The Quality of Floor and Electronic Trading Systems Directly Compared: Evidence from a Natural Experiment on the German Stock Market*

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Abstract

This paper contributes to the debate about the relative qualities of floor and electronic trading systems by analysing the effects of bringing forward the Xetra closing time from 8.00pm to 5.30pm in November 2003, while the Frankfurt floor remains open until 8.00pm. This natural experiment provides a 'cleaner' institutional setting than in previous studies, as it enables us to investigate trading quality on *both* platforms for the *same* stocks before and after the event. The empirical evidence suggests that primarily institutional investors trading in large stocks transfer to the floor when Xetra closes earlier. It appears that investors remain with Xetra for informed trading though.

JEL Classification: D82, G14, G20

Keywords: Informed Trading, After-hours Trading, Exchange Regulation

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1 Introduction

On 3 November 2003, the closing time of the German electronic trading platform Xetra was brought forward from 8.00pm to 5.30pm, while the Frankfurt floor remained open until 8.00pm. We analyse the effects of this event on the trading qualities on both platforms, thereby contributing to the ongoing debate on whether anonymous electronic trading systems provide more or less favourable conditions for investors than the non-anonymous floor. While a few studies find evidence for the electronic system offering lower execution costs than the floor (e.g. Pirrong (1996), Domowitz and Steil (1999)), the majority of authors argue that higher information asymmetries in computerised trading lead to higher transaction costs (e.g. Venkataraman (2001), Theissen (2002), Barclay et al. (2003), Jain et al. (2006)).

Previous studies either compare floor and electronic trading platforms at the same time (e.g. Venkataraman (2001), Grammig et al. (2001), Theissen (2002)), or they investigate how the market properties change over time when an electronic system is introduced instead of the existing trading floor (Gilbert and Rijken (2006)). In our study, this is reversed in that part of the trading time in the *electronic* system is abolished, which enables us to observe potential transfers of investors from Xetra to the floor. This institutional setting is 'cleaner' than in previous studies as we examine continuous trading of the same stocks in two trading mechanisms inside Germany.

Generally, the higher the information asymmetry is, the less liquid and less deep a market. While traders on the floor have better knowledge about the order flow and the identity of their trading counterparties, those who trade on a computerised system have easier access to fundamental information and prices on other markets (Pirrong (1996)). Pirrong compares theoretically and empirically the liquidity of German Bund Futures contracts traded simultaneously on the open-outcry platform LIFFE and electronically on Deutsche Terminboerse DTB. He finds that the computerised system offers lower spreads and is more liquid and deeper than the floor system.

Domowitz and Steil (1999) examine the total execution costs on various U.S. trading platforms and hypothesise that electronic trading systems compete for traders with floor-based ones. The degree of automation and the resulting lower running costs of a computerised platform should lead to lower overall execution costs in an electronic system than the floor can offer. In fact, they find that electronic markets provide more favourable conditions to investors than the floor for trading in over-the-counter stocks. As for trading listed issues, commissions for traditional brokers are so high that they over-compensate the lower implicit execution costs on the floor.

In contrast to the above studies, there is evidence for the floor offering lower execution costs and hence more favourable conditions for investors than electronic trading systems. Venkataraman (2001) analyses the trade execution costs for the non-anonymous New York Stock Exchange com-

pared with the anonymous Paris Bourse for large and liquid stocks. He finds that trading costs in Paris are higher than at the NYSE by 0.14 percent of the trading volume and concludes that human intermediation may increase liquidity on a stock exchange. However, Venkataraman (2001) examines two stock exchanges in different regulatory settings with different sets of stocks that are matched using various algorithms. Moreover, he investigates two auction markets which makes the interpretation of the spreads difficult (Madhavan (2001)).

Theissen (2002) contrasts the transaction costs on the Frankfurt floor with those in the electronic system (then IBIS, now Xetra) and finds that the electronic system offers lower bid-ask spreads for actively traded stocks. The floor, by contrast, offers more favourable conditions for less frequently traded stocks, with the market share of less liquid stocks being lower in the electronic system than on the floor. Theissen attributes the higher execution costs on the electronic platform to the adverse selection component of the spread.

Several related studies investigate the influence of market makers on information asymmetry. Jain et al. (2006) examine the price impact for stocks traded parallel in the electronic system SETS and on the dealer market at the London Stock Exchange. They find empirical evidence for the computerised trading system to attract relatively more informed trades than the non-anonymous dealer market. Similarly, Barclay et al. (2003) conclude for Nasdaq stocks that informed traders prefer electronic systems over market makers. Benveniste et al. (1992) construct a theoretical model for the spread whose primary implication is that information asymmetries are lower in a non-anonymous market. However, Lehmann and Modest (1994) examine empirically the Tokyo Stock Exchange's (TSE) success in providing liquidity without a specialist on the floor and the electronic system. They conclude that the TSE is a well-functioning, liquid market despite the lack of market makers. Ding and Lau (2001) investigate how the Stock Exchange of Singapore (SES) - which includes a screen-based dealer system that has no specialist - performs relative to the NYSE and NASDAQ. They find, to a large extent, similarities between the SES and the NYSE and NASDAQ.

Bringing forward the closing time of Xetra provides an ideal setting to study the extent to which investors transfer from Xetra to the floor, and the type of investors that accept trading on a non-anonymous system when the anonymous one closes earlier. This should yield insights into the perceptions of traders regarding the relative market qualities of both trading platforms. As information asymmetry impacts directly on market quality, we examine whether it is primarily uninformed investors that accept the floor as a substitute of the electronic system. Theissen (2002) finds differences in relative execution costs between large and small stocks. This is consistent with Dennis and Weston (2001), who suggest that institutional investors are generally better informed

than individual ones, and Falkenstein (1996), who concludes that mutual funds prefer large stocks. We therefore conduct our analysis separately for large and for small stocks, which might give further indications regarding the type of investors that transfer to the floor. Finally, we draw conclusions regarding the design of a trading platform.

We expect trading volume to increase sharply on the floor in November 2003 after 5.30pm, driven by uninformed trades which can thereby be settled at a time when Xetra is closed. As informed traders prefer the anonymity of the electronic system (e.g. Barclay et al. (2003)), this might lead, under otherwise equal conditions, to a higher fraction of informed traders in Xetra, thereby increasing the adverse selection costs and hence making the computerised platform less favourable for investors. This might induce further transfers to the floor. Alternatively, it is possible that the fraction of informed traders increases on the floor if the transferring traders are a representative subset of all traders in Xetra. If primarily institutional (individual) investors move to the floor, we expect especially trading volume for large (small) stocks to increase there in November 2003. If mostly uninformed traders transfer to the floor, we conclude that a trading platform should be non-anonymous in order to avert informed trading.

In order to empirically analyse the relative market quality on both trading platforms over time, section 2 introduces the dataset and the methodology before section 3 describes the empirical results. Section 4 summarises our findings and concludes.

2 Data and Methodology

2.1 Data

Our dataset captures three months prior to, and after, the bringing forward of the Xetra closing time on 3 November 2003 from 8.00pm to 5.30pm. This results in 66 trading days from August 2003 to October 2003 and 60 trading days from November 2003 to January 2004. The data comprise transactions and quotes data for 136 shares traded contemporanously on both Xetra and the floor. The transactions data were obtained from the University of Karlsruhe database and the quotes data from Deutsche Boerse AG. These stocks were selected based on the instrument groups set up by Deutsche Boerse and contain predominantly German companies' shares. Transactions data include timestamp, price, and number of shares.

Quotes are only available for Xetra as this platform has one orderbook from which we received the data. On the floor, by contrast, several market makers operate who are not obliged to publish their orderbooks. For this institutional reason, it is impossible to obtain a comprehensive set of quotes for the floor. Quotes data for Xetra comprise bid and ask prices with timestamps and the

respective number of shares. The relative spreads, which are reported multiplied with 100, are calculated as the difference between ask and bid prices divided by the spread midpoint. We do not calculate the realised spread as it is rare that several transactions in one share have equal timestamps.

We conduct common plausibility checks on the data (Madhavan et al. (1997), Chung and Van Ness (2001)) and eliminate observations with negative spreads, with negative or zero trading volume, and entries with changes in absolute spreads, spread midpoints or returns larger than 50 percent as well as overnight returns. We only use data from continuous trading, i.e. we exclude auctions and observations outside the trading times. This results in a dataset containing 1,106,147 transactions for the floor, 10,376,549 transactions for Xetra, and 28,165,410 quotes.

2.2 Methodology

In order to analyse the anonymous and the non-anonymous trading platforms over time, we apply descriptive methods from the market microstructure literature and decompose the bid-ask spreads following George et al. (1991). For the descriptive analysis, we choose the turnover as a proxy for trading volume, transaction size as an indicator for the presence of institutional investors, and return volatility (Barclay and Hendershott (2003)) and the relative bid-ask spread (Glosten and Milgrom (1985)) to reflect information asymmetry. The trading time is split into 15-minute intervals, and within each interval the average is calculated per share on each trading day following Abhyankar et al. (1997). Rather than aggregating the shares into a portfolio, this method preserves the characteristics of each stock in each interval.

Turnover is calculated as the cumulative product of price and number of shares, transaction size gives the number of shares per trade, and return volatility is computed cumulatively across each intervall with the return being $(p_t - p_{t-1})/p_{t-1}$.[1] The volatility and the spreads are reported in percent. We employ t-tests to determine whether the means in the indicators have changed significantly over time. Statistically, this is identical to estimating dummy regressions and t-testing the estimated coefficients.

As there are no spread data available for the floor, we estimate it following Roll (1984). The basis of this approximation is the autocovariance γ_T of the returns:

$$Spread_T = \sqrt{(-4)\gamma_T} \ , \tag{1}$$

where T is the last period for which a return observation is available. $Spread_T$ can be interpreted as the average relative spread since the returns that feed into the estimation are relative. In case

[1] For the descriptive analysis, we follow Roll (1984) and do not take the logarithm of the prices.

of $\gamma_T > 0$ it is not defined.

George at al. (1991) propose two methods for decomposing the spread into its order processing and adverse selection cost components. Under the first approach, continuously compounded returns $\ln(p_t/p_{t-1})$ are used, whereas the second version takes the difference between this return and the logarithm of the bid price return to compute a synthetic spread $Spread_{calc}$. In either case, the regression

$$Spread_{calc,i} = \alpha_0 + \alpha_1 Spread_{obs,i} + \epsilon_i \tag{2}$$

is estimated where $Spread_{calc,i}$ is the calculated spread, $Spread_{obs,i}$ the observed spread, and i denotes the observation. α_1 measures the order processing costs and $(1 - \alpha_1)$ are the adverse selection costs. While the constant has to be included in the model specification (George et al. (1991)), it is not needed to determine the estimated components of the spread. When $\hat{\alpha_1} < 0$ then the adverse selection costs are set to 1. As there are no observed spread data $Spread_{obs,i}$ available for the floor, we can only decompose the spreads from Xetra.

3 Empirical Results

We expected a sharp increase in trading volume on the floor in November 2003 after 5.30pm. In fact, turnover almost doubles there in the evening. As can be seen from Panel A in Table 1, it increases slightly in the daytime but grows from approximately 15,400 Euros in the evening in October to 29,700 Euros at the same time in November. This increase coincides with bringing forward the closing time in Xetra on 3 November 2003, which we view as empirical evidence for investors transferring to the floor rather than remaining with the electronic trading platform and trading in the daytime instead. In Xetra, the trading volume increases steadily from August 2003 to November 2003, drops in December 2003 and grows strongly in January 2004.

Insert Table 1 about here

The results of the cross-sectional analysis, which are not reported here in detail but are available on request, suggest that the sharp growth in trading volume on the floor is driven by large stocks, while daytime turnover in Xetra for small stocks increases. This is an indication that primarily institutional investors transfer to the floor in the evening, while individual investors trading in small stocks remain with the electronic trading platform and adjust their trading time.

Since transactions in Xetra tend to be larger than those settled on the floor, an increase in transaction size on the floor could be interpreted as further evidence for investors transferring to the floor when Xetra is closed. As Panel B of Table 1 shows, the average number of shares traded

per transaction on the floor increases significantly from about 394 to 535 in November 2003 after 5.30pm. On average, transactions in the evening are then larger than during the daytime. Thus, the substantial increase in trading volume on the floor is driven by the growth in transaction size, and is interpreted as further evidence for the increased trading volume originating from Xetra. Similarly to turnover, transactions in Xetra grow steadily from August 2003 to October 2003, drop in size in November 2003 and resume growing thereafter.

The transaction size on the floor increases substantially for large stocks in November 2003 after 5.30pm, while the transaction size in Xetra grows slowly across the six months under investigation. We conclude that investors trading in large stocks transfer to the floor when Xetra closes earlier. As a larger fraction of market participants in Xetra are informed traders than on the floor (Barclay et al. (2003)), and since those traders that appear to have transferred tend to be well informed, we expect this movement of investors to increase information asymmetry on the floor in November 2003. We investigate this by analysing return volatility and the bid-ask spread.

Turning to the volatility, it decreased on both trading systems, with the floor showing a significant reduction in the daytime and in the evening (Panel C, Table 1). Following Barclay and Hendershott (2003), we interpret this as a decrease in asymmetric information on the floor. It therefore appears that the transfer of investors from Xetra to the floor does not result in higher information asymmetries on the floor. This can be explained in two ways: Either those investors that are prepared to transfer to the floor are not informed, or they are informed but the trades they choose to settle on the floor are not information-based. Either way, this transfer should increase information asymmetry in Xetra under otherwise equal conditions. Since we are investigating a dynamic market across six months, holding everything else equal is too restrictive an assumption. Therefore, we also observe an overall reduction in volatility in Xetra which could be attributed to a growth in liquidity.

The bid-ask spread is another measure of information asymmetry as it contains a component that compensates the market maker for losses incurred when trading against informed investors. The overall spread decreases on both trading systems, with the reduction being particularly sharp on the floor in the evening in November 2003 (Panel D, Table 1). For actively traded stocks, the decrease in the spread is so large that the usual pattern of lower spreads in the daytime than in the evening reverses. Thus, for large stocks, the daytime spread is larger than that in the evening from November 2003 onwards. The reduction in spreads in Xetra could be driven by the increase in liquidity or other factors beyond the transfer of traders to the floor.

As explained in section 2.2, the adverse selection component of the spread can be analysed for Xetra only. Table 2 shows the mean adverse selection costs for the first version of the spread

decomposition according to George et al. (1991). This cost component of the spread increased significantly in the daytime, with the time after 5.30pm scoring even higher relative costs. Thus, the trades that are affected by bringing forward the closing time of Xetra are informed to a larger extent than the trades in the daytime. The increase in information asymmetry before 5.30pm can be seen as evidence for informed traders remaining with the electronic trading system and settling transactions in the daytime, be it earlier on the same day or on the following day. Alternatively, the trading quality might have become less favourable because of uninformed traders transferring to the floor, thereby increasing information asymmetries in Xetra (all else being equal). This might have induced further moves to the floor.

Insert Table 2 about here

Interestingly, after the announcement in September 2003 of the earlier closing time from November 2003 onwards, adverse selection costs in the daytime rise to their maximum in November, followed by a steady decline until January 2004. It is unlikely that investors were able to bring forward informed trades when they learnt about the forthcoming shorter opening hours of Xetra, because such trades are only possible as private information becomes available, and they are only profitable as long as the information they are based upon remains private.

For turnover, transaction size, return volatility and spread, large stocks drive the empirical results. There are at least two possible explanations for this finding. First, Xetra has a much larger market share in large stocks than in smaller ones. It is therefore plausible that primarily large stocks are affected by bringing forward the Xetra closing time, which is what we see reflected in the data. Second, consistent with this interpretation is Falkenstein's (1996) result that institutional investors prefer large stocks over small ones. Therefore it is likely that primarily institutional investors transferred to the floor in November 2003, but continued to settle informed trades on the anonymous electronic platform. It can be concluded that non-anonymous trading platforms offer favourable conditions to uninformed traders, while the anonymity of a computerised platform is preferred for settling informed trades.

As a robustness check, we conducted our analysis of turnover, transaction size, volatility, spread and the spread decomposition for each of the six months from August 2003 to January 2004 separately for either trading platform. The results are not reported in detail but are available from the authors on request. Apart from the year-end observation which we identified for Xetra, the prominent changes in all these time series occurred in November 2003. We regard this as support for our attributing those changes to the earlier closing time in Xetra. Furthermore, we decomposed the spread following the second approach of George et al. (1991). The results are identical with

the ones reported above and can also be obtained from the authors.[2]

4 Summary and Conclusions

The aim of this paper was to contribute to the debate about the relative qualities of floor and electronic trading systems. This issue is investigated in a natural experiment: The trading hours on the anonymous electronic trading system Xetra are reduced, while the non-anonymous floor remains open from 9.00am to 8.00pm. Previous studies either compare both trading platforms operating parallel, or they examine how the market properties change over time when a computerised system is introduced to replace the trading floor. Our setting enables us to observe potential transfers of investors from Xetra to the floor, it is 'cleaner' than in previous studies since the same stocks are traded on the Frankfurt floor as in Xetra, and we base our analysis on continuous trading only.

We find empirical evidence for primarily investors trading in liquid shares transferring to the floor after 5.30pm when Xetra closes early. The transactions they settle on the floor are, on average, not informed, while the adverse selection cost component of the bid-ask spread increases in Xetra, thereby making the electronic trading system less favourable for investors. This might in turn induce further investors to transfer to the floor, where trading conditions become more favourable for investors. Our insights are consistent with Barclay et al. (2003), Jain et al. (2006), Benveniste et al. (1992), and Venkataraman (2001) who find that informed traders prefer the anonymity of the electronic trading system. Uninformed investors should choose non-anonymous trading systems, and they should settle their transactions before 5.30pm. Likewise, if information-based trading is to be reduced, the trading platform should not be anonymous.

Further empirical research should take into account the explicit trading costs as well. Fees and commissions that investors face for transactions they settle on the floor might outweigh the relative benefits of the non-anonymous trading platform (Domowitz and Steil (1999)). Since institutional investors tend to have their own dealers on the floor, they might be able to save on those fees. This could be another reason why we observe primarily institutional investors transferring to the floor.

[2] A further robustness check is the estimation of the Easley et al. (1996) model. However, this approach is based on the assumption that information events occur only *outside* of trading hours, and the market maker learns the information throughout the trading process. As a result, splitting the trading day into 9.00am to 5.30pm and 5.31pm to 8.00pm is not meaningful. In light of our empirical results, which underscore the sharp changes on the floor in the evening, we do not include estimates of the probability of informed trading for the entire day.

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		Panel A: Turnover						
		Floor				**Xetra**		
			H_0: equal means				H_0: equal means	
		mean	t-test	P-value		mean	t-test	P-value
Aug03-Oct03	daytime	34,135.45	2.57	0.01		915,752.10	9.87	<0.0001
Nov03-Jan04	daytime	34,989.55				1,000,625.36		
Aug03-Oct03	evening	16,417.06	19.47	<0.0001		198,846.24		
Nov03-Jan04	evening	28,527.03				not applicable		
Oct03	evening	15,444.56	12.74	<0.0001	daytime	947,214.42	2.86	0.004
Nov03	evening	29,712.98			daytime	990,182.64		
		Panel B: Transaction Size						
		Floor				**Xetra**		
			H_0: equal means				H_0: equal means	
		mean	t-test	P-value		mean	t-test	P-value
Aug03-Oct03	daytime	493.85	-4.00	<0.0001		768.33	-0.72	0.47
Nov03-Jan04	daytime	478.49				765.25		
Aug03-Oct03	evening	420.31	8.59	<0.0001		629.00		
Nov03-Jan04	evening	512.23				not applicable		
Oct03	evening	394.23	7.13	<0.0001	daytime	782.88	-4.57	<0.0001
Nov03	evening	534.66			daytime	756.32		

Table 1: Descriptive Statistics

		Panel C: Return Volatility						
		Floor				Xetra		
			H_0: equal means				H_0: equal means	
		mean	t-test	P-value		mean	t-test	P-value
Aug03-Oct03	daytime	0.286	-26.45	<0.0001		0.187	-20.04	<0.0001
Nov03-Jan04	daytime	0.245				0.168		
Aug03-Oct03	evening	0.274	-18.49	<0.0001		0.232		
Nov03-Jan04	evening	0.199				not applicable		
Oct03	evening	0.249	-6.63	<0.0001	daytime	0.173	0.76	0.45
Nov03	evening	0.205			daytime	0.174		
		Panel D: Bid-Ask Spread						
		Floor				**Xetra**		
			H_0: equal means				H_0: equal means	
		mean	t-test	P-value		mean	t-test	P-value
Aug03-Oct03	daytime	0.356	-21.12	<0.0001		0.636	-36.54	<0.0001
Nov03-Jan04	daytime	0.307				0.553		
Aug03-Oct03	evening	0.350	-16.46	<0.0001		0.778		
Nov03-Jan04	evening	0.252				not applicable		
Oct03	evening	0.322	-6.21	<0.0001	daytime	0.618	-12.26	<0.0001
Nov03	evening	0.262			daytime	0.571		

Table 1: Descriptive Statistics, Continued

			H_0: equal means	
		mean	t-test	P-value
Aug03-Oct03	daytime	0.9939	19.27	<0.0001
Nov03-Jan04	daytime	0.9943		
Aug03-Oct03	evening	0.9991		
Oct03	daytime	0.9951	27.76	<0.0001
Nov03	daytime	0.9959		

Table 2: Relative Adverse Selection Costs in Xetra based on George et al. (1991)