Floor versus Screen Trading: Evidence from the German Stock Market*

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Abstract: The last decade has witnessed a dramatic increase in both the number and the market share of screen-based trading systems. Electronic trading systems do offer lower operating costs and the possibility of remote access to the market. On the other hand, arguments based on the anonymity of electronic trading systems suggest that adverse selection may be a more severe problem and that, therefore, bid-ask spreads may be higher. The present paper addresses the issue of transaction costs in floor and computerized trading systems empirically. In Germany, floor and screen trading for the same stocks exist in parallel. Both markets are liquid and operate simultaneously for several hours each day.

An analysis of the bid-ask spreads reveals that the electronic trading system is relatively less attractive for less liquid stocks. The market shares of the competing systems reveal a similar pattern. The market share of the electronic trading system is negatively related to the total trading volume of the stock, is positively related to the difference between spreads on the floor and in the screen trading system and is at least partially negatively related to return volatility. We further document that spreads in the electronic trading system respond more heavily to changes in return volatility and that the adverse selection component of the spread is larger. We discuss implications our results have for the design of electronic trading systems.

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1 Introduction

The last decade has witnessed a dramatic increase in both the number and the market share of screen-based trading systems. The most recent example is the introduction of the SETS system in London. The issue of the relative merits of screen-based trading is, however, not yet settled. Electronic trading systems do offer lower operating costs and the possibility of remote access to the market. This should contribute to lower spreads. On the other hand there are arguments suggesting that adverse selection may be a more severe problem in electronic trading systems and that, therefore, the bid-ask spreads may be higher.

These arguments are based on the observation that most existing screen trading systems are anonymous whereas floor trading systems like the specialist systems of the NYSE and the Frankfurt Stock Exchange are not. In the non-anonymous environment the specialist may be able to identify informed traders *ex ante* or *ex post*. Ex-ante identification may be based on observed trader behavior and enables the specialist to offer less favorable prices to those traders that he considers to be informed. Ex-post identification of informed traders gives the specialist the opportunity to punish a counterparty by offering less favorable prices in future transactions.[1] The specialist's sanctioning power may induce traders to trade less aggressively on their information in order to retain their reputation and thus receive favorable prices in future transactions. This, in turn, decreases the degree of adverse information and may lead to a lower adverse selection component in effective bid-ask spreads.

In order to make use of his knowledge of trader identities the specialist must be able to price discriminate. He can achieve this by quoting a large spread and executing transactions initiated by

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[1] BENVENISTE / MARCUS / WILHELM (1992) and CHAN / WEINSTEIN (1993) discuss this point in more detail and take into account the fact that traders on the floor are often brokers that represent customer orders.

counterparties deemed uninformed at prices inside the quoted spread. Note that it is not required that the specialist is able to identify informed traders with certainty. It is sufficient if he is able to correctly assign to some traders a higher probability of trading on private information.

Empirical evidence suggests that anonymity is indeed associated with higher adverse selection costs. DE JONG / NIJMAN / RÖELL (1996) report that trades that are negotiated bilaterally (and thus non-anonymously) and are then executed through the Paris Bourse's CAC system have a much lower price impact than regular CAC trades. HARRIS / SCHULTZ (1997) provide evidence that trades executed through NASDAQ's anonymous SOES system have a larger price impact than trades negotiated with the dealers. MADHAVAN / CHENG (1997) confirm the prediction made by SEPPI (1990) in his model of block trading that the non-anonymous upstairs market attracts uninformed traders. Finally, GARFINKEL / NIMALENDRAN (1998) find that spreads on the NYSE are larger on insider trading days[2] than on non insider trading days. This is consistent with the specialists recognizing the presence of informed traders and adjusting their spreads accordingly.[3]

Both theoretical arguments and empirical evidence thus suggest that a non-anonymous trading system like the one of the Frankfurt Stock Exchange offers mechanisms that alleviate the adverse selection problem. In an anonymous trading system, on the other hand, these mechanisms can not work because there is no way to identify traders and price discriminate accordingly.

The present paper addresses the issue of transaction costs and adverse selection in non-anonymous floor trading and anonymous electronic trading systems directly. In Germany, floor and screen trading for the same stocks exist in parallel. Both trading systems - the floor of the Frankfurt Stock

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[2] An insider trading day is defined as a day on which officers or directors have traded in shares of their firm. Such trades have to be reported and are subsequently published by the SEC.

[3] GARFINKEL / NIMALENDRAN (1998) further document that spreads on NASDAQ also increase on insider trading days, but to a lesser extent. The order flow is more centralized on the NYSE than in NASDAQ. This

Exchange and the screen trading system IBIS (which, in November 1997, was replaced by XETRA) had a significant market share in the sample period. This offers an almost ideal environment to analyze the relative merits of the two trading systems.

Most previous papers comparing floor and screen trading use data from two futures markets (e.g. COPEJANS / DOMOWITZ 1997, FRINO / MCINISH / TONER 1998, FRANKE / HESS 1997, MARTENS 1997, PIRRONG 1996, SHYY / LEE 1995 and WANG 1999) or from a futures market and the underlying spot market (GRÜNBICHLER / LONGSTAFF / SCHWARTZ 1994, SHYY / VIJAYRAGHAVAN / SCOTT-QUINN 1996). Since adverse information problems are less pronounced in index futures markets as compared to stock markets, it is not clear whether the results of these studies extend to stock markets.

Both DE JONG / NIJMAN / RÖELL (1995) and FRINO / MCCORRY (1995) analyze cross-listed stocks that are floor traded in one country and screen traded in another country. They conclude that bid-ask spreads are lower in the screen trading system. However, in both studies the screen trading system is the home market. Spreads in the home market may be lower for reasons other than the trading mechanism.

SCHMIDT / IVERSEN / TRESKE (1993) and SCHMIDT / OESTERHELWEG / TRESKE (1996) compare floor and screen trading for German stocks. At the time these studies were done, data on bid-ask spreads from the floor was not available. Therefore, both studies relate transaction prices from the floor to spreads from the screen trading system and find that transaction prices from the floor tend to lie inside this spread. This approach introduces a potential bias because observations are recorded conditional on a transaction occurring on the floor.

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may enable the specialist to better exploit the potential benefits of non-anonymity and may thus help to explain the different results obtained for the NYSE and NASDAQ.

NAIDU / ROZEFF (1994) and BLENNERHASSET / BOWMAN (1998) compare measures of market quality before and after the introduction of electronic trading systems at the Singapore Stock Exchange and the New Zealand Stock Exchange, respectively. This design does not control for confounding events.[4] Both studies rely on daily data. Furthermore, the results for the Singapore Stock Exchange are somewhat inconclusive because bid-ask spreads increase after the introduction of the electronic trading system whereas other measures of market quality suggest higher liquidity after the change in market microstructure. NAIK / YADAV (1999) analyze the introduction of SETS in 1997. Their focus is, however, on the change from a dealer to an auction market rather than on the introduction of a screen trading system.

The design of the present study has distinct advantages over the design of previous studies. Analyzing a sample of stocks rather than a single futures contract permits to analyze the cross-sectional determinants of the relative advantages of the trading systems. Further, stock markets are likely to be more severely affected by adverse selection problems than index futures markets. For the present study data on bid and ask quotes from the floor of the Frankfurt Stock Exchange was available. Therefore, the potential bias resulting from using transaction prices instead of quotes is absent. The floor and the screen trading system operate simultaneously for several hours each day The assets traded (German blue chip stocks) are identical. There is no potential for a home market bias because both markets are located in Germany. Finally, both markets are liquid and their market shares are almost equal in our sample.

Our results document that the electronic trading system offers low spreads for liquid stocks. The floor, on the other hand, is more competitive for less liquid stocks. This is corroborated by an

4 For example, the electronic trading system in New Zealand replaced three exchanges. As BLENNERHASSET / BOWMAN (1998, p. 263) acknowledge, their analysis is thus a joint test of the effects of introducing an

analysis of market shares. The market shares of the screen trading system are lower for less liquid stocks. They also show a tendency to be negatively related to return volatility. We further document that spreads in the electronic trading system are more sensitive to changes in return volatility and that the adverse selection component of the spread is larger in the electronic trading system. Our results are thus consistent with the hypothesis that the latter depicts a higher degree of operational efficiency but, on the other hand, also higher adverse selection costs.

The remainder of the paper is organized as follows. Section 2 provides a brief description of the German stock market. Section 3 describes the data set. The hypotheses are outlined in section 4. Section 5 presents our empirical results. Section 6 concludes and discusses the policy implications of the results.

2 The German stock market

The German stock market offers ideal conditions for a comparison of floor and screen trading systems. Since April 1991 an anonymous electronic open limit order book system (IBIS, *Integriertes Börsenhandels- und Informations-System*) operates parallel to the floor. All stocks that are traded in IBIS are also traded on the floor. The market shares of the two trading systems are almost equal. In our sample IBIS accounts for 55.1% of the trading volume during the three hours of parallel trading. In the following a brief description of floor and screen trading is given. It documents the organization of trading in our sample period.[5]

electronic trading system and consolidating the order flow. Besides that, trading hours were extended from two to six hours each day upon introduction of the electronic trading system.

[5] There have been major changes since then. Most importantly, the electronic trading system IBIS has been replaced with a new system, XETRA, in November 1997. Like IBIS, XETRA is an anonymous open limit order book system. For less liquid stocks traded in XETRA dealers („Betreuer“) provide additional liquidity. This does not apply to the stocks analyzed in the present paper. Other changes in market microstructure since 1997 comprise the extension of the trading hours on the floor in July 1998 and the abolition of the minimum order size for the continuous trading session on the floor in June 1999.

The Frankfurt Stock Exchange (FSE) is the leading exchange in Germany.[6] At the end of 1997 535 domestic stocks were listed. Trading hours extend from 10.30 to 13.30. Two trading regimes are employed, a call market, or batched auction, regime and a continuous trading regime which combines features of a continuous auction and a dealership market. Batched auctions are used at the opening and at the close. A third auction takes place at noon.[7]

Trading is conducted through the *Amtlicher Kursmakler* (henceforth Makler). His position resembles that of a NYSE specialist. Several stocks are assigned to each Makler. He has exclusive control over the limit order book and he conducts the batched auctions. Like the NYSE specialists he has some price setting latitude.

The continuous trading session is called *variabler Handel*. The Makler may trade for his own account, but is, unlike the NYSE specialists, not obliged to do so. In practice, however, the participation rates are very high. FREIHUBE / KEHR / KRAHNEN / THEISSEN (1999) document that the Makler participates in more than 80% of all transactions and accounts for more than 40% of the trading volume.

The Makler continuously quotes bid and ask prices. These are called *Pretrades*. The quotes posted by the Makler either represent limit orders in his book or his willingness to trade for his own account. They are entered into an electronic system (BOSS-CUBE). After each transaction they are automatically deleted and have to be re-entered. This has two consequences. First, quotes are only available for (on average) 86% of the time because new quotes are not always entered immediately. Second, the likelihood of quotes becoming stale is reduced because the Makler has to enter new

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[6] Regional exchanges exist in Düsseldorf, München, Berlin, Stuttgart, Hamburg, Hannover and Bremen. Frankfurt is by far the largest exchange.

[7] Odd-lot orders can only be submitted to the noon auction. A round lot comprises 50 shares for stocks with a nominal value of 50 DM and 100 shares for stocks with a nominal value of 5 DM.

quotes after each transaction. The quotes are displayed on a large screen on the trading floor. Another, equal-sized screen displays the best bid and ask quotes from the electronic trading system.

There are two sources of income for the Makler. First, he may earn a profit on his market making activities. Second, he receives a commission called *Courtage*. Both the buyer and the seller have to pay 0.04% (for stocks included in the DAX index) or 0.08% (for other stocks). These rates are only upper bounds to the amount effectively paid because floor brokers (*Freimakler*) pay a lower commission, amounting to 15% of the regular rate. Institutional investors often execute their orders through a Freimakler. This has the potential benefit of economizing on transaction costs but, on the other hand, may cause agency problems (e.g., front running) because a second layer of intermediation is introduced.

In April 1991 trading in IBIS started.[8] From 1991 through January 1996, the 30 stocks constituting the DAX index and about 10 additional stocks were traded. In January 1996, the 70 stocks constituting the midcap index MDAX were added. IBIS is a continuous auction system. Traders anonymously enter bids and asks. These constitute the open limit order book. Orders can be removed from the system at any time but are binding as long as they are displayed on the screen. A transaction occurs whenever a standing bid or ask is accepted. The Makler is allowed to participate in IBIS trading.[9] Trading is completely anonymous. No broker identification codes are displayed on the screen and the identity of the counterparty in a transaction is only revealed in the settlement note. Only round lots can be traded. The round lot is 100 or 500 shares, depending on the characteristics

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[8] Since 1989 IBIS had already existed as a quotation system. Trades had to be arranged via telephone. A second quotation system, MATIS (Makler-Tele-Information-System) was in operation from 1989 through 1992. The market share of both systems was low. See SCHMIDT / IVERSEN (1993) for details.

[9] When submitting limit orders the Makler has the choice of requiring Courtage payment on any transaction resulting from acceptance of that order. Such an order will, however, only be displayed as the best bid or ask when it improves on all other orders after inclusion of the Courtage. In our dataset, quotes are recorded net of Courtage whereas transaction prices are not. We added or subtracted the Courtage from the transaction prices whereever applicable.

of the specific stock. IBIS trading starts at 8.30 in the morning, two hours before the floor opens, and extends until 5 pm. The analysis in the present paper is, however, restricted to the three hours in which the floor and screen trading systems operate parallel.

An order may be entered into the IBIS system with a provision that it can only be accepted completely. If a trader wishes to trade a smaller quantity than that specified in such an order, she has to accept a bid or ask further up in the order book. This leads to a transaction at a price outside the quoted spread.

3 Data

The sample for the present study covers the 30 stocks which constitute the DAX index. These stocks are the most liquid German stocks and account for more than 80% of the total trading volume in domestic stocks. The sample period spans the 44 trading days in June and July 1997.[10] Two days (July 21st and July 23rd) had to be removed from the sample. On both days heavy trading caused a breakdown of the exchange's computer facilities. Trading had to be suspended several times.

The IBIS data comprises time-stamped best-bid, best-ask and transaction prices, trading volume and volume at the best bid and best ask. IBIS transaction and quote data stem from two different source data sets. The time-stamps of the trade and quote data were incompatible in some cases. Specifically, a transaction at the bid or ask price triggers a new quote because the bid or ask price and/or the quantity available at the best bid or ask changes. In many cases the new quote was recorded earlier than the transaction that triggered the quote.[11] We corrected this by re-ordering the

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[10] The sample size was restricted by data availability. Quotation data for the German stock market is not available on a regular basis. The data set for this paper was generously provided by Deutsche Börse AG.

[11] LEE / READY (1991) report that a similar problem arises in NYSE data. There it is caused by the fact that trades and quotes are often recorded by different persons. They suggest to match transactions with the quotes in effect 5 seconds before the transaction. It should be noted that, first, in the present case the difference in the recorded time is usually only some hundredth of a second and, second, that the available data allows us to

data. Making use of the fact that transactions at prices inside the spread are impossible and using the data on the quantities available at the bid and ask quotes, we were able to set up an algorithm which matches new quotes triggered by a transaction with the respective transactions.

Data from the floor trading system comprises time-stamped transaction prices, volume data and the quotes entered by the Makler. Batched auction prices were removed from the data set because they do not have a counterpart in IBIS. Quote data from the floor does not include information about quoted depth. However, for 29 of the 30 stocks and for 86.1% of the 1260 stock days (30 stocks*42 trading days) in the sample, the average transaction size is larger on the floor. It, therefore, seems save to conclude that the depth at the floor quotes is not inferior to the depth in IBIS.

The minimum tick size is equal in both markets. It is very low, amounting to DM 0.01 and DM 0.05 for stocks trading below and above DM 100, respectively. Given the price levels of our sample stocks, the largest minimum tick size in the sample is 0.05% of the stock price. Price discreteness is, therefore, unlikely to be an important issue.

Insert Table 1 here

Summary statistics are given in Table 1. Stocks have been sorted by DM trading volume into six groups It is apparent that the sample covers a wide range of market capitalizations and trading volumes. The ratio of the average market capitalization of the largest and the smallest group is more than 8; the most heavily traded stocks have more than 5 times the number of transactions and more than 10 times the volume of the least liquid group. There is also significant variation in the market share of the electronic trading system. The average is 51.6% with group averages ranging from

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exactly match quotes and transactions in almost all cases. Exceptions occur only for transactions at prices

45.30% to 59.15% and values for individual stocks (not shown in the table) ranging from 37.3% to 63.4%.

4 Hypotheses and Methodology

Our general hypothesis, outlined in the introduction, states that the electronic trading system offers higher operational efficiency than the floor but that, on the other hand, adverse selection costs may also be higher. This does not allow a prediction as to whether spreads are generally lower on the floor or in the screen trading system. It does, however, allow a prediction about the relative advantages of floor and screen trading. Empirical evidence suggests that adverse selection is a more severe problem for less liquid stocks. EASLEY / KIEFER / O'HARA / PAPERMAN (1996) for the US and, using the same methodology, GRAMMIG / SCHIERECK / THEISSEN (1999) for the German market document that the risk of trading with an informed trader is negatively related to the liquidity of the stock. The same conclusion can be derived from empirical research on the components of the bid-ask spread. It has been found (e.g. STOLL 1989, GEORGE / KAUL / NIMALENDRAN 1991 and the results in this paper) that adverse selection costs represent an approximately constant percentage of the total spread. This implies that the adverse selection costs in absolute terms are larger for less liquid stocks.

Combining these stylized facts with the characteristics of the trading systems leads us to expect that floor trading is relatively more advantageous for less liquid stocks. This hypothesis can be tested by calculating and comparing bid-ask spreads for the floor of the Frankfurt Stock Exchange and the electronic trading system IBIS. The difference between the spreads can then be related to a measure of the overall liquidity of the stocks.

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outside the quoted spread.

The coexistence of floor and screen trading offers investors the choice between the two competing trading systems. Rational investors will trade in the market that they perceive to be best suited given their trading needs and the stock characteristics. The relative advantages of the trading systems should, therefore, be reflected in their market shares. Extending the arguments outlined above, we expect the market share of the electronic trading system to be positively related to the overall liquidity (as measured by, e.g., the trading volume). It further follows that the IBIS market share should be negatively related to return volatility because volatility is likely to be related to the presence of private information (e.g., FRENCH / ROLL 1986). These relations should hold cross-sectionally as well as in a time series context. We test these hypotheses by relating the market share of the electronic trading system to the total trading volume and the standard deviation of the midquote returns. As investors are likely to take into account the expected execution costs we include the difference between the bid-ask spreads of the two trading systems as an additional explanatory variable.

The stylized fact that volatility is a proxy for the degree of information asymmetry is consistent with the observation, documented in numerous empirical studies, that the bid-ask spread is positively related to measures of return volatility. Periods of higher volatility are characterized by a higher degree of information asymmetry and are, therefore, associated with higher bid-ask spreads. This relation should be stronger in a market that is more severely affected by adverse selection problems. This leads us to expect that the sensitivity of the bid-ask spread with respect to return volatility is more pronounced in the electronic trading system. We test this hypothesis by regressing the time series of the bid-ask spreads for each stock on the time series of the standard deviation of returns and test whether the slope coefficients estimated for the two trading systems differ.

The hypothesis of a lower order processing cost component and a higher adverse selection component in the electronic trading system can be tested directly by estimating the components of the bid-ask spread. We decompose the effective spread into an estimate of the realized spread and the adverse selection component using a procedure similar to that employed by HUANG / STOLL (1996).

5 Results

5.1 Bid-Ask Spreads

The bid-ask spread is a direct measure of the transaction costs borne by the investors. We use three different measures of the bid-ask spread in order to compare the floor of the Frankfurt Stock Exchange to the electronic trading system IBIS. The first is the average quoted spread, defined as the average of the spreads quoted in the sample period. This measure overestimates the costs actually paid by the investors for two reasons. First, investors may delay the order submission until spreads are lower. This timing of transactions reduces transaction costs. The benefit of timing can be assessed by comparing the quoted spread to the average of those spreads which were quoted immediately before a transaction occured. It should be noted, however, that this measure (termed the *current spread* by NEAL 1992) does not incorporate any non-monetary costs that may be associated with the timing of transactions.

Second, transactions on the floor often occur at prices inside the quoted spread. In our sample the frequency of such transactions averages 40.1% and values for individual stocks range from 27.7% to 51.7%. The effective spread incorporates this price improvement and measures the costs actually paid by the investors.

Insert Table 2 here

Table 2 reports the results for all three spread measures. Stocks are sorted into six groups in descending order of their trading volume. The results show that the quoted spreads on the floor and in IBIS are similar on average. The average quoted spread on the floor is 0.316% as compared to 0.326% in IBIS. The null hypothesis of equal means cannot be rejected. Spreads on the floor are lower for 3 of the 6 groups and for 15 of the 30 individual stocks. There is a tendency for spreads on the floor to be lower than the IBIS spreads for groups of stocks with lower total trading volume. The correlation between the difference of the spreads on the floor and in IBIS on the one hand and the log of the average daily trading volume on the other hand is, however, only 0.30 which is not significantly different from zero.[12]

The current spread on the floor is slightly lower than the average quoted spread (0.288% as compared to 0.316%). Thus, at the moment a transaction occurs the spread is lower by 0.028% than it is on average. This difference can be interpreted as the benefit to the timing of transactions. This benefit is more pronounced in IBIS. Here, the difference between quoted and current spread amounts to 0.08%. Current and effective spread are almost identical in IBIS.[13] On the floor, however, many transactions occur at prices inside the spread. This leads to a significant cost reduction. The average effective spread is 0.197%. It is lower than the effective spread in IBIS (average 0.246%) for all six groups and for 26 of the 30 individual stocks. The null hypothesis of equal means is rejected at the 10% level. The figures in Table 2 reveal that the difference between effective spreads in IBIS and on the floor is negatively related to the total trading volume. This is

[12] Using the number of transactions or the log of market capitalization as a proxy for liquidity yields similar results. Note that the result is *not* inconsistent with our hypothesis. We have argued that the quoted spread on the floor contains a significant adverse selection component, but that trades with counterparties deemed uninformed by the Makler would tend to occur at prices inside the spread. Therefore, the relative advantage of the floor in trading less liquid stocks should manifest itself in effective spreads, but not necessarily in quoted spreads.

borne out by an analysis on the level of individual stocks. The correlation between the spread differential (floor - IBIS) and the log of the average daily trading volume is 0.59, the rank correlation is 0.60. Both values are significantly different from zero at the 1% level. This is consistent with our hypothesis that the floor is relatively more competitive for less liquid stocks.

As outlined in section 2, investors have to pay the Courtage when transacting on the floor. The results so far did not include this commission. The regular rate amounts to 0.04% of the transaction volume; the reduced rate for floor brokers amounts to 0.006%. Adding twice the regular rate to the floor spreads shown in Table 2 results in an estimate of the upper bound of the transaction costs on the floor. Results of a comparison of floor spreads and IBIS spreads based on this estimate are less favorable for the floor. Quoted spreads on the floor are now higher than the IBIS spreads for 27 of the 30 stocks and the null hypothesis of equal means is rejected at the 5% level. Similarly, the average effective spread on the floor is now 0.277%, 0.031% higher than the IBIS spread. The means are, however, not significantly different from each other and spreads on the floor remain lower for the group of the least liquid stocks and for 9 individual stocks.

The uncertainty about the effective Courtage rate introduces some ambiguity into the results of our comparison of floor spreads and IBIS spreads.[14] We wish to emphasize, however, that our main finding - an increasing attractiveness of the floor for less liquid stocks - is not affected by this ambiguity.

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[13] The differences are solely due to some transactions occurring at prices outside the quoted spread. The fact that the difference between effective and current spreads is negligible supports our statement that transactions at prices outside the spread are very rare events and do not affect the results of this study.

[14] Reliable data on the fraction of the trading volume intermediated through a Freimakler is not available. The Maklers claim that approximately two thirds of the trading volume are intermediated through a Freimakler. This would result in an effective Courtage rate of 0.0173%, less than half the regular rate of 0.04%. We do not take that figure at face value, however, because the Maklers may have an incentive to understate their Courtage revenues.

Another remark is in order. Our sample contains only the 30 most liquid German stocks. Given that the floor tends to be more attractive for less liquid stocks, inclusion of less liquid stocks in the sample would very likely yield results which are more favorable for the floor.

5.2 Stock Characteristics and Market Share

Our hypothesis states that the market share of the electronic trading system is positively related to the overall liquidity of a stock and negatively related to return volatility which serves as a proxy for the degree of adverse selection. We measure the market share as the fraction of the total trading volume during the three hours of parallel trading that occurs in IBIS. We use the total trading volume, measured by the log of the daily average DM trading volume, as a proxy for a stock's liquidity.[15] Return volatility is measured by the standard deviation of midquote returns.

In a first step we perform a cross-sectional analysis. We regress the average IBIS market share of the sample stocks on the log of the average daily DM trading volume and the standard deviation of returns calculated from daily midquotes.[16] To account for the impact of execution costs on the market shares we re-estimate the model including the difference between the percentage spread on the floor and the percentage spread in IBIS. We use both the average quoted spread (model 2) and the average effective spread (model 3). The results are shown in Panel A of Table 3.

The independent variables explain a large part of the cross-sectional differences in the IBIS market shares. The adjusted R^2 for model 1 is 0.57. As hypothesized, the market share of IBIS increases with the total trading volume. The coefficient on return volatility has the expected sign in all three

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[15] Using the log of the number of transactions instead of the log of the trading volume yields very similar results. We use a log specification because the volume variable is skewed.

[16] We used the last spread published prior to 13:30 to calculate the midquote. One potential problem is that the standard deviation of the midquote returns depends on whether the midquotes are taken from the floor or from IBIS. We found, however, that the two standard deviations are very similar. This is evidenced by a correlation

models but is significantly different from zero only in model 2 and only at the 10% level. The results for models 2 and 3 provide evidence that the spread differential is an important determinant of the IBIS market shares. Including it on the right-hand side leads to an increase in the explanatory power of the regression. As expected, an increase in both the quoted and the effective spread on the floor relative to the IBIS spread is associated with a significant increase in the market share of the IBIS system.

Insert Table 3 here

The regressions just discussed were cross-sectional, i.e., all variables were averaged over the whole sample period. This neglects the time-series variability in the variables. Therefore we estimated a pooled time-series cross-section regression. The IBIS market share for stock i on trading day t was regressed on the log of the trading volume on that day and the standard deviation of 5-minute midquote returns for stock i on day t.[17] The model accounts for different stock characteristics by including stock-specific dummy variables.[18] We also estimate models which include the difference in quoted (model 2) and effective (model 3) spreads for stock i on day t as explanatory variables. The results are shown in Panel B of Table 3.

The independent variables do a good job at explaining the day-to-day variability of the IBIS market shares. The adjusted R^2 lies between 0.35 and 0.40. Consistent with our hypothesis and the cross-sectional results, the IBIS market share increases with trading volume. The estimated coefficients in the pooled regression and the cross-sectional regression are similar in magnitude. The coefficient on return volatility is significantly negative. This is consistent with the hypothesis that the market share of

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of 0.999. In the regression we used an unweighted average of the standard deviations calculated from floor and IBIS midquotes.

17 Again we computed the standard deviations separately from floor and IBIS data and used the unweighted average in the regressions.

the electronic trading system is negatively related to return volatility. Finally, the coefficients on the spread differentials in models 2 and 3 do have the expected sign and are significantly different from zero.

In the pooled time series-cross section regression we restrict the slope coefficients to be identical for all stocks. However, a Wald test rejected the null hypothesis of equal slope coefficients. We therefore estimated equations similar to models 1, 2 and 3 for each stock separately. To account for contemporanous correlation of the error terms we estimated the 30 equations jointly using SUR (see Panel C of Table 3). Consistent with our previous results we find that the market share of the electronic trading system is positively related to the log of the trading volume for almost all stocks (28, 26 and 27 for models 1, 2 and 3, respectively); between 18 and 22 [17 and 22] of the estimated coefficients are significantly different from zero at the 5% [1%] level. The mean value of the coefficients on the log of trading volume is similar in magnitude to the coefficients in the cross-sectional and pooled regressions of Panels A and B. For 23 stocks the estimated coefficient for the volatility measure is negative in model 1; 10 [6] of these coefficients are significantly smaller than zero at the 5% [1%] level. A Wald test rejects the null hypothesis of a mean coefficient equal to zero.

The coefficients on the spread differentials in models 2 and 3 have the expected sign and are significantly different from zero for almost all stocks. The coefficient on the standard deviation of returns changes upon introduction of the spread differential into the model. Although still negative for the majority of the stocks, the mean value of the coefficients is less negative in model 3 and positive in model 2. This may indicate that the spread differential is related to changes in return volatility. We pursue this issue further in section 5.3.

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[18] We do not include time dummies because there is no a priori reason to expect a time dependence of the market shares beyond what is already captured by trading volume and return volatility.

5.3 Bid-Ask Spreads and Return Volatility

Our hypothesis states that the spreads in the electronic trading system are more sensitive to changes in return volatility which serves as a proxy for the degree of information asymmetry. We proceed as follows. We calculate the return volatility (as defined in the preceeding section) and the bid-ask spread for both markets and for each trading day. We then estimate the regression[19]

$$s_{i,t}^{q} = a_i + b_i D_{IBIS} + g_i Vola_{i,t} + d_i D_{IBIS} Vola_{i,t} + e_{i,t}$$

where $s_{i,t}^{q}$ is the average quoted spread on day t for stock i, D_{IBIS} is a dummy variable which takes on the value 1 if the observation is from the electronic trading system, and $Vola_{i,t}$ is the standard deviation of five minute midquote returns of stock i on day t. We have 84 observations for each stock; one observation for each of the 42 trading days and for each market. The regression allows for market-specific intercept terms to account for the different spread levels documented in section 5.1. Our primary interest is in the coefficient d_i which measures the difference in the slope coefficients for the two markets. Our hypothesis implies $d_i > 0$. The error terms for the 30 stocks in the sample are likely to be contemporanously correlated. Therefore, we estimated the 30 equations jointly using SUR. We estimated a similar model using the effective spread rather than the quoted spread as the dependent variable.[20]

Insert Table 4 here

The results for both sets of regressions are summarized in Table 4. The upper part of the table presents the results for the quoted spread. The mean value of the intercept is 0.2251. The intercept

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[19] The method is similar to the one used by Wang (1999).

[20] We also estimated a model where we included the log of trading volume as an additional exp lanatory variable. The results were qualitatively similar and the increase in explanatory power was modest. We further estimated

for the observations from the electronic trading system is lower by 0.0288. The mean value for the slope coefficient is 0.6595 and all but two of the individual values are significantly larger than zero, indicating that the quoted spreads increase with return volatility. d_i is positive for 24 stocks, in 11 cases d_i is significantly larger than 0 at the 5% level. A Wald test rejects the hypothesis that the mean of the 30 coefficients is zero. This is consistent with the hypothesis that the spreads in IBIS are more sensitive to changes in return volatility. The combined result of a smaller intercept and a greater slope for the electronic trading system implies that quoted spreads in IBIS are lower than the floor spreads when volatility is low and higher than the floor spreads when volatility is high.[21]

The results for the effective spread are qualitatively similar, albeit somewhat weaker. Effective spreads in both trading systems increase with return volatility. The mean value of the coefficient d_i is 0.0572. 18 of the individual values are positive (and 6 significantly so) whereas 12 values are negative (4 significant). The Wald test rejects the hypothesis that the mean of the coefficients is zero. Both the intercept and the slope are lower for the floor, which, taken together, implies that effective spreads are expected to be lower on the floor for each level of volatility. Note, however, that this result was obtained without adding the Courtage to the floor spreads.

Taken together, the results imply that the bid-ask spreads in the electronic trading system tend to be more sensitive to changes in return volatility.[22] A possible explanation for the weaker results obtained when using the effective instead of the quoted spread lies in the existence of inventory holding costs. These costs are likely to be more important on the floor where a single person, the Makler, accounts

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the model in first differences rather than in levels. The results were qualitatively very similar. Given the low minimum tick size (see section 2), price discreteness is unlikely to be an important factor.

21 Based on the mean of the estimated coefficients, the „break even“ volatility level for which spreads in both trading systems are equal is found to be 0.1237. In fact, 54.0% of the daily standard deviation estimates in our sample are smaller and 46.0% are larger than this value.

22 This may explain the finding, documented in section 4, that the impact of return volatility on the IBIS market share is reduced once the spread differential is included in the regression. Given the higher sensitivity of IBIS

for a large portion of the trading volume. Increasing return volatility increases the inventory risk. The effective spread has to include the compensation for this risk.

5.4 Components of the Bid-Ask Spread

The adverse selection cost is the amount that suppliers of immediacy loose to traders who possess superior information. It can be estimated as the difference between the effective spread and the realized spread where the latter measures the amount actually earned by the suppliers of immediacy. We estimate the realized spread as follows. First, transactions are classified as being buyer-initiated or seller-initiated. Transactions in IBIS are categorized as buyer-initiated [seller-initiated] if the transaction price is at or above the ask [at or below the bid] at the moment the transaction occurs.[23] Transactions on the floor were categorized following the method proposed by LEE / READY (1991).[24] Each transaction was then matched with a subsequent transaction at the opposite side of the market; i.e. each buyer-initiated transaction was matched with a subsequent seller-initiated transaction and vice versa. The realized spread is calculated as

$$s^R = \frac{p_t^a - p_{t+1}^b}{p_t^a}$$

if the initial transaction was at the ask and

$$s^R = \frac{p_{t+1}^a - p_t^b}{p_t^b}$$

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spreads to changes in volatility, the spread differential may already capture the impact of volatility on market shares.

23 Some transactions occur at zero spreads. This is possible when one of the orders has been entered with the provision that it can only be accepted completely. A trader wishing to trade a smaller quantity can not accept that order but can submit an equally-priced limit order at the opposite side of the market. Transactions occuring at zero spreads can be classified by making use of the information contained in the best bid and ask quotes and quoted depths immediately after the transaction.

if the initial transaction was at the bid.[25] We calculated two versions of the measure. The first was obtained by matching each transaction with the next transaction at the opposite side of the market. For the second version we matched each transaction with the next transaction which occured after at least 5 minutes at the opposite side of the market. The results of both HUANG / STOLL (1996) and HARRIS / SCHULTZ (1998) suggest that no systematic price movements are to be expected after 5 minutes. The realized spread on the floor was estimated without taking the Courtage requirement into account. Adding 0.08% yields an estimate including the regular Courtage rate. Subtracting the realized spread from the effective spread yields our measure of the amount lost to informed traders.

Results for groups of stocks sorted by trading volume are presented in Table 5. It is apparent that the two versions of the realized spread measure yield almost identical results. We therefore restrict the discussion to the first version of the measure.

Insert Table 5 here

Realized spreads average 0.0155% on the floor and 0.0096% in IBIS. The value for the floor is significantly different from zero whereas the value for the electronic trading system is not (t-values 2.21 and 1.43, respectively). Realized spreads in the two trading systems are not significantly different from each other (t-value 0.61). This changes, however, when the regular Courtage rate is added to the realized spread on the floor. The estimate of the realized spread on the floor is now 0.0955% and a t-value of 8.88 signals significant differences between the realized spread estimates.

[24] LEE / READY (1991) address the problem that quotes are recorded ahead of the trade that triggered them. This problem does not arise at the Frankfurt Stock Exchange because trades and new quotes are both entered by the Makler or his clerc.

[25] Our measure is similar to the one proposed by HUANG / STOLL (1996) with the difference that we match buyer-initiated transactions with subsequent seller-initiated transactions and vice versa whereas HUANG / STOLL only categorize the initial transaction and match it with a subsequent transaction that may be either buyer- or seller-initiated. Our approach explicitly takes into account the fact that a supplier of immediacy can close a position only by a transaction at the opposite side of the market. In HUANG / STOLL this is taken into account

Given that the order processing costs have to be covered by the realized spread this result is consistent with the hypothesis that order processing costs are higher on the floor.

For almost a third of the sample stocks (8 on the floor, 9 in IBIS) the realized spread is negative. This already indicates that losses to better informed traders are economically significant in both trading systems. The estimates of the adverse selection component average 0.183% on the floor and 0.238% in IBIS. The difference between these two averages just falls short of being significant at the 5% level (t-value 1.98, p-value 0.053; p-value of a non-parametric Mann-Whitney u-test 0.044). For all six groups and for 28 of the 30 individual stocks the estimated adverse selection component is larger in the electronic trading system.

The Courtage requirement on the floor does not affect the estimated adverse selection component. Adding the Courtage increases both the effective and the realized spread, leaving the difference unchanged. However, if the adverse selection component is expressed as a percentage of the effective spread, including the Courtage does affect the results. Without including the Courtage, the adverse selection component accounts for 90.0% of the effective spread (compared to 96.4% in IBIS). If the regular Courtage rate is added, this percentage reduces to 62.3%.

Two remarks are in order. First, it should be noted that inventory management may also reduce the fraction of the effective spread that is realized. Having accumulated a large long or short position, a supplier of immediacy may alter his quotes in order to attract offsetting orders (HO / STOLL 1981). This quote revision reduces his earnings. The difference between effective and realized spread may thus include an inventory holding cost component. However, inventory considerations shoul be of much greater importance on the floor where the liquidity is, to a large extent, supplied by a single

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implicitly because their measure is interpreted as the realized *half*-spread. If transactions at the bid and at the ask are equally likely, both measures have the same expected value.

person, the Makler. Therefore, our measure of the adverse selection component will, if anything, *over*estimate the relative importance of adverse selection costs on the floor.

Second, as different methods to estimate the adverse selection component have proven to yield different results, it is useful to check the validity of our method. Although the level of the adverse selection component is, as has been documented, different in the two trading systems, we should expect stocks that have a higher adverse selection component than other stocks in one trading system to also have a higher adverse selection component in the other trading system. Figure 1 presents the estimated adverse selection component for both markets. The cross-sectional patterns are reassuringly similar. The correlation is 0.88, highly significant at conventional levels. This finding suggests that our results are not an artefact of the procedure used.

Insert Figure 1 here

6 Discussion

In this paper we compare the transaction costs on the floor of the Frankfurt Stock Exchange to the transaction costs in the electronic trading system IBIS. The German stock market offers an ideal environment for this kind of analysis because identical stocks are traded simultaneously in both systems for several hours each day. Our main hypothesis states that the screen trading system offers higher operational efficiency but, on the other hand, is likely to be more severly affected by adverse selection problems.

Our analysis of the bid-ask spreads in the two trading systems reveals that the floor is relatively more competitive for less liquid stocks. This is consistent with our hypothesis because adverse selection is likely to be a more severe problem for less liquid stocks. These results are confirmed by an analysis of the market shares of the competing trading systems. We find strong evidence in favor of the hypothesis that the market share of the electronic trading system increases with the trading volume, our measure of the liquidity of a stock. This is true both in the cross-section and in a time series context. Differences between the bid-ask spreads in the two trading systems have a significant impact on market shares. In the time-series regressions we found some evidence that the IBIS market share is negatively related to return volatility. This is consistent with the hypothesis that the electronic trading system is more severely affected by adverse selection problems because return volatility is related to the degree of information asymmetry.

We analyze the reaction of quoted and effective spreads to changes in volatility and find that quoted spreads in IBIS are more sensitive to changes in volatility than quoted spreads on the floor. Results for the effective spreads are somewhat less clear but point in the same direction. We further document that the adverse selection component of the spread is smaller on the floor. This supports the notion that the non-anonymous trading system on the floor is better suited to cope with adverse selection problems. Finally, we find that the realized spread, which has to cover the order processing costs, tends to be larger on the floor. This is consistent with the hypothesis of lower operational efficiency of the floor.

The results have important policy implications. Electronic trading systems are well suited for trading liquid stocks. For these stocks, the degree of asymmetric information is low and the higher operational efficiency of electronic trading systems outweighs any disadvantages associated with higher adverse selection costs. For illiquid stocks the reverse may be true. The recent experience in Germany is a case in point. In October 1998 Deutsche Börse AG dramatically increased the number of stocks that could be traded in the electronic trading system XETRA. However, in response to insufficient liquidity and large price deviations between XETRA and the floor (where the same stocks are traded) it was announced in January 1999 that a large number of stocks traded continuously in XETRA thus far would be traded only in a single daily call auction in the future.

Thus, before existing floor trading systems are replaced with electronic trading systems, the design of these systems should be reconsidered. It is not clear, however, whether improvements can easily be achieved. The anonymity of the trading system has been identified as being at the heart of the problem. One important point to note is that electronic trading systems are inherently anonymous in a certain sense. It is of course possible (and practiced on some exchanges) to display broker identification codes on the screen. This does not solve the problem, however, because now the supplier of liquidity is known whereas those who demand liquidity by accepting displayed orders are still anonymous. If, as is argued in the present paper, the advantage of the floor lies in the fact that the Makler (or specialist) is able to identify those who demand liquidity, then it will be difficult for electronic trading systems to come up with a solution for the problems associated with trader anonymity.

Deutsche Börse AG has started an interesting experiment by introducing Betreuer (banks which perform market making activities) into their XETRA system in October 1998. Future research should address the question whether this is sufficient to improve the liquidity of the system for less liquid stocks.

References

Benveniste, L., A. Marcus and W. Wilhelm, 1992, What's special about the specialist? *Journal of Financial Economics,* 32, 61-86.

Blennerhasset, M. and R.G. Bowman, 1998, A Change in Market Microstructure: The Switch to Electronic Screen Trading on the New Zealand Stock Exchange, *Journal of International Financial Markets, Institutions and Money,* 8, 261-276.

Chan, Y.-S. and M. Weinstein, 1993, Reputation, Bid-Ask Spread and Market Structure, *Financial Analysts Journal*, July/August, 57-62.

Copejans, M. and I. Domowitz, 1997, The Performance of an Automated Trading Market in an Illiquid Environment, working paper, Duke University and Northwestern University.

de Jong, F., Th. Nijman and A. Röell, 1995, A Comparison of the Cost of Trading French Shares on the Paris Bourse and on SEAQ International, *European Economic Review,* 39, 1277-1301.

de Jong, F., Th. Nijman and A. Röell, 1996, Price Effects of Trading and Components of the Bid-Ask Spread on the Paris Bourse, *Journal of Empirical Finance,* 3, 193-213.

Easley, D., N. Kiefer, M. O'Hara and J. Paperman, 1996, Liquidity, Information, and Infrequently Traded Stocks, *Journal of Finance*, 51, 1405-1436.

Franke, G. and D. Hess, 1997, Information Diffusion in Electronic and Floor Trading, working paper, Universität Konstanz, Konstanz.

Freihube, Th., C.-H. Kehr, J. Krahnen and E. Theissen, 1999, Was leisten die Kursmakler? Eine empirische Untersuchung am Beispiel der Frankfurter Wertpapierbörse, *Kredit und Kapital,* 32, 426-460.

French, K. and R. Roll, 1986, Stock Return Variances: The Arrival of Information and the Reaction of Traders, *Journal of Financial Economics,* 17, 5-26.

Frino, A. and M. McCorry, 1995, Why are Spreads Tighter on the Australian Stock Exchange than the NYSE? An Electronic Open Limit Order Book versus the Specialist Structure, working paper, University of Sydney.

Frino, A., Th. McInish and M. Toner, 1998, The Liquidity of Automated Exchanges: New Evidence from German Bund Futures, *Journal of International Financial Markets, Instututions and Money,* 8, 225-241.

Garfinkel, J. and M. Nimalendran, 1998, Market Structure and Trader Anonymity: An Analysis of Insider Trading, working paper, Loyola University of Chicago and University of Florida.

George, Th., G. Kaul and M. Nimalendran, 1991, Estimation of the Bid-Ask Spread and its Components: A New Approach, *Review of Financial Studies,* 4, 623-656.

Grammig, J., D. Schiereck and E. Theissen, 1999, Informationsbasierter Aktienhandel über IBIS, working paper, Johann Wolfgang Goethe-Universität Frankfurt; forthcoming in *Zeitschrift für betriebswirtschaftliche Forschung*.

Grünbichler, A., F. Longstaff and E. Schwartz, 1994, Electronic Screen Trading and the Transmission of Information: An Empirical Examination, *Journal of Financial Intermediation,* 3, 166-187.

Harris, J. and P. Schultz, 1997, The Importance of Firm Quotes and Rapid Executions: Evidence from the January 1994 SOES Rule Change, *Journal of Financial Economics*, 45, 135-166.

Harris, J. and P. Schultz, 1998, The Trading Profits of SOES Bandits, *Journal of Financial Economics*, 50, 39-62.

Ho, Th. and H. Stoll, 1981, Optimal Dealer Pricing Under Transaction and Return Uncertainty, *Journal of Financial Economics*, 9, 47-73.

Huang, R. and H. Stoll, 1996, Dealer versus Auction Markets: A Paired Comparison of Execution Costs on NASDAQ and the NYSE, *Journal of Financial Economics*, 41, 313-357.

Lee, Ch. and M. Ready, 1991, Inferring Trade Direction from Intraday Data, *Journal of Finance*, 46, 733-746.

Madhavan, A. and M. Cheng, 1997, In Search of Liquidity: Block Trades in the Upstairs and Downstairs Market, *Review of Financial Studies*, 10, 175-203.

Martens, M., 1997, *Interaction Between Financial Markets.* Tinbergen Institute Research Series No. 139, Rotterdam.

Naidu, G. N. and M. Rozeff, 1994, Volume, Volatility, Liquidity and Efficiency of the Singapore Stock Exchange before and after Automation, *Pacific-Basin Finance Journal*, 2, 23-42.

Naik, N. and P. Yadav, 1999, The Effects of Market Reform on Trading Costs of Public Investors: Evidence from the London Stock Exchange, working paper, London Business School and University of Strathclyde.

Neal, R., 1992, A Comparison of Transaction Costs between Competitive Market Maker and Specialist Market Structures, *Journal of Business*, 65, 317-334.

Petersen, M. and D. Fialkowski, 1994, Posted versus Effective Spreads: Good Prices or Bad Quotes? *Journal of Financial Economics*, 35, 269-292.

Pirrong, C., 1996, Market Liquidity and Depth on Computerized and Open Outcry Trading Systems: A Comparison of DTB and LIFFE Bund Contracts, *Journal of Futures Markets*, 16, 519-543.

Schmidt, H., O. Oesterhelweg and K. Treske, 1996, Deutsche Börsen im Leistungsvergleich: IBIS und BOSS-CUBE, *Kredit und Kapital*, 29, 90-122.

Schmidt, H. and P. Iversen, 1993, Automating German Equity Trading: Bid-Ask Spreads on Competing Systems, *Journal of Financial Services Research*, 6, 373-397.

Schmidt, H., P. Iversen and K. Treske, 1993, Parkett oder Computer? *Zeitschrift für Bankrecht und Bankwirtschaft*, 5, 209-221.

Seppi, D., 1990, Equilibrium Block Trading and Asymmetric Information, *Journal of Finance*, 45, 73-94.

Shyy, G. and J. Lee, 1995, Price Transmission anmd Information Asymmetry in Bund Futures Markets: LIFFE vs. DTB, *Journal of Futures Markets*, 15, 87-99.

Shyy, G., V. Vijayraghavan and B. Scott-Quinn, 1996, A Further Investigation of the Lead-Lag Relationship between the Cash Market and Stock Index Futures Market with the Use of Bid/Ask Quotes: The Case of France, *Journal of Futures Markets*, 16, 405-420.

Stoll, H., 1989, Inferring the Components of the Bid-Ask Spread: Theory and Empirical Tests, *Journal of Finance*, 44, 115-134.

Wang, J., 1999, Asymmetric Information and the Bid-Ask Spread: An Empirical Comparison Between Automated Order Execution and Open Outcry Auction, *Journal of International Financial Markets, Institutions and Money*, 9, 115-128.

White, H., 1980, A Heteroskedasticity Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity, *Econometrica*, 48, 817-838.

Table 1: Descriptive statistics

group	trading volume million DM	capitalization billion DM	IBIS market share	# transactions, floor	# transactions, IBIS
largest	110,86	61,28	59,15	88,04	168,02
2	64,30	40,31	55,59	82,02	133,64
3	41,80	38,78	49,29	49,75	78,14
4	29,14	20,12	52,40	30,01	55,96
5	21,84	15,72	48,05	34,59	55,98
smallest	10,97	7,35	45,30	19,27	30,88
average	46.48	30.59	51.63	50.61	87.10

Stocks were sorted into six groups according to their DM trading volume. All figures are unweighted averages for the stocks in the group. Figures on market capitalization are in billion DM and are for June 30, 1997. Figures on trading volume, market share and the number of transactions are daily averages for the sample period. Market share calculations are based on the total DM trading volume in the three hours of parallel trading.

Table 2: Bid-ask spreads

	quoted spread		current spread		effective spread	
group	floor	IBIS	floor	IBIS	floor	IBIS
largest	0.1811	0.1753	0.1753	0.1370	0.1165	0.1373
2	0.2086	0.1873	0.1798	0.1430	0.1181	0.1435
3	0.2966	0.3301	0.2794	0.2457	0.2044	0.2463
4	0.3620	0.3374	0.3420	0.2598	0.2270	0.2602
5	0.3478	0.3777	0.3186	0.2866	0.2152	0.2871
smallest	0.5022	0.5472	0.4324	0.4011	0.2981	0.4015
average	0.3164	0.3258	0.2879	0.2455	0.1965	0.2460

The quoted spread is the average of the spreads quoted in the sample period. The current spread is defined as the average of those spreads that were quoted immediately before a transaction occured. The effective spread is the absolute difference between the transaction price and the midquote immediately prior to the transaction, multiplied by 2 and expressed as a percentage of the midquote. Spreads for the floor have been calculated without taking the Courtage into account. Adding 0.08% yields estimates of the spread including the regular Courtage rate. Stocks are sorted into groups by trading volume.

Table 3, Panel A: Market shares - cross-sectional regression

model adj. R^2	intercept	ln(Vol)	standard deviation	difference quoted spreads	difference effective spreads
1	-51.017	6.104	-1,890		
(0.57)	(-2.90)	(6.12)	(-1,55)		
2	-38.925	5.419	-1.938	25.060	
(0.64)	(-2.29)	(5.62)	(-1.72)	(2.39)	
3	-20.658	4.445	-1.667		40.818
(0.63)	(-0.96)	(3.69)	(-1.45)		(2.18)

All market share calculations are based on the volume in the three hours of parallel trading. Panel A reports the results of a cross-sectional regression (n = 30). The dependent variable is the IBIS market share (in %) for the sample stocks, averaged over the sample period. The independent variables are the log of the average daily trading volume and the standard deviation of the daily midquote returns. Model 2 [3] includes the difference between the average quoted [effective] spread in the sample period. The difference is defined as spread on the floor (without Courtage) minus IBIS spread. t-values are given in parentheses. We used a White test to test for heteroskedasticity but could never reject the null of no heteroskedasticity at the 10% level.

Table 3, Panel B: Market shares - pooled time series-cross section regression

model R^2	ln(Vol)	standard deviation	difference quoted spreads	difference effective spreads
1	6.181	-12.048		
(0.35)	(9.82)	(-3.79)		
2	5.956	-10.666	21.096	
(0.40)	(9.26)	(-3.60)	(2.52)	
3	5.613	-9.102		27.406
(0.39)	(9.39)	(-3.13)		(6.32)

Panel B reports the results of a pooled time-series cross-section regression (n = 1260). All variables were calculated for each stock and each day separately. The standard deviation was calculated from 5-minute midquote returns. We allowed for stock-specific intercepts but omitted the estimated coefficients from the table. t-values based on White (1980) heteroskedasticity consistent standard errors are given in parentheses.

Table 3, Panel C: Market shares - simultanous equation system

model R^2	ln(Vol)	standard deviation	difference quoted spreads	difference effective spreads
1	6.948	-12.523		
(0.36)	pos.: 28 (22)	pos.: 7 (3)		
	neg.: 2 (0)	neg.: 23 (10)		
		χ^2 = 18.91		
2	5.200	7.251	57.100	
(0.47)	pos.: 26 (18)	pos.: 13 (7)	pos.: 29 (27)	
	neg.: 4 (1)	neg.: 17 (4)	neg.: 1 (1)	
		χ^2 = 6.69		
3	5.838	-2.061		52.182
(0.41)	pos.: 27 (20)	pos.: 11 (6)		pos.: 30 (26)
	neg.: 3 (1)	neg.: 19 (11)		neg.: 0 (0)
		χ^2 = 0.57		

Panel C reports the results of a simultanous equation system where one equation is estimated for each stock. The system was estimated using SUR. The entries in the cells report the mean value of the 30 coefficients, the number of positive and negative coefficients and (in parentheses) the number of coefficients that are significantly different from zero at the 5% level. The χ^2 statistic tests the null hypothesis that the mean value of the coefficients is zero. The statistic is distributed χ^2 with one degree of freedom; the 5% critical value is 3.84.

Table 4, Panel A: Bid-ask spread and return volatility - quoted spread

	intercept	D_{IBIS}	$Vola_{i,t}$	$D_{IBIS}\,Vola_{i,t}$
quoted spread	0.2251	-0.0288	0.6595	0.2329
				$\chi^2 = 41.28$
positive	30	7	30	24
(sign. at 5% level)	(30)	(1)	(28)	(11)
negative	0	23	0	6
(sign. at 5% level)	(0)	(10)	(0)	(2)

Table 4, Panel B: Bid-ask spread and return volatility - effective spread

	intercept	D_{IBIS}	$Vola_{i,t}$	$D_{IBIS}\,Vola_{i,t}$
effektive spread	0.1109	0.0374	0.6166	0.0572
				$\chi^2 = 3.98$
positive	30	26	29	18
(sign. at 5% level)	(28)	(11)	(28)	(6)
negative	0	4	1	12
(sign. at 5% level)	(0)	(2)	(0)	(4)

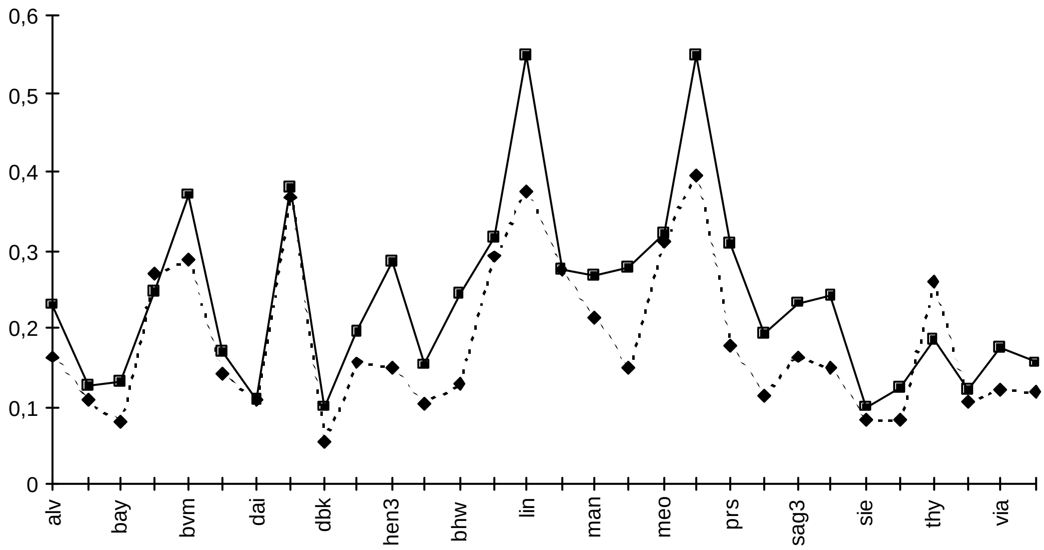
The table reports the results of the regression $s_{i,t} = a_i + b_i D_{IBIS} + g_i Vola_{i,t} + d_i D_{IBIS} Vola_{i,t} + e_{i,t}$ where $s_{i,t}$ is the quoted spread (panel A) or the effective spread (panel B) on day t for stock i, D_{IBIS} is a dummy variable which takes on the value 1 if the observation is from the electronic trading system, and $Vola_{i,t}$ is the volatility measure. Spreads for the floor do not include the Courtage. The regression is run for a total of 84 observations for each stock; one observation for each of the 42 trading days and for each market. The 30 equations were estimated jointly using SUR. The first line in both panels reports the mean value of the estimated parameters. The remaining lines report the number of positive and negative parameters and the number of parameters which are significantly different from zero. Our primary interest is in the coefficient d_i which measures the difference in the slope coefficients for the two markets. Our hypothesis implies $d_i > 0$. The χ^2 statistic shown in the last column tests the hypothesis that the mean of the coefficients is zero. It follows a χ^2 distribution with one degree of freedom, the critical value at the 5% level is 3.84.

Table 5: Adverse selection

	based on next transaction				based on next transaction after at least 5 min.			
	floor		IBIS		floor		IBIS	
group	realized spread	adv. sel. comp.	realized spread	adv. sel. comp.	realized spread	adv. sel. comp.	realized spread	adv. sel. comp.
largest	0.0119	0.1053	-0.0013	0.1390	0.0087	0.1083	-0.0155	0.1537
2	0.0116	0.1074	0.0034	0.1404	0.0079	0.1110	-0.0165	0.1600
3	0.0177	0.1889	-0.0279	0.2752	0.0106	0.1948	-0.0399	0.2883
4	0.0182	0.2117	0.0126	0.2483	0.0172	0.2125	0.0014	0.2606
5	0.0096	0.2067	0.0224	0.2639	0.0084	0.2082	0.0080	0.2796
smallest	0.0239	0.2790	0.0482	0.3590	0.0196	0.3044	0.0439	0.3649
average	0.0155	0.1832	0.0096	0.2376	0.0121	0.1899	-0.0031	0.2512

The realized spread measures the amount earned by the suppliers of immediacy. It is calculated as follows: Transactions were classified as being buyer-initiated or seller-initiated. Each transaction was then matched with a subsequent transaction at the opposite side of the market; i.e. each buyer-initiated transaction was matched with a seller-initiated transaction and vice versa. The realized spread was then calculated as $s^R = \left(p_t^a - p_{t+1}^b\right)/p_t^a$ or $s^R = \left(p_{t+1}^a - p_t^b\right)/p_t^b$ if the initial transaction was at the ask or at the bid, respectively. We set p^i_{t+1}, $i = a, b$ to be the next transaction at the opposite side of the market (columns 2 to 5) or to be the next transaction which occured after at least 5 minutes at the opposite side of the market (columns 6 to 9). The realized spread for the floor has been calculated without taking the Courtage into account. Adding 0.08% yields an estimate of the realized spread including the regular Courtage rate. Subtracting the realized spread from the effective spread gives the estimate of the adverse selection component. Stocks are sorted into groups by trading volume.

Figure 1: Estimated adverse selecton costs (% of stock value)



The figure shows the adverse selection component of the spread, expressed as a percentage of the share price, for the 30 sample stocks and both markets. The solid line represents the adverse selection component in IBIS, the dotted line the adverse selection component on the floor.