:15PM	820	0.0018	0.9403	0.2201
2:30PM	884	0.0019	0.9283	0.4537
2:45PM	1082	0.0024	0.9221	0.2781
3:00PM	1282	0.0043	0.9202	0.3011
3:15PM	1291	0.0028	0.9201	0.2914
3:30PM	1368	0.0026	0.9157	0.2956
3:45PM	1371	0.0026	0.9155	0.3063
4:00PM	1403	0.0024	0.9206	0.2970
4:15PM	1563	0.0024	0.9375	0.3027
4:30PM	1519	0.0028	0.9473	0.3072
4:45PM	1524	0.0025	0.9445	0.3155
5:00PM	1797	0.0024	0.9460	0.3078
5:15PM	1769	0.0027	0.9692	0.3263
5:30PM	2112	0.0027	0.8603	0.3978

Figure 5-1
Volume Across the Trading Day

This figure depicts the average volume for each 15 minute interval across the trading day for the 20 stocks that moved from the auction market to the Star market on 2 April, 2001.

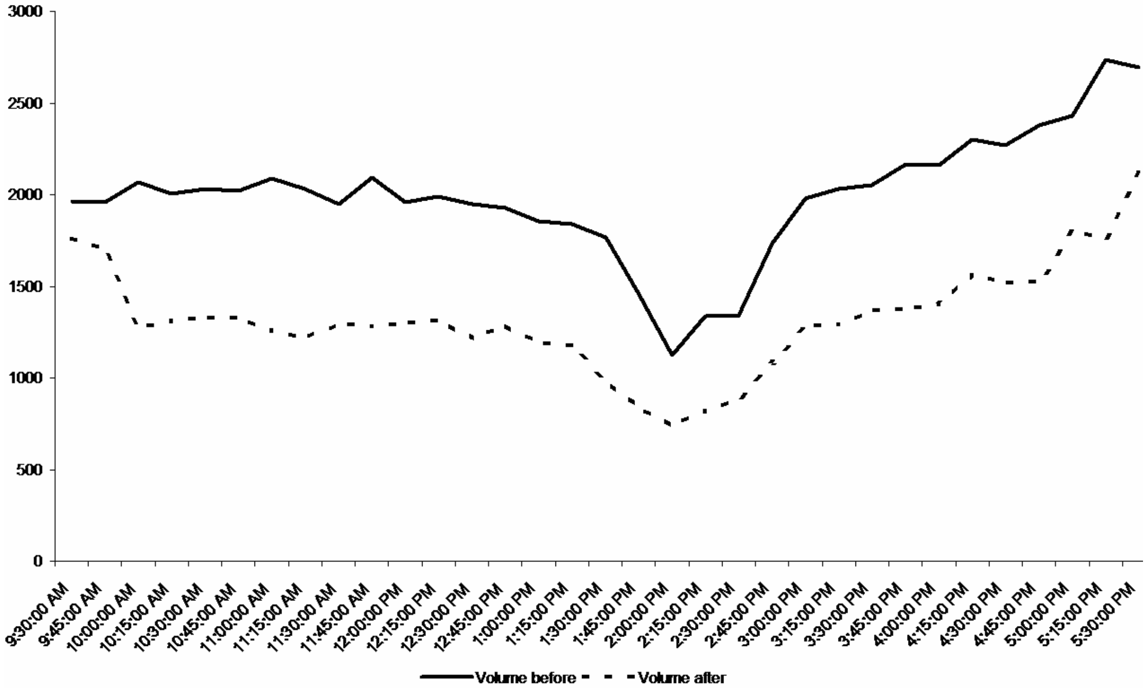
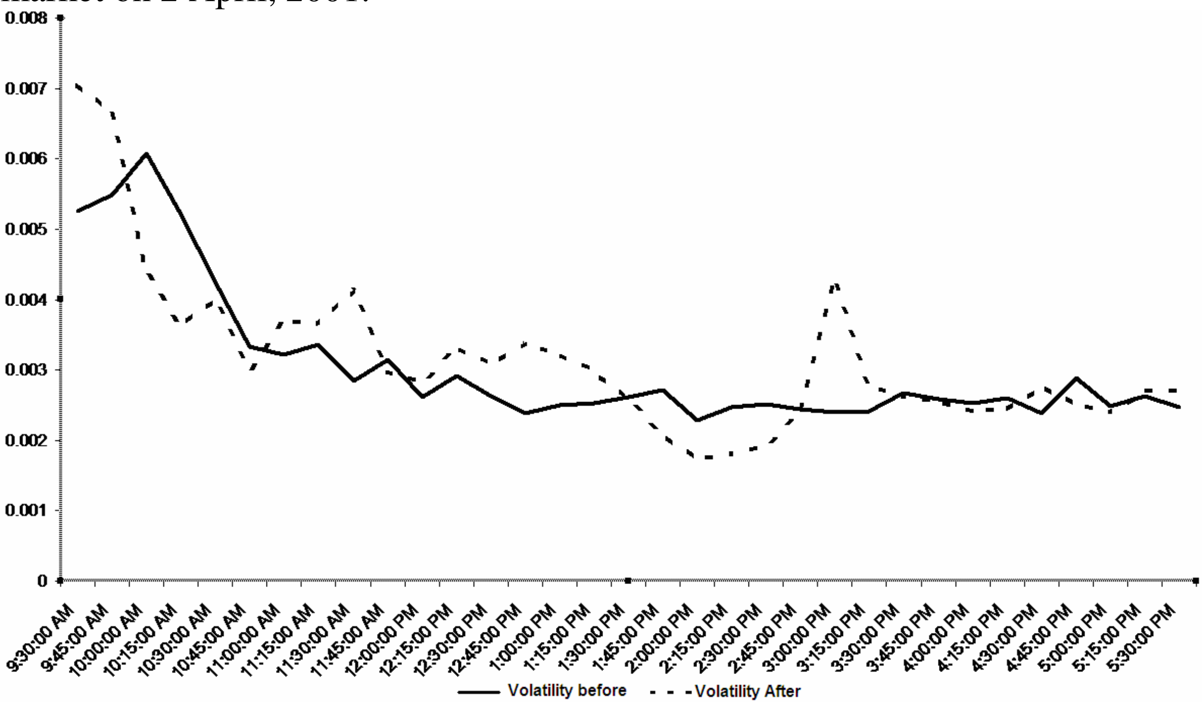


Figure 5-2
Volatility Across the Trading Day

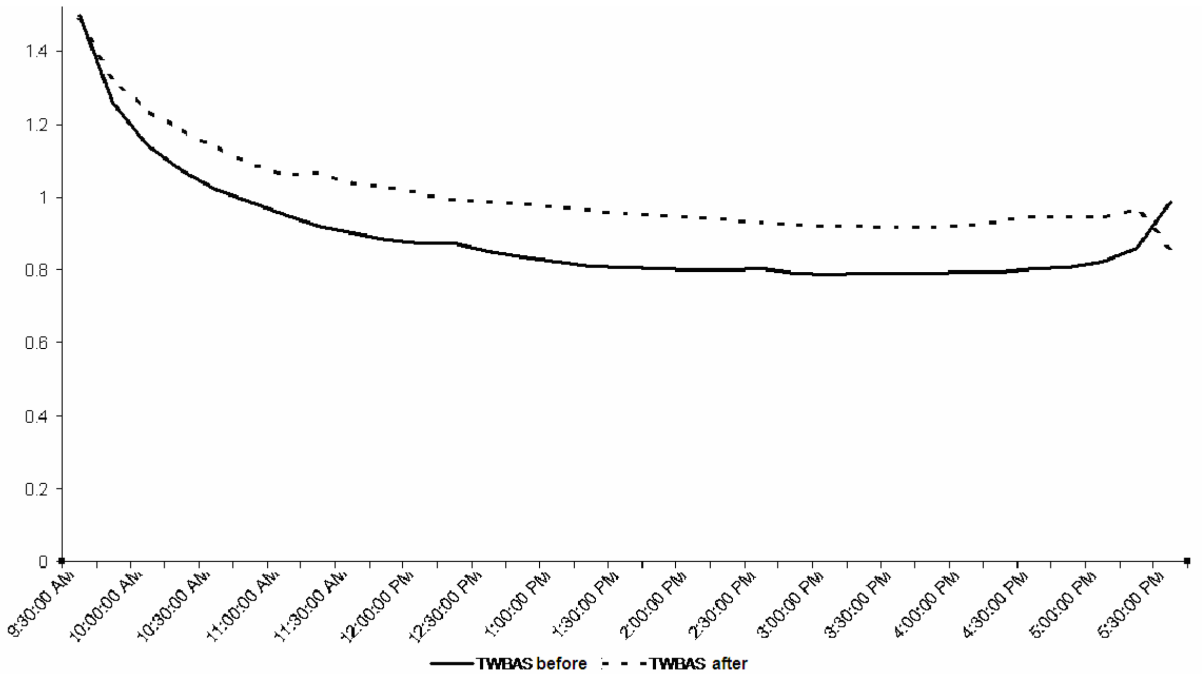
This figure depicts the average volatility for each 15 minute interval across the trading day for the 20 stocks that moved from the auction market to the Star market on 2 April, 2001.



Turning attention to bid-ask spreads, time-weighted spreads for the Star stocks prior to the structural change exhibit a definite U-shaped pattern. Spreads are wider at the start of the trading day, tighten throughout the day, and begin to widen towards the end of the day. The time-weighted spread pattern after the structural change commences in a similar fashion with spreads widest at the open. However, time-weighted spreads in the final 15-minutes of trading are 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 5-3. Overall, apart from the final 15-minute interval, spreads are tighter under an auction rather than specialist market structure.

Figure 5-3
Time-Weighted Proportional Spread Across the Trading Day

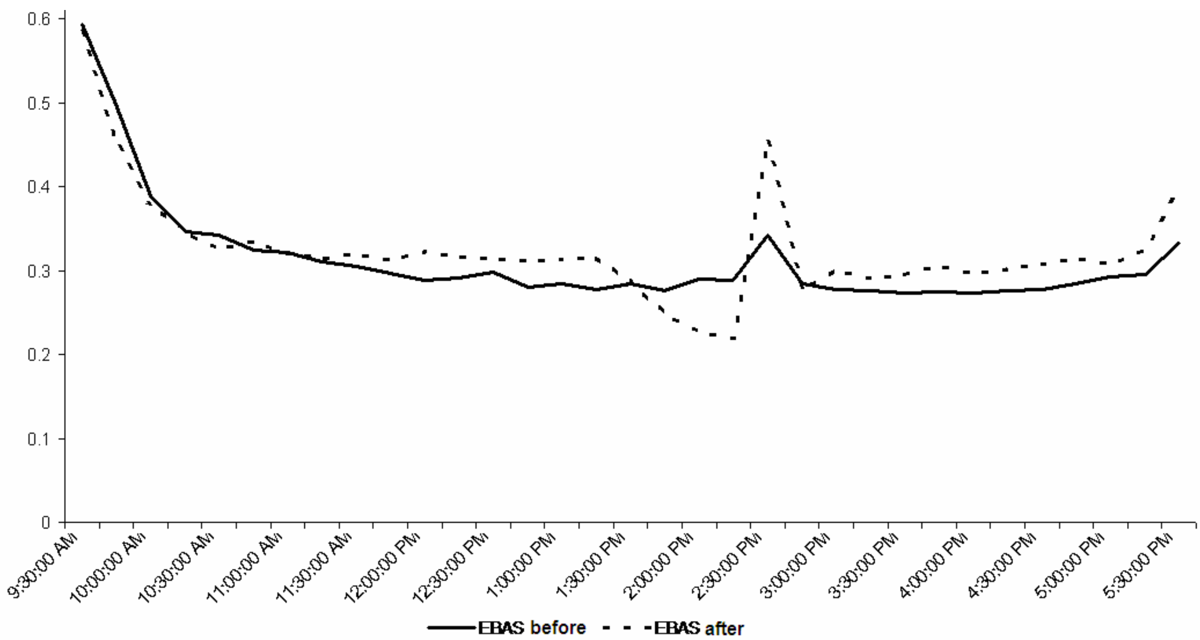
This figure depicts the time-weighted proportional spread for each 15 minute interval across the trading day for the 20 stocks that moved from the auction market to the Star market on 2 April, 2001.



Finally, to capture the 'real' cost of trading to market participants, the volume-weighted effective percentage half spread is compared. Both before and after the structural change, the effective spread exhibits a U-shaped intraday pattern. Surprisingly, but consistent with the volatility results, there is a spike in spreads both before and after the structural change, at around 2:30 p.m. Figure 5-4 which presents 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 5-4
Volume-Weighted Effective Spread Across the Trading Day

This figure depicts the volume-weighted effective percentage half spread for each 15 minute interval across the trading day for the 20 stocks that moved from the auction market to the Star market on 2 April, 2001.



5.4.2 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 in the previous section is estimated. The results of this are presented in Table 5-4. 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 under both auction and specialist market structures. 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.[19] 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

[19] This finding of smaller spreads in the final 15-minute interval is consistent with the findings of the previous chapter, in which the closing spread was shown to be tighter under a specialist market structure.

is significantly negative, while the volatility variable is 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-the-week effects are not robust. In direct contrast to the time-weighted results, the majority of time-interval dummy variables are significantly negative. Apart from the first two 15-minute intervals, and at 2:30 p.m., 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 ($H_{5,1}$) is accepted. Bid-ask spreads, volume and volatility exhibit a U-shaped pattern in both an auction and specialist market structure.

Table 5-4
Multiple Regression Results

This table reports regression results for the 20 stocks that moved from an auction market to the Star market on 2 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 is measured as the time-weighted bid-ask spread, while in the second regression it 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	EBAS		TWBAS	EBAS
Intercept	0.7491**	0.4236**	D19	0.2067**	-0.1214**
Volatility	9.803**	0.2706**	D20	0.2164**	0.0347**
Volume	-0.0426**	-0.0567**	D21	0.2162**	-0.0893**
D1	0.7399**	0.1069**	D22	0.2329**	-0.0819**
D2	0.5345**	0.0150**	D23	0.2240**	-0.0875**
D3	0.4448**	-0.0241**	D24	0.2266**	-0.0869**
D4	0.4057**	-0.0361**	D25	0.2377**	-0.0815**
D5	0.3751**	-0.0411**	D26	0.2286**	-0.0867**
D6	0.3457**	-0.0498**	D27	0.2392**	-0.0819**
D7	0.3146**	-0.0593**	D28	0.2496**	-0.0794**
D8	0.3267**	-0.0593**	D29	0.2543**	-0.0717**
D9	0.2971**	-0.0671**	D30	0.2628**	-0.0700**
D10	0.2964**	-0.0655**	D31	0.2825**	-0.0581**
D11	0.2764**	-0.0674**	D32	0.3484**	-0.0546**
D12	0.2779**	-0.0653**	Tuesday	-0.0212**	-0.0008
D13	0.2526**	-0.0759**	Wednesday	-0.0113	0.0005
D14	0.2664**	-0.0739**	Thursday	-0.0207**	-0.0007
D15	0.2553**	-0.0862**	Friday	-0.0137**	-0.0023
D16	0.2422**	-0.1100**	R-squared	0.0981	0.0327
D18	0.2023**	-0.1156**			

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

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 a specialist system. However, the time-weighted spread does not capture specialist trading inside the best quotes. Comparison 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, I reject the second hypothesis ($H_{5,2}$). The specialist does not use his market powers to consistently charge higher prices.

5.5 Additional Tests

5.5.1 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" (which are analyzed in Chapter 3), the stocks remaining in the Star market are already medium to small capitalization stocks. To examine the impact of firm size, I divide the samples of Star stocks into two groups, as in the previous chapter. 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 5-5 and Table 5-5 for small capitalization stocks, and Figure 5-6 and Table 5-6 for medium capitalization stocks.[20]

[20] Relevant market capitalization and descriptive statistics are identical to those presented in Chapter 4.

Table 5-5
Small Stock Segment

This table reports regression results for small capitalization stocks that moved from an auction market to the Star market on 2 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 is measured as the time-weighted bid-ask spread, while in the second regression it 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.

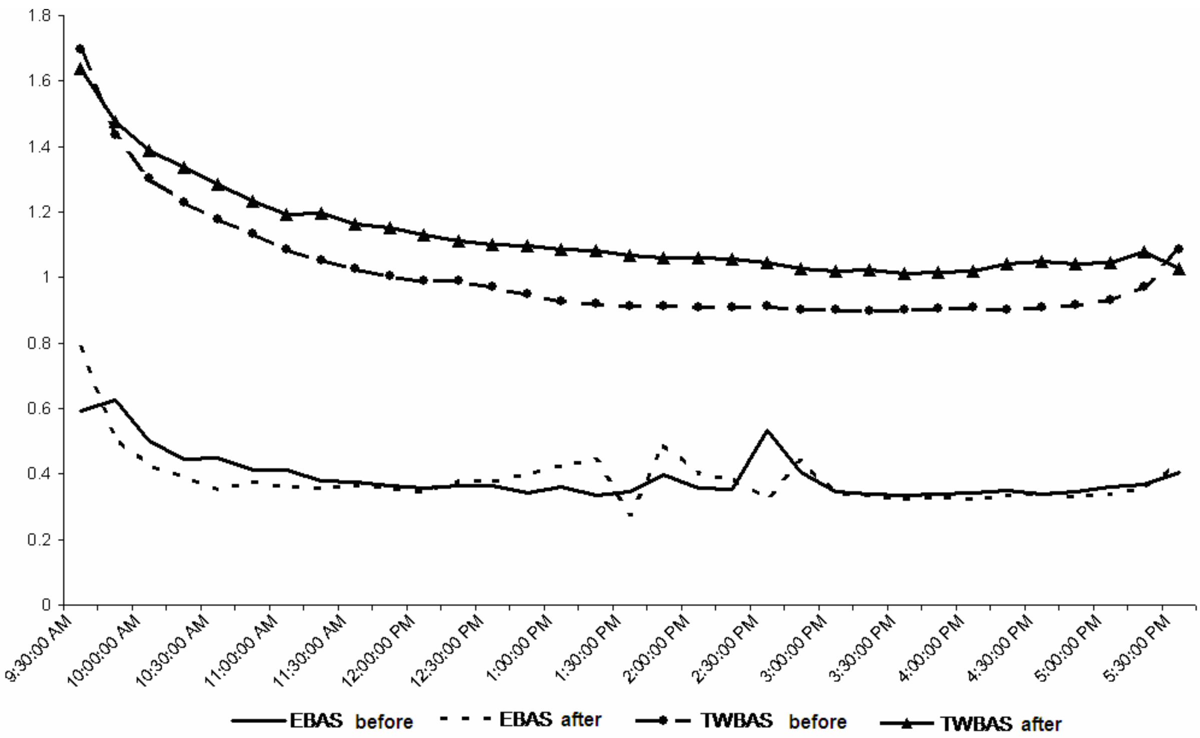
	TWBAS	EBAS		TWBAS	EBAS
Intercept	0.7498**	0.6238**	D19	0.2045**	-0.0692**
Volatility	9.394**	0.1829**	D20	0.1965**	-0.0324**
Volume	-0.0305**	-0.0279**	D21	0.2026**	-0.0143**
D1	0.7900**	0.1500**	D22	0.211**	-0.0910**
D2	0.5585**	0.0576**	D23	0.2025**	-0.0918**
D3	0.4652**	0.0021	D24	0.2065**	-0.1051**
D4	0.4266**	-0.0055	D25	0.2181**	-0.0961**
D5	0.3876**	-0.0168**	D26	0.2038**	-0.0961**
D6	0.3519**	-0.0242**	D27	0.2170**	-0.0838**
D7	0.3130**	-0.0528**	D28	0.231**	-0.0834**
D8	0.3259**	-0.0533**	D29	0.2220**	-0.0714**
D9	0.2884**	-0.0648**	D30	0.2334**	-0.0695**
D10	0.2959**	-0.0749**	D31	0.2617**	-0.0599**
D11	0.2545**	-0.0679**	D32	0.3521**	-0.0003
D12	0.2692**	-0.0512**	Tuesday	-0.0194**	0.0025
D13	0.2325**	-0.0713**	Wednesday	-0.0103	0.0008
D14	0.2576**	-0.0408**	Thursday	-0.0032	0.0026
D15	0.2384**	-0.1178**	Friday	0.0040	-0.0019
D16	0.2254**	0.0103	R-squared	0.1036	0.0533
D18	0.1878**	-0.0623**			

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

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. The pattern is similar to the specialist market, except for the final 15-minute interval which experiences 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.

Figure 5-5
Intraday Spread Patterns for Small Capitalization Stocks

This figure depicts the time-weighted proportional spread and volume-weighted effective percentage half spread for each 15 minute interval across the trading day for the small capitalization stocks that moved from the auction market to the Star market on 2 April, 2001.



The regression results for the time-weighted spread are consistent with the aggregated results (spreads are wider 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.

Table 5-6
Medium Stock Segment

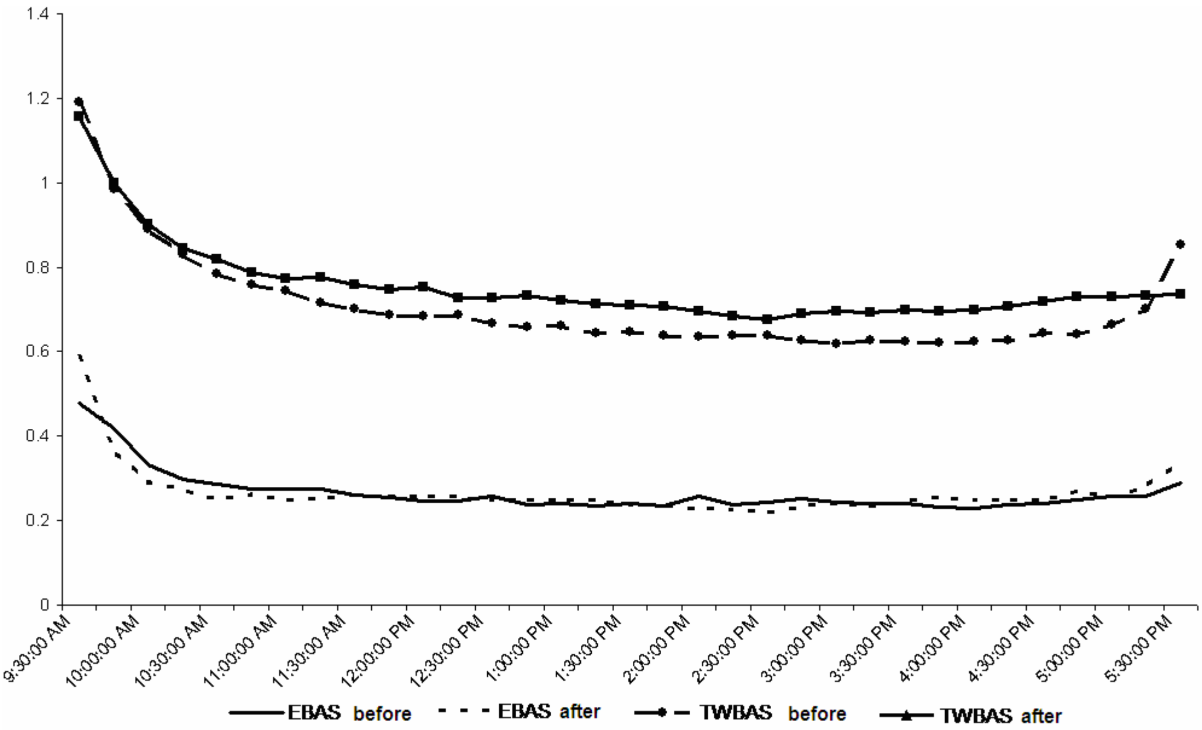
This table reports regression results for medium capitalization stocks that moved from an auction market to the Star market on 2 April, 2001. Stocks are included if they traded continuously for 12 months prior to and after the structural change. In the first regression the dependant variable is measured as the time-weighted bid-ask spread, while in the second regression it 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	EBAS		TWBAS	EBAS
Intercept	0.5504**	0.2476**	D19	0.1977**	-0.0467**
Volatility	0.4650**	1.532**	D20	0.2182**	-0.0424**
Volume	-0.0271**	-0.0035**	D21	0.2125**	-0.0278**
D1	0.6410**	0.1195**	D22	0.2245**	-0.0330**
D2	0.4760**	0.0341**	D23	0.2164**	-0.0368**
D3	0.3880**	0.0075	D24	0.2227**	-0.0358**
D4	0.3457**	-0.0035	D25	0.2268**	-0.0352**
D5	0.3265**	-0.0085	D26	0.2215**	-0.0412**
D6	0.3037**	-0.0153**	D27	0.2286**	-0.0367**
D7	0.2845**	-0.0153**	D28	0.2333**	-0.0346**
D8	0.2871**	-0.0193**	D29	0.2584**	-0.0155**
D9	0.2688**	-0.0211**	D30	0.2642**	-0.0188**
D10	0.2616**	-0.0260**	D31	0.2756**	-0.0073
D11	0.2673**	-0.0294**	D32	0.2974**	-0.0338**
D12	0.2607**	-0.0236**	Tuesday	-0.0114	0.0053
D13	0.2402**	-0.0341**	Wednesday	0.0016	-0.0013
D14	0.2425**	-0.0291**	Thursday	-0.0225*	0.0003
D15	0.2412**	-0.0351**	Friday	-0.0053	0.0048
D16	0.2323**	-0.0362**	R-square	0.0691	0.0245
D18	0.1979**	-0.0385**			

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

Figure 5-6
Intraday Spread Patterns for Medium Capitalization Stocks

This figure depicts the time-weighted proportional spread and volume-weighted effective percentage half spread for each 15 minute interval across the trading day for the medium capitalization stocks that moved from the auction market to the Star market on 2 April, 2001.



5.5.2 Length of Event Window

Following the lead of the previous chapter, I examine the sensitivity of results to the length of the event window. As a 12 month pre- and post- event window could include significant variation in turnover and volatility, I repeat the analysis for both three and six months before and after the structural change. The results are presented in Figure 5-7 and Table 5-7 (three month window) and Figure 5-8 and Table 5-8 (six month window).

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. The pattern is similar under a specialist system, except for the final 15-minute interval which experiences a reduction in spreads. The effective spreads also exhibit a U-shaped pattern, except for a period in the middle of the trading day for both the three and six month event windows, which exhibit considerable volatility, both before and after the structural change.

The regression results are consistent with the 12 month results. Volume is negatively related, volatility is positively related, while day-of-the-week dummy variables are 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.

5.5.3 Intraday Spreads for SBO Stocks

Although findings in the previous section indicate that the cost of trading is lower under a specialist market structure, it could be that market wide forces are driving this reduced cost. I thus repeat 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 and no trading takes place within the quotes, analysis is restricted to time-weighted bid-ask spreads. The results are presented in Figure 5-9 and Table 5-9.

Table 5-7
Three Month Event Window

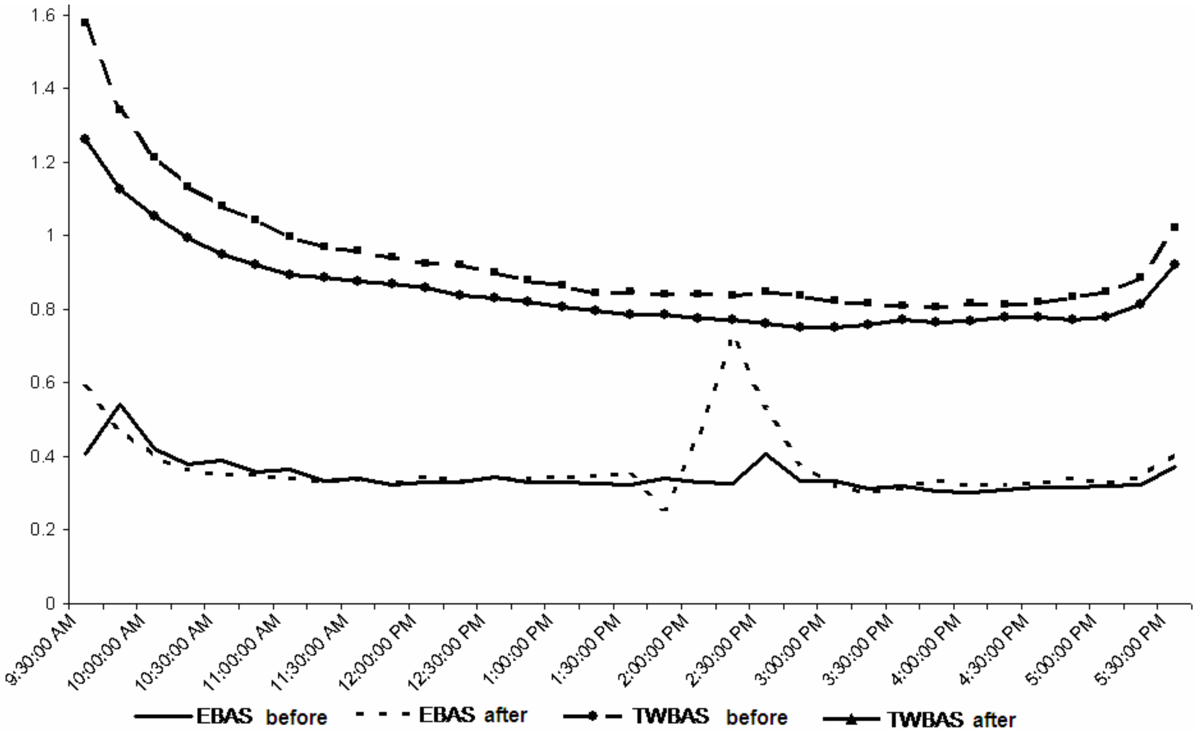
This table reports regression results for the 20 stocks that moved from an auction market to the Star market on 2 April, 2001. Stocks are included if they traded continuously for 12 months prior to and after the structural change. All variables are calculated using data from three months before and after the structural change. In the first regression the dependant variable is measured as the time-weighted bid-ask spread, while in the second regression it 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	EBAS		TWBAS	EBAS
Intercept	0.9020**	0.5138**	D19	-0.1588**	-0.1706**
Volatility	0.3600**	0.4318*	D20	-0.1676**	-0.1755**
Volume	-0.0020**	0.0001**	D21	-0.2104**	-0.2126**
D1	-0.0325**	-0.0410**	D22	-0.2079**	-0.2120**
D2	-0.1330**	-0.1341**	D23	-0.2189**	-0.2264**
D3	-0.1698**	-0.1722**	D24	-0.2167**	-0.2198**
D4	-0.1631**	-0.1656**	D25	-0.2194**	-0.2225**
D5	-0.1869**	-0.1902**	D26	-0.2281**	-0.2317**
D6	-0.1845**	-0.1892**	D27	-0.2226**	-0.2240**
D7	-0.2021**	-0.2083**	D28	-0.2173**	-0.2187**
D8	-0.1992**	-0.1981**	D29	-0.2154**	-0.2180**
D9	-0.2136**	-0.2139**	D30	-0.2182**	-0.2188**
D10	-0.2010**	-0.2045**	D31	-0.2125**	-0.2153**
D11	-0.2087**	-0.2109**	D32	-0.1607**	-0.1550**
D12	-0.2016**	-0.2033**	Tuesday	0.0052	0.0032
D13	-0.2057**	-0.2085**	Wednesday	-0.0030	-0.0033
D14	-0.1971**	-0.2064**	Thursday	-0.0008	-0.0016
D15	-0.2111**	-0.2143**	Friday	-0.0044	-0.0058*
D16	-0.1976**	-0.2091**	R-square	0.0440	0.0405
D18	-0.2038**	-0.2091**			

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

Figure 5-7
Intraday Spread Patterns for Three Month Event Window

This figure depicts the time-weighted proportional spread and volume-weighted effective percentage half spread for each 15 minute interval across the trading day for the 20 stocks that moved from the auction market to the Star market on 2 April, 2001. All spreads are calculated using data from three months before and after the structural change.



The time-weighted intraday spread pattern exhibits the classical U-shaped pattern, with spreads wider 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. 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 day-of-the-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 5-8
Six Month Event Window

This table reports regression results for the 20 stocks that moved from an auction market to the Star market on 2 April, 2001. Stocks are included if they traded continuously for 12 months prior to and after the structural change. All variables are calculated using data from six months before and after the structural change. In the first regression the dependant variable is measured as the time-weighted bid-ask spread, while in the second regression it 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	EBAS		TWBAS	EBAS
Intercept	1.018**	0.4023**	D19	-0.0858**	0.1231**
Volatility	18.29**	0.2077**	D20	-0.0858**	0.0517**
volume	-0.0020**	-0.0011**	D21	-0.0834**	-0.0611**
D1	0.5473**	0.0905**	D22	-0.0916**	-0.0961**
D2	0.3525**	-0.0196**	D23	-0.0938**	-0.1112**
D3	0.2459**	-0.0607**	D24	-0.0898**	-0.1116**
D4	0.1810**	-0.0664**	D25	-0.0911**	-0.1080**
D5	0.1360**	-0.0773**	D26	-0.0877**	-0.1086**
D6	0.0885**	-0.0608**	D27	-0.0736**	-0.1066**
D7	0.0480**	-0.0753**	D28	-0.0635**	-0.1068**
D8	0.0521**	-0.0726**	D29	-0.0586**	-0.0843**
D9	0.0255	-0.0812**	D30	-0.0491**	-0.0860**
D10	0.0097	-0.0756**	D31	-0.0437**	-0.0767**
D11	-0.0028	-0.0791**	D32	-0.0354**	-0.0223**
D12	-0.0071	-0.0687**	Tuesday	0.0043	0.0014
D13	-0.0199	-0.0914**	Wednesday	-0.0130	0.0016
D14	-0.0368**	-0.0839**	Thursday	-0.0297**	0.0022
D15	-0.0514**	-0.0775**	Friday	-0.0054	0.0002
D16	-0.0679	-0.1243**	R-square	0.0470	0.0315
D18	-0.0909**	-0.0171**			

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

Figure 5-8
Intraday Spread Patterns for Six Month Event Window

This figure depicts the time-weighted proportional spread and volume-weighted effective percentage half spread for each 15 minute interval across the trading day for the 20 stocks that moved from the auction market to the Star market on 2 April, 2001. All spreads are calculated using data from six months before and after the structural change.

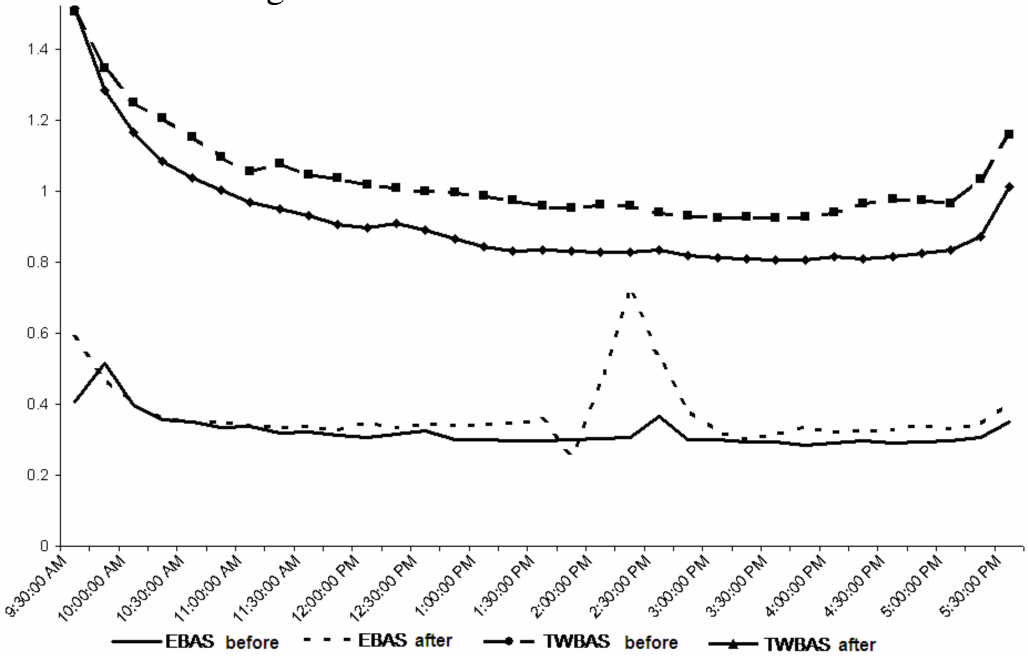


Figure 5-9
Intraday Spread Patterns for SBO Stocks

This figure depicts the time-weighted proportional spread for each 15 minute interval across the trading day for the 57 stocks that remained in the ordinary SBO auction market.

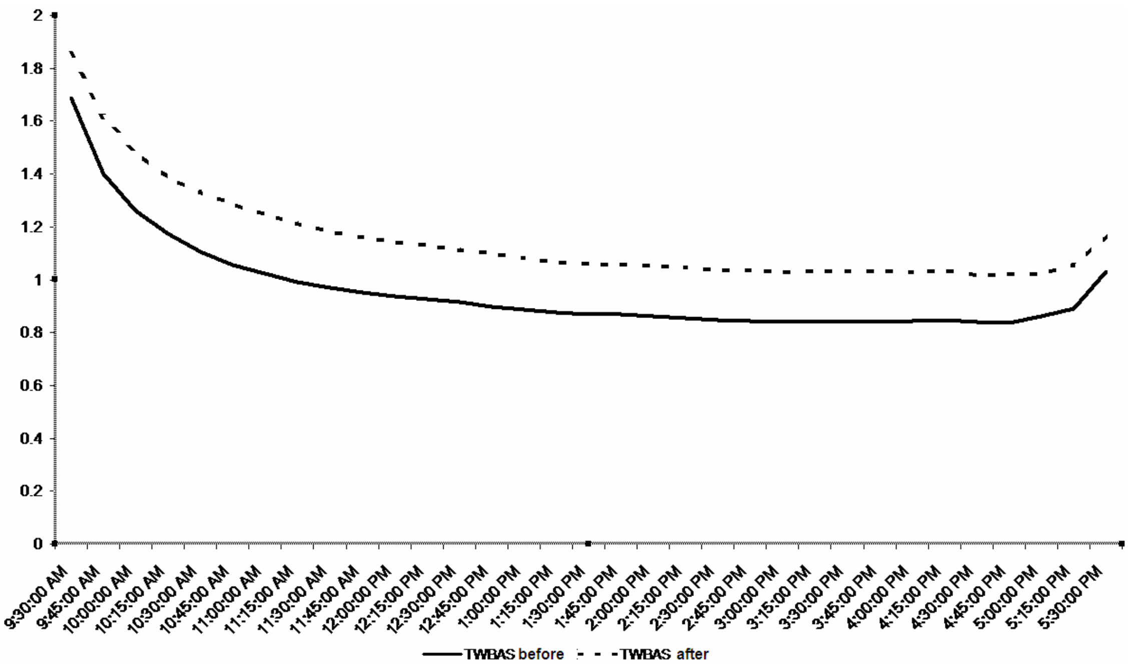


Table 5-9
SBO Stock Analysis

This table reports regression results for the 57 stocks that remained in the ordinary SBO auction market. Stocks are included if they traded continuously for 12 months prior to and after the structural change. The dependant variable is measured as the time-weighted bid-ask 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		TWBAS
Intercept	1.173**	D19	-0.0796**
Volatility	3.997**	D20	-0.0885**
Volume	-0.0598**	D21	-0.0635**
D1	0.6519**	D22	-0.0265*
D2	0.3722**	D23	-0.0210*
D3	0.2770**	D24	-0.0101
D4	0.2201**	D25	-0.0147
D5	0.1681**	D26	-0.0031
D6	0.1284**	D27	-0.0045
D7	0.1035**	D28	-0.0023
D8	0.0843**	D29	-0.0112
D9	0.0677**	D30	-0.0027
D10	0.0449**	D31	0.0045
D11	0.0437**	D32	0.1002**
D12	0.0383**	Tuesday	0.0249
D13	0.0292**	Wednesday	0.0002
D14	0.0136	Thursday	-0.0041
D15	-0.0027	Friday	-0.0010
D16	-0.0186	R-square	0.0981
D18	-0.0863**		

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

5.6 Summary

Intraday analysis of bid-ask spreads has generally shown that spreads exhibit a U-shaped intraday pattern. Spreads are widest at the open, fall throughout the day, and then begin to rise towards the close of trading. On 2 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.

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 and overall market-wide changes. Based on these results, the first hypothesis which conjectures that volume, volatility and spreads exhibit U-shaped patterns is accepted. However, the second hypothesis which conjectures that specialists use their market powers to consistently charge higher prices is rejected.

Chapter 6: Conclusions

This dissertation brings further evidence to bear on the liquidity of various market structures. The literature reviewed in Chapter 2 highlights a number of gaps in the existing literature. The analysis of liquidity surrounding earnings announcements has generally produced inconclusive evidence. This may be attributed to the hybrid nature of trading in US markets, where the specialist's or dealer's impact on the bid-ask spread cannot be directly ascertained. Extending this, the interaction between the specialist and the limit order book on the NYSE make comparing bid-ask spreads across market structures ambiguous. Finally, this hybrid nature of trading on the NYSE makes understanding the intraday pattern of bid-ask spreads, as a result of specialist behavior, difficult, if not impossible. Based on these difficulties in analyzing liquidity, this dissertation presents three essays which bridge gaps in the literature.

The first essay of this dissertation (Chapter 3) analyzes bid-ask spreads around earnings announcements on the Italian Bourse. This chapter provides new evidence that bid-ask spreads increase significantly surrounding earnings announcements, in contrast to prior evidence from US markets which is inconclusive. The use of bid-ask spreads from a purely order-driven environment mitigates the problems inherent in prior studies that use dealer spreads, enabling a cleaner test of information asymmetry surrounding earnings announcements. The results are consistent with an increase in information surrounding earnings announcements, suggesting that private and public information are complements.

The second essay of this dissertation (Chapter 4) analyzes bid-ask spreads across specialist and auction market structures on the Italian Bourse. Several studies have compared the differences in bid-ask spreads for stocks listed on the NYSE and Nasdaq. The majority of these studies show that the cost of executing trades is lower on the NYSE. However, the nature of trading on the NYSE is ambiguous, sometimes referred to as an auction market and other times a specialist market. The existence of a limit order book 'competing' with the specialist further complicates the comparison of spreads with other market structures.

On 2 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). As the Star specialist controls, rather than competes with the limit order book, there is a 'natural' experiment where the impact of a specialist's involvement on the bid-ask spread can be ascertained.

Results indicate that spreads tighten when stocks move from an auction market to a specialist market. After controlling for the bid-ask spread, the turnover and the volatility in the SBO and Star markets, both the quoted and proportional Star spreads exhibit considerable reductions after the structural change. This reduction in spreads is robust to the market capitalization of the stock, the firms' industry affiliation and the event window around the structural change. Using the New Market to control for market wide factors, I confirm the reduction in spreads for Star stocks. The specialist, in allowing price improvement inside the best quotes, is further reducing the cost of executing trades. I conclude that bid-ask spreads are tighter with a specialist. Compared to an auction market, a specialist market proves more advantageous to market participants.

The final essay of this dissertation (Chapter 5) analyzes intraday patterns in bid-ask spreads across specialist and auction market structures on the Italian Bourse. Intraday patterns in bid-ask spreads have been extensively studied in finance research. Most of this research has generally shown that spreads exhibit a U-shaped intraday pattern. Spreads are widest at the open, 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.

The switch from an auction to a specialist market on the Italian Bourse provides a 'natural' experiment where the intraday patterns in spreads can be directly compared across auction and specialist market structures. It also allows an evaluation of how specialists use their market power across the trading day. 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 and overall market-wide changes.

The three essays and their conclusions outline several potential future research directions. To further investigate liquidity surrounding earnings announcements, the liquidity 'market model' of Chordia, Roll and Subrahmanyam (2000) could be used to control for market-wide movements in bid-ask spreads. The evidence provided in the final two essays indicates that the effective cost of trading is lower under a specialist market structure. Analyzing bid-ask spreads around earnings announcements to determine how the specialist reacts to an increase in adverse information is another possible extension. Also, determining how quickly information is disseminated into the market with specialist intervention, compared to a pure order driven environment, is an area of significant interest. In summary, determining the differences between auction, dealer and specialist market structures, and thus which design provides market participants the best overall trading experience, is an area of immediate practical importance.

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