

The Impact of Crossing on Market Quality: an Empirical Study on the UK Market*

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All errors are mine. Suggestions are welcome.

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Abstract

Since 1998, a few alternative trading systems have been operating on the UK stock market. As a result, investors as well as dealers can not only trade on the central market of the LSE but may also submit orders to anonymous crossing networks, among which the most active has been POSIT, the matching system run by the agency stockbroker ITG.

By comparing market data from the LSE and internal data from the POSIT crossing network over a 6-months' period, this paper tests the impact of crossing on market quality and, in particular, on transactions costs, adverse selection and volatility.

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1. Introduction

During the last decades, competition has intensified between major market centres as well as between established exchanges and new trading systems. Among other catalysts, progress in automation and technological innovation have reduced the cost of establishing new proprietary trading systems. As a result, new electronic trading systems have emerged all around the world and multi-system trading has increased. European stock markets have made no exception to the rule.

New electronic systems, when not registered as exchanges, have been regulated by the SEC and designated as Alternative Trading Systems (ATS).¹ They include Electronic Communication Networks (ECN) and Crossing Networks (CN). The former are defined by the SEC as electronic systems that widely disseminate to third parties orders entered by an exchange market maker or OTC market maker, and permit such orders to be executed against in whole or in part. Though, the term ECN does not include any system that crosses multiple orders at specified times at a single price. Conversely, the latter are defined by the SEC as systems that allows participants to enter unpriced orders to buy and sell securities and that crosses orders at specified times at a price derived from another market.

The competition coming from these new trading facilities has changed the structure of financial markets, and probably also the role of intermediaries on these markets. The implications for liquidity are of much interest for academics, regulators and investors. In order to address, at least partially, this issue, this paper focuses on the consequences of trading through a crossing network, by testing market and CN private data.

Concentrating on the impact of crossing on European stock markets is relevant because, if ECNs have tremendously developed in the US², it is still not the case in Europe where only CNs have emerged.

¹ ATS are defined by the SEC as automated systems that centralise, display, match, cross or otherwise execute trading interest but that are not registered with the Commission as national securities exchanges or separated by a registered securities association.

² According to Barclay, Hendershott and McCormick (2001), "ECNs are involved in more than a third of total NASDAQ trading volume and are now attempting to build market share in NYSE-listed issues".

1.1. The development of CNs

CNs generally promise anonymity and lower transaction costs, but do not guarantee execution. In such, they address the needs of a certain type of traders. As a matter of fact, institutional investors have long expressed the need for trading systems that provide low-cost execution while sacrificing immediacy and execution guarantees. This led to the development of the Reuters' Instinet Crossing Network, ITG's POSIT and the New York Stock Exchange's Crossing Network in the US, the largest of these CNs being POSIT. In Europe, two London-based crossing networks³ are currently active on European stock markets. POSIT, the crossing system of ITG Europe, was the first one to open for European ordinary shares in 1998. It has been followed by E-crossnet in 1999, but still has the biggest market share.

These crossing networks match buy and sell orders periodically, at specified times of the trading day. At the hour of a match, buy and sell orders are matched in order to maximise the trading volume but without calculating any transaction price. Executed orders are crossed at the central market mid-quote.

As a result, since 1998, institutional investors and broker dealers have several venues to trade on the UK stock market: they can either submit an order to the central market of the London Stock Exchange (LSE) or submit it to an CN. In the former case, they incur the bid-ask spread but get higher execution guarantee. In the latter case, their probability of execution is little but they are provided anonymity, they incur no adverse selection cost as their orders are not visible from the rest of the market and if executed, they trade at the mid-quote with no implicit transaction costs.

1.2. The theoretical debate

The development of CNs in Europe raises several questions around the trade-off between the benefits of competition and the potential costs of order flow fragmentation. The debate began in 1979, with Hamilton, who pointed out the two opposite effects of multi-market trading and the deviation of a part of the order flow from the central market. Either multi-system trading increases competition among liquidity providers and thus reduces bid-ask spreads, or, conversely, the fragmentation of the order flow between several locations lowers economies of scale and probabilities of execution, resulting in higher volatility and spreads.

³ Let us note that an other brokerage firm, Garban, has also began to run some crosses on the UK market.

On the one hand, multi-market trading models predict that the fragmentation of the order flow will reduce liquidity. According to Mendelson (1987), the dispersal of orders between several markets lowers the probability of execution and lowers liquidity. Chowdry and Nanda (1991) show that informed trade volumes get higher with the number of markets : market makers incur higher adverse selection costs but trade prices are more efficient. Hendershott and Mendelson (2000) model a dealership market with competition for order flow coming from a CN. They show that the deviation of some orders from the exchange on to the CN and unexecuted orders coming back to the market from the CN make the market riskier, so that market makers widen their spreads. The CN makes long lived informational advantages more profitable and increase adverse selection.

1.3. Objective and general organisation of the paper

CNs allow informed traders to submit orders anonymously with no public disclosure. This new opportunity for informed traders may well increase the cost of information asymmetry. Besides, by fragmenting the order flow, CNs may also lower the informational content of trades. These negative effects will be referred to as the *fragmentation effect*. On the other hand, giving the opportunity to trade at the mid-quote, CNs such as POSIT contribute to reduce the average cost of trading, increase the competition between liquidity providers, as market makers and limit order traders, resulting in lower bid-ask spreads, and finally, if they bring informed traders to trade higher volumes, the higher proportion of informed transactions could well enhance efficiency. Such positive effects will be referred to as the *competition effect*. This paper empirically investigates which of these theoretical effects is actually dominant on the UK stock market, by analysing the impact on the market of orders submitted and crossed into POSIT, over a six months' period. It is organised as follows. Section 2 provides information on the organisation of the UK stock market. Section 3 presents the workings of the POSIT crossing network. Section 4 describes the data and lays out the tested hypotheses. Methodology and results are developed in section 5.

2. The organisation and the workings of the UK stock market

The London Stock Exchange (LSE) administers three stock markets: the Alternative Investment Market (AIM) for domestic small and growing companies, the Domestic Equity Market (DEM) for ordinary shares of UK, Channel Islands and Isle of Man companies and other companies with primary UK listing (principally Irish companies), and the International Equity Market (IEM) for non-UK stocks.

Three trading platforms are operating for the DEM and the AIM: SETS, SEAQ and SEATS PLUS. SETS is the trading platform for most liquid stocks of the DEM. SEAQ is the main trading platform for non SETS domestic equity market securities and SEATS PLUS is the trading platform for less liquid domestic stocks (SEATS securities) and AIM securities.

2.1. The Stock Exchange Electronic Trading Service (SETS)

SETS is the electronic order book that replaced the quote-driven competing market maker system for most liquid domestic equity market securities. These securities are either constituents of the FTSE 100 Share Index, or UK constituents of the Eurotop 300 Index, or securities that have individual stock options traded on LIFFE.

The trading day for SETS securities runs from 8:00 am to 4.30 pm subject to a random opening and closing time adjustment. The trading day begins with an opening auction, then goes on with a continuous auction, and ends with a closing auction. Auctions may also take place during the trading day triggered by substantial price movements.

Auctions are preceded by an auction call period during which member firms are permitted to enter and delete only two types of orders on the order book: limit orders and market orders.⁴ At the opening, the auction call period lasts from 7:50 am to a random time between 8:00:00 am and 8:00:30 am ("the random start period"). At the end of this random start period, the order book is frozen and an auction matching algorithm is run.⁵ Once the auction matching process is complete, continuous trading begins. Four types of order can be input during continuous trading: limit orders, at best orders,⁶ execute and eliminate orders⁷ and fill or kill orders.⁸ Automatic execution suspensions may occur if the execution of an order other than fill or kill causes a price movement exceeding 5% against the last transaction price. In that case, trading is suspended during 5 minutes then an auction call period takes place.

⁴ Market orders have a specified size but are entered without a price. They can only be input during an auction call period.

⁵ This calculates the price at which the maximum volume of shares in each security can be traded. All orders that can be executed at this price will be executed automatically, subject to the price and time priorities. If the auction matching process results in a price which is 20% above or below the price of the last automatically executed trade of the previous business day, then auction matching is temporarily halted. The auction call period is then extended for 2 minutes. At the end of this extension, the auction matching process is run again and there will be no further price checks.

⁶ No limit price is specified on an at best order, which is executed at as many different prices as necessary until the order is completed in full. As much of the order as possible will be executed immediately and any remainder will be cancelled.

⁷ Execute and eliminate orders allow participants to fill as much of their order as is available on the order book up or down to a specified limit price. So, they are entered with a quantity and a limit price. They are executed immediately for as much as possible and any unexecuted portion will be cancelled.

Finally, the closing auction call period begins at 4:30 pm and ends at a random time between 4:35:00 pm and 4:35:30 pm (“random close time”). At the random close price, the auction-matching algorithm is run, in the same way as the opening auction. Moreover, if the total volume that would execute is less than a pre-determined multiple of the Normal Market Size (NMS)⁹ of the security, then auction matching will not occur.

Besides, particularly large trades or trades with non-standard conditions can be negotiated away from the order book, enabling member brokerage firms to commit risk capital to large trades.

2.2. SEAQ

SEAQ is the screen based competitive market making segment of the Exchange trading system for non order book domestic equity securities. A SEAQ security is a domestic equity market security for which a minimum of two market makers register with the Exchange. Each market maker is obliged to display firm two-way prices on SEAQ in the NMS,¹⁰ or reduced NMS in the case of reduced size market makers¹¹, during the Mandatory Quote Period (MQP), which lasts from 8:00 am to 4:30 am. From 7:30 am to 8:00 am, quotes may be opened but prices are regarded as being indicative only. From 4:30 pm to 5:15 pm, market makers may continue to display firm quotes but are not obliged to do so and the trading system remains open for trading reporting.

During the trading day, the best bid and best offer prices quoted by market makers on SEAQ are commonly referred to as the yellow strip. In the event that quotations by or more market makers are identical in terms of price, the best quote will be the one that was entered first.

Besides, three auctions, where only limit orders can be submitted, are run during the trading day for SEAQ securities that are part of the FTSE 250 Share Index. The SEAQ auction times are 11:00 am, 3:00 pm and 4:45 pm. These auctions were turned into crosses in April 2001, but nearly no transactions are effectively executed through these batch algorithms.

⁸ A fill or kill order must be entered with a quantity and may be defined with a limit price. It will be executed either in full or not at all and non-executed fill or kill orders do not sit on the book.

⁹ For a SETS security, the NMS is a quantity specified by the Exchange according to the average size of trades over the last 12 months. The pre-determined multiples for the closing volume check are 0,5 for securities with a NMS of 5000 or more, or the aggregate executable volume of 2500 for securities with a NMS of below 5000.

¹⁰ The NMS classification of SEAQ securities are reviewed quarterly using the following formula: (value of customer turnover in previous 12 months in £)/(closing mid-price on last day of quarter×10000). NMS's are then rounded up or down to one of the following bands: 100, 200, 500, 1000, 2000, 3000, 5000, 10000, 15000, 25000, 50000, 75000, 100000, 150000, 200000.

¹¹ Some market makers are granted special permission to display prices in smaller quantities than NMS. The reduced NMS is half the NMS rounded down to the nearest NMS band.

2.3. SEATS PLUS

SEATS PLUS is the Stock Exchange Alternative Trading Service for the trading SEATS and AIM securities. It is a mixed system which supports the entry of both market makers' quotes and orders. NMS for SEATS securities is set at 1000 shares and NMS for AIM securities falls under the same regime as used for SEAQ securities. Three types of orders are available for entry on SEATS PLUS: firm exposure orders (limit orders), indicative exposure orders¹² and hit orders (order submitted to execute automatically against a firm exposure order). The entry of exposure orders is allowed throughout the trade reporting period (7:15 am-5:15 pm). Yet, the entry of hit orders is restricted to the MQP.

3. The POSIT crossing network

Run by the agency stockbroker ITG, POSIT is an intra-day electronic trading system,¹³ which matches buy and sell orders at predetermined times in the day. The system is totally anonymous and reduces transaction costs by using mid-market pricing for execution. It was created in 1987, as a joint venture between ITG Inc. and BARRA Inc., the California based quantitative house, in response to the dealing inefficiencies in the US equity market, primarily with respect to smaller, less traded, stocks and in particular in response to the issues of market impact. As a matter of fact, "opening" to the market a decision to buy or sell a less liquid stock would often result in a major shift in the share price of that stock, with little or no turnover having taken place. This led to reluctance from institutional investors to even pass orders to the market in such stocks. ITG crossing technology aims at addressing these inefficiencies.

Already operating in the US and the Australian markets, POSIT was launched in Europe in 1998, and is now working in ten European countries (UK, Germany, Switzerland, France, Belgium, Netherlands, Italy, Spain, Sweden, Finland).

3.2. The crossing technology and the matching times

Orders can be submitted to POSIT continuously, at any time of the trading day. Anonymity is protected and order details are never divulged externally or disclosed to the market. Submissions are free of charge.

¹² An indicative exposure order indicates a price at which the person on whose behalf the order is displayed may be prepared to deal.

¹³ POSIT stands for *Portfolio System for Institutional Traders*.

The proprietary matching algorithm within POSIT is run at designated times each day. In order not to allow gaming and manipulating strategies, at the designated time of a match, a random execution time within a seven minute window is generated from the POSIT computer so that no one, neither clients nor the trading desk, is aware of the exact match time. Any order received before the designated match time will be included in the match pool, but any order received after the start of the match window will be taken on a best endeavour basis up to the time the match is run. Any order subsequently received would be for the next scheduled match.

The POSIT algorithm compares all submitted orders confidentially and is set to maximise the total value of shares traded, given the constraints¹⁴ associated with submitted orders. Matching orders are crossed at the ruling mid-price taken from the lead market quote for each stock,¹⁵ and reported to the relevant authority after execution. Only executed orders are charges a 10 basis points brokerage commission.

The match timetable (in UK time) consists of six intra-day matching times as follows: 9:00 am, 10:00 am, 11:00 am, 12:00 am, 2:00 pm, 3:00 pm, and according to trading activity, some days, a seventh match is also run at 4:00 pm.

Table 1
POSIT match times (UK time)

Period	Match times
18 nov 1998 - 19 sep 1999	11:00 am, 15:00 pm
20 sep 1999 - 9 jan 2000	9:30 am, 11:00 am, 3:00 pm
10 jan 2000 - 27 mar 2000	9:30 am, 11:00 am, 12:00 am, 3:00 pm
28 mar 2000 - 29 nov 2000	9:30 am, 11:00 am, 12:00 am, 3:00 pm, (4:00 pm)
30 nov 2000 - 15 jan 2001	8:30 am, 9:30 am, 11:00 am, 12:00 am, 3:00 pm, (4:00 pm)
16 jan 2001 - 18 mar 2001	8:45 am, 9:30 am, 11:00 am, 12:00 am, 3:00 pm, (4:00 pm)
From 19 mar 2000	9:00 am, 10:00 am, 11:00 am, 12:00 am, 2:00 am, 3:00 pm, (4:00 pm)

Lines in grey correspond to the observation period.

¹⁴ Clients can associate different types of constraints on the orders they submit to POSIT, so as to avoid unfavourable match executions. These constraints are detailed in Appendix 1.

¹⁵ POSIT technology also offers clients the ability to generate trades that require market prints (e.g. internal crosses across different underlying clients) by means of "directed crosses". These bespoke matches may take place at any time during the trading day, outside of the normal scheduled match times and may use the standard POSIT mid-point pricing or some other benchmark pricing, e.g. VWAP. These directed crosses are excluded from our dataset.

This current timetable results from several changes summarised in table 1. When ITG Europe launched POSIT for UK equities in November 1998, only two daily matches were run at 11:00 am and at 3:00 pm. A third match was introduced at 9:30 am, in September 1999 and a further one, at midday, was added in January 2000. Then, in March 2000, the unofficial 4:00 pm match was introduced. A new 8:30 am was added in November 2000 and moved to 8:45 am in January 2001. Finally, the match times were moved to the current hourly timetable in March 2001.

4. Data and testable hypotheses

The data used in the empirical investigations consist of LSE high frequency market data for all UK domestic stocks, over a six months' period from July to December 2000, and of POSIT order data, for UK stocks, on the same period of time.

4.1. Market data

Tick by tick market data from the London stock market include transaction data and best prices data. Best prices correspond to the best bid and offer market makers' quotes for SEAQ and SEATS stocks and to the best limit prices from the order book for SETS stocks. Quantities associated to best prices are not available so that the NMS is used as a proxy.

4.2. POSIT data

We have been provided with POSIT data over the same observation period. These data consisted of two SQL tables. One table included the characteristics of the orders submitted in the CN, such as the ITG code identifying the stock, the size of the order in number of shares, the type of the initiator, that is "institutional investor" or "broker-dealer", the constraints associated with order and the date and time of the match to which the order is being submitted. The second table included the characteristics of the orders executed in the CN: the stock ITG code, the executed quantity, the type of initiator, the mid-price used for execution and the date and time of the corresponding match.

All these characteristics are used for the empirical tests, except the constraints associated to the orders (see Appendix 1) as they convey no relevant information for our purpose.

Before running any empirical tests, these raw data have been rearranged for the purpose of the research in a few ways. First, the submission table was merged with the execution table, so as to allow to exhibit for each submission whether it is totally or partially executed, or not executed at all. Then, we established the correspondence between the stock ITG codes and the ISIN codes used to identify stocks in the LSE market database. Finally, a procedure was

set up to determine whether a submission to POSIT was made for the first time or whether it was an order resubmitted after remaining unexecuted in the previous match. In the end, a single table was built up. It contains, for each submission to POSIT: the stock ITG code, the ISIN code, the date and time of the match that is submitted to, the type of the initiator, the submitted quantity, the executed quantity and the price of execution if any.

4.3. The sample

The study is first restricted to SEAQ stocks, as POSIT has been particularly active on these stocks since its launch, and will further be extended to SETS equities.

During the observation period, that is 127 trading days from July to December 2000, SEAQ market-makers quoted prices for 1657 domestic stocks, among which 1647 were priced in GBP (either pennies or pounds) and 10 were priced in USD. Over the 1647 GBP quoted stocks, 1643 were effectively traded while no transaction took place for 4 of them. The total amount in GBP traded over these 1643 stocks was 80 450 millions, that is 44 325 millions in number of shares. Over these volumes, 955 millions of GBP (379 millions of shares) were traded through POSIT, which equals 1,22% of the whole volume traded on the market over the 6-months' observation period. Details on intra-day trading activity for these 1643 stocks are given in tables 2 and 3.

Then, most illiquid stocks were eliminated from this sample, to avoid strange effects due to extreme values. Looking at the distribution of average quoted spreads across the sample, it appears that the average quoted spread is under 30% for 98,1% of the 1643 stocks, which represents 99,99% of the total traded volume over the observation period for these stocks. Henceforth, excluding the stocks¹⁶ for which the average quoted spread exceeds 30% does not substantially distort the sample.

Furthermore, we require that every stock included in the sample was effectively quoted by SEAQ market makers during at least 100 days of the observation period, in order to get similar numbers of daily observations (i.e. between 100 and 127) for all the stocks and thus to make empirical variables comparable on an inter-stock basis.

Following these criteria, the sample is then reduced to 1451 stocks, from which one is excluded because effective spreads applied on transactions for this stock can not be computed.¹⁷

¹⁶ These equities are generally very low-priced stocks, with very little trading volumes, which explains their incredibly high spreads.

¹⁷ To determine the side of a trade, we use two conditions: the side officially reported by the market maker who declared the trade and the difference between the transaction price and the current mid-

Table 2
Trading volumes for UK GBP-priced SEAQ stocks

GBP volumes traded throughout the trading day ¹⁸	Total over the period	Average per day
On the market	78 391 147 702	617 253 132
In POSIT	954 583 303	7 516 404
% in POSIT	1,22%	1,22%

Table 3
Number of trades for UK GBP-priced SEAQ stocks

Number of trades throughout the trading day	Total over the period	Average per day	Average size of trade in GBP
On the market	2 261 930	17 810	34 657
In POSIT	7 685	61	124 204
% in POSIT	0,34%	0,34%	---

Consequently, the final sample consists of 1450 SEAQ stocks. Orders were submitted into POSIT for 1262 of them, out of which 562 were traded at least once in the CN. The POSIT share in total traded volume exceeded 1% for 275 of these stocks and exceeded 5% for 22. 73 718 millions of GBP were traded on the stocks of the sample from July to December 2000, over which 1,27%, that is 935 millions, were transacted through POSIT. These 73 718 millions of GBP represented 2,17 millions of transactions, on which 0,35% (i.e. 7 534 trades) were POSIT-executed orders. Such is the case because the average size of a trade in POSIT is 3,7 times the average size of a trade on the market. These figures are set out in Tables 4 and 5.

Table 4
Trading volumes for the stocks of the sample

GBP volumes traded throughout the trading day	Total over the period	Average per day
On the market	73 717 626 148	580 453 749
In POSIT	934 722 524	7 360 020
% in POSIT	1,27%	---

quote at the time of the trade. Following Lee and Ready (1991), a positive difference is supposed to indicate a purchase while a negative difference would indicate a sale. In case of contradiction between both conditions, we consider that the side of the trade is unknown and that the effective spread applied on the transaction ($|\text{trade price} - \text{midquote}| / \text{midquote}$) can not be computed.

¹⁸ Overnight transactions are excluded from the analysis as POSIT is only working during the day. The trading intra-day period we consider lays from 8:00 am to 5:00 pm, as we noticed that trading volumes keep high till 5:00 pm, even if the MQP closes at 4:30 pm.

Table 5
Number of trades for the stocks of the sample

Number of trades throughout the trading day	Total over the period	Average per day	Average size of trade in GBP
On the market	2 170 504	17 091	33 963
- buying orders	1 199 458	9 445	32 544
- selling orders	971 040	7 646	34 481
In POSIT	7 534	59	124 067
% in POSIT	0,35%	---	---

Throughout the observation period, the market was rather bearish. The cross-sectional average close-to-close return rose to $-0,0659\%$ for the sample. This average is obtained as follows. First, for each stock of the sample, the equally weighted mean of daily returns is calculated in logarithm on closing mid quotes. Second, a mean of the individual average returns is computed, weighting each stock by the total volume traded on the stock over the period.

The cross-sectional average volatility of close-to-close returns, computed in the same manner, equals $2,8072\%$ (see Table 6).

Table 6
Daily returns

Cross-sectional analysis on stock-by-stock average returns	Weighted mean	Standard deviation	Minimum	Maximum	Number of stocks
Close-to-close average returns	$-0,0659\%$	$0,3136\%$	$-1,8335\%$	$0,7894\%$	1450
Close-to-close returns volatility	$2,8072\%$	$1,8036\%$	0	$21,1142\%$	1450

Concerning transaction costs, the cross-sectional mean of time-weighted average quoted spreads is $2,3723\%$ while the volume-weighted average effective spread applied on transactions only equals $1,77\%$, the average effective spread on sales ($2,0221\%$) being substantially superior to the average effective spreads on purchases ($1,3921\%$).

As a measure for depth, the average NMS in GBP equals 9281,55 over the period. Furthermore, the level of liquidity for the sample is estimated using the Kyle depth coefficient, that is the deviation in price from mid-quote to accept to be able to trade one more unit of share. We will calculate this variable in percentage of mid price and will refer to it as the unit marginal cost (UMC). Over our sample, the cross-sectional mean of the average quoted UMC equals $0,000359\%$ of mid quote. It goes down to $0,000127\%$ when calculated with effective spreads applied on trades (see Table 8). Yet, the sample is heterogeneous in terms of liquidity, as for the most liquid stock, the average quoted UMC equals $0,000007\%$

while it rises to 0,028130% for the least one. Differences in liquidity across the sample are even more striking, looking at the average effective UMC, the lowest being nearly null (0,37.10⁻⁸) and the highest one reaching 0,019290%. Tables 7 and 8 provide statistics on transaction costs, depth and liquidity.

Table 7
Transaction costs

Cross-sectional analysis on stock-by-stock average spreads	Weighted mean	Standard deviation	Minimum	Maximum	Number of stocks
Time-weighted average quoted spread	2,3723%	1,4875%	0,4847%	28,6074%	1450
Volume-weighted average effective spread	1,7700%	1,7780%	0,0338%	50,5649%	1450
V-W average effective spread on purchases	1,3921%	1,3398%	0,0000%	52,6957%	1446
V-W average effective spread on sales	2,0221%	2,4578%	0,0000%	78,8388%	1449

Table 8
Unit marginal cost (UMC) in % of mid-price

Cross-sectional analysis on stock-by-stock average UMC	Weighted mean	Standard deviation	Minimum	Maximum	Number of stocks
Time-weighted average quoted UMC	0,000359	0,000705	0,000007	0,028130	1450
Volume-weighted average effective UMC	0,000127	0,000227	0,00000037	0,019290	1450
V-W average effective UMC on purchases	0,000141	0,001268	0,000000	1,851852	1446
V-W average effective UMC on sales	0,000119	0,000239	0,000000	0,020397	1449

Quotes on the stocks of our sample are not very frequently revised: the average number of quote revisions per day and per stock is 11,6 (see Table 9).

Table 9
Number of quote revisions

Cross-sectional analysis on stock-by-stock averages	Weighted mean	Standard deviation	Minimum	Maximum	Number of stocks
Average daily number of quote revisions	11,6	8,0	1	56	1450

Trading activity within POSIT was substantial for the stocks of the sample. The amount of submitted orders reached 43 162 millions of GBP over the period, that is 58,55% of the total traded volume on the market. Including resubmissions, this amount goes up to 71 846 millions of GBP. Institutional investors initiated 51,8% of these orders while market makers submitted 48,2%. Selling orders (59,86%) exceed buying orders (40,14%), this imbalance being higher for orders placed by market makers. Market makers placed nearly twice (1,9 times) more sell orders than buy orders in the CN.

If the major part of submitted orders came from institutional investors, most executed orders were market maker-initiated (67,69% of the volume executed in POSIT over the period). Table 10 displays more details about submissions and executions in the CN over the observation period.

Table 10
Trading activity in POSIT

	Total over the observation period	From institutional investors	From broker- dealers
Total submitted volume* in GBP	43 162 465 832	22 356 870 573	20 805 595 259
- in % of total submitted volume*	100,00%	51,80%	48,20%
Total number of submitted orders*	123 191	35 663	87 528
Average size of an submitted order*	350 370	626 893	237 702
Total submitted buy volume* in GBP	17 326 822 218	10 058 683 880	7 268 138 338
- in % total submitted volume*	40,14%	23,30%	16,84%
Total number of submitted buy orders*	42 480	14 484	27 996
Average size of an submitted buy order*	407 882	694 469	259 613
Total submitted sell volume* in GBP	25 835 643 615	12 298 186 694	13 537 456 921
- in % of total submitted volume*	59,86%	28,49%	31,36%
Total number of submitted sell orders*	80 711	21 179	59 532
Average size of an submitted sell order*	320 101	580 678	227 398
Total executed volume in GBP	934 722 524	302 005 599	632 716 925
- in % total executed volume	100,00%	32,31%	67,69%
- in % of total market traded volume	1,27%	0,41%	0,86%
Total executed volume over total submitted volume	2,17%	1,35%	3,04%
Total number of executed orders	7 534	1 848	5 686
Average size of an executed order	124 067	163 423	111 276

* Including new submissions only / excluding resubmissions of unexecuted orders

Before investigating the implications for the market of the CN activity, the testable hypotheses ensuing from theoretical models are listed in next subsection.

4.2. Testable hypotheses

From theoretical models on fragmentation, we derive a series of testable hypotheses on the implication of trading through a CN for market quality.

1. Fragmentation effect vs competition effect

H1. *The competition effect dominates the fragmentation effect.*

If H1 is true, the effective spread should be negatively related to the share of traded volume executed in the CN (positively otherwise).

2. Adverse selection

H2. *The fragmentation of the order flow between the central market and the CN creates additional adverse selection costs.*

Under H2, spreads would increase with the share of order flow submitted to POSIT.

3. Inventory costs

H3. *The CN gives an opportunity to market makers to reallocate their positions with no implicit trading cost and thus lowers inventory costs.*

Under H4, quoted spreads should be negatively related to the share of volume traded by market makers through the CN.

4. Unexecuted CN order flow and implicit transaction costs

H4. *Unexecuted order flow coming back from the CN to the central market for execution, creates temporary tension on liquidity, either because it increases adverse selection, as demonstrated in Hendershott and Mendelson (200), or because it suddenly generates abnormal inventory costs for market makers.*

Provided H3, spreads would widen with the amount of unexecuted CN order flow.

5. Market impact

H5. *Crossing reduces global market impact of trades.*

Given the realisation of H5, the return volatility per unit of traded volume would decrease with the share of volume transacted through the CN.

H6. *Crossing reduces temporary market impact.*

Provided H6, intra-day volatility around VWAP would be negatively related to the share of traded volume executed in the CN.

H7. *Crossing reduces short-term volatility around fundamental value.*

Under H7, the ratio hourly return volatility over daily return volatility would decrease with the share of traded volume executed in the CN.

5. Informed trading and efficiency

H8. *Informed traders submit more orders to the CN than to the central market.*

Returns could then be explained not only by buy and sell trades on the market but also by buy and sell orders submitted to the CN.

H9. *As for the implications of H8 for efficiency, the following alternative will be tested: either informed trading through the CN harms efficiency and slows down the discovery of prices (H9a), or, by increasing the total proportion of informed trading on the market, crosses in the CN accelerate the discovery of prices (H9b).*

If H9a (H9b) holds, then the number of quote revisions per day would decrease (increase) with the share of order flow (either submitted or executed) going to the CN.

H10. *Finally, if crossing accelerates quote revisions, does it effectively speed up the discovery of prices (H10a), or does it just make the process of discovery more complex (H10b)?*

Under H10a (H10b), the lower the share of order flow (either submitted or executed) going to the CN, the later (the earlier) price movements would take place within the trading day.

5. Methodology and results

The methodology consists of a cross-sectional analysis on stock-by-stock average measures, as a preparatory work to a stock-by-stock temporal analysis. We first define the variables used in the cross-sectional regressions and then give the results.

5.1. Variables and notations

Dependent variables

Our analysis uses as dependent variables average spreads, measures of volatility, average daily returns and the average number of quote changes per day.

- QS_i is the average quoted touch or market spread (i.e. the difference between the best offer and the best bid quoted on the market reported to the mid-quote), for stock i , calculated by weighting each quoted spread with its time of validity.
- ES_i is the average effective spread weighted by trade volumes for stock i .
- $\frac{\sigma_i}{DTV_i}$ is the empirical standard deviation of close-to-close returns on the observation period for stock i divided by the average daily traded volume in GBP. This variable measures the impact of trading volumes on prices.
- $\sigma(VWAP)_i$ is the average standard deviation of trade prices from VWAP during the trading day. VWAP is the volume-weighted average price of the stock on a given trading day and is used by operators as a benchmark either to price transactions or to valuate trading performance. $\sigma(VWAP)_i$ measures short-term volatility around the mean level of prices due to implicit transaction costs and market impact of trades.

– $\frac{\sigma^2(h)_i}{\sigma^2(oc)_i}$ is considered as a proxy for short-term volatility around fundamental value. It

reports the sum of hourly return variances to $\sigma^2(oc)_i$, the variance of open-to-close

returns. Let us note $\sigma^2(k)_i$ the variance of mid-quote returns on the k^{th} hour of the

trading day for stock i : $\sigma^2(h)_i = \sum_{k=1}^{8.5} \sigma^2(k)_i$.

– R_i is the mean of daily returns calculated in logarithm on closing mid-quotes for stock i .

– NQ_i is the average number of quote revisions per day. As a dependent variable, it is a proxy for the speed of price adjustment to information.

– SP_i is computed to measure, for each stock i , the speed of price adjustment throughout the trading day. It is the mean of the different hours (1, 2, 3, 4, 5, 6, 7, 8, 8.5) of the trading

day, each hour k being weighted by $\frac{\sigma^2(k)_i}{\sum_{k=1}^{8.5} \sigma^2(k)_i} = \frac{\sigma^2(k)_i}{\sigma^2(h)_i}$. Thus, $SP_i = \sum_{k=1}^{8.5} k \times \frac{\sigma^2(k)_i}{\sigma^2(h)_i}$.

The higher SP_i , the later price movements take place within the MQP.

Control variables

For each dependent variables, control variables are determined by running stepwise linear regressions of the dependent variable over a range of possibly explaining variables and keeping the most powerful model. For each dependant variable, the results from the stepwise regressions confirm theoretical and intuitive predictions. Table 11 describes the selected control variables and Table 12 exhibits, for each dependent variable, the corresponding control variables

Explaining variables

Our analysis consists of examining the effects of variables measuring the trading activity in the CN, on the dependent variables we have defined. These CN-activity related variables are:

- X_i , which is the total volume in GBP traded through POSIT for stock i over the period, in percentage of the total volume (in GBP) of stock i traded on the market,
- NS_i , which is the total amount in GBP of orders submitted to POSIT on stock i reported to the total market traded volume, including new submissions only and excluding resubmissions of unexecuted orders,

Table 11
Selected control variables

Control variable	Signification
σ_i	Standard deviation of daily returns for stock i
TV_i	Logarithm of the total volume in GBP traded on stock i over the period
BTV_i	Logarithm of the total amount in GBP of buying trades on stock i
STV_i	Logarithm of the total amount in GBP of selling trades on stock i
NMS_i	Logarithm of the average NMS (in GBP) of stock i
QS_i	Average quoted market spread for stock i
ES_i	Average effective spread weighted by trade volumes for stock i
$EUMC_i$	Average effective marginal cost of one share for stock i
NQ_i	Average number of quote revisions per day for stock i
NT_i	Average number of trades per day for stock i

Table 12
Correspondence between dependent variables and control variables

Dependant variable	Control variables
QS_i	σ_i, TV_i, NQ_i
ES_i	σ_i, TV_i, NMS_i
σ_i / DTV_i	$ES_i, EUMC_i$
$\sigma(VWAP)_i$	$QS_i, \sigma_i, TV_i, NT_i$
$\sigma^2(h)_i / \sigma^2(oc)_i$	NT_i, TV_i, QS_i, NQ_i
R_i	BTV_i, STV_i
QN_i	$NT_i, NMS_i, TV_i, \sigma_i$
SP_i	TV_i, NT_i, QS_i, NQ_i

- S_i , which is the total amount in GBP of all orders submitted to POSIT on stock i reported to the total market traded volume, including resubmissions of unexecuted orders,
- U_i , which is the total amount in GBP of unexecuted POSIT orders reported to the total market traded volume for stock i ($U_i = NS_i - X_i$),
- XM_i , which is the total volume in GBP of stock i traded by market makers through POSIT, in percentage of the total volume (in GBP) of stock i traded on the market,
- XI_i , which is the total volume in GBP of stock i traded by institutional investors through POSIT, in percentage of the total volume (in GBP) of stock i traded on the market,

- SBI_i , which is the total amount in GBP of buy orders submitted to POSIT by institutional investors on stock i reported to the total market traded volume,
- SSI_i , which is the total amount in GBP of sell orders submitted to POSIT by institutional investors on stock i reported to the total market traded volume,
- SBM_i , which is the total amount in GBP of buy orders submitted to POSIT by market makers on stock i reported to the total market traded volume,
- SSM_i , which is the total amount in GBP of sell orders submitted to POSIT by market makers on stock i reported to the total market traded volume.

5.2. Fragmentation effect vs competition effect

First, to test H1, we regress, as shown in equation (1), the average effective spread on X_i , the share of the CN in the total traded volume for stock i , controlling for σ_i , TV_i and NMS_i .

$$ES_i = a + b\sigma_i + cTV_i + dNMS_i + eX_i + \varepsilon_i \quad (1)$$

By running a linear OLS-regression on our 1450 observations, we obtained

$$ES_i = 19,799 + 0,866 \sigma_i - 0,9 TV_i - 0,438 NMS_i - 1,18 \cdot 10^{-2} X_i + \varepsilon_i \quad (2),$$

$(25,874)$
 $(20,022)$
 $(-10,554)$
 $(-3,645)$
 $(-0,161)$

with $R^2=48,6\%$.

The e coefficient is negative but not significantly different from zero. Running the regression on the sub-sample of the 562 stocks effectively traded through the CN over the period, the results become:

$$ES_i = 8,77 + 0,509 \sigma_i - 0,255 TV_i - 0,343 NMS_i - 0,156 X_i + \varepsilon_i \quad (3),$$

$(5,459)$
 $(8,98)$
 $(-1,615)$
 $(-1,988)$
 $(-2,878)$

with $R^2=19,7\%$.

e is significantly negative at a 1% level in equation (3). According to these results, the fragmentation is not dominant, and the domination of the competition effect is slight.

5.3. Adverse selection

Regressions (4) and (5) tests H2:

$$QS_i = a_1 + b_1\sigma_i + c_1TV_i + d_1NQ_i + e_1NS_i + \varepsilon_{1i} \quad (4),$$

$$ES_i = a_2 + b_2\sigma_i + c_2TV_i + d_2NMS_i + e_2NS_i + \varepsilon_{2i} \quad (5).$$

The estimates given in equations (6) and (7) show that the relative amount of orders submitted to the CN has a negative impact on quoted spreads and no significant effect on

effective spreads, which allow us to conclude that it does not create additional adverse selection costs.

$$QS_i = 20,659 + 0,924 \sigma_i - 1,113 TV_i - 6,87 \cdot 10^{-2} NQ_i - 2,01 \cdot 10^{-4} NS_i + \varepsilon_{1i} \quad (6).$$

(31,031) (27,228) (-25,113) (-3,082) (-3,082)

$$(R^2 = 61,5\%)$$

$$ES_i = 19,782 + 0,865 \sigma_i - 0,897 TV_i - 0,443 NMS_i + 1,936 \cdot 10^{-5} NS_i + \varepsilon_{2i} \quad (7).$$

(25,957) (20,033) (-10,442) (-3,730) (0,327)

$$(R^2 = 48,6\%)$$

5.4. Inventory costs

To test H3, we run the regression (8), first on the total sample, secondly on a sub-sample consisting of the 562 stocks for which trades have been executed through the CN.

$$QS_i = a + b\sigma_i + cTV_i + cNQ_i + dXM_i + \varepsilon_i \quad (8)$$

Results for the total sample (1450 stocks) show that quoted spreads are negatively related to the relative amount of transactions traded by market makers through POSIT but the negative coefficient is not significantly different from zero (see equation 9).

$$QS_i = 20,164 + 0,907 \sigma_i - 1,079 TV_i - 6,74 \cdot 10^{-2} NQ_i - 0,108 XM_i + \varepsilon_i \quad (9).$$

(30,25) (26,237) (-24,217) (-2,958) (-1,234)

$$(R^2 = 61,1\%)$$

Focusing on the sub-sample (562 stocks), this negative effect becomes significant at a 1% threshold (see equation 10), meaning that trading in the CN reduces inventory costs for market makers and allow them to tighten quotes.

$$QS_i = 8,511 + 0,635 \sigma_i - 0,362 TV_i - 8,76 \cdot 10^{-2} NQ_i - 0,236 XM_i + \varepsilon_i \quad (10).$$

(8,996) (17,824) (-6,503) (-6,301) (-4,604)

$$(R^2 = \%)$$

5.5. Unexecuted order flow and implicit transaction costs

H4 is tested through regressions (11) and (12):

$$QS_i = a_1 + b_1\sigma_i + c_1TV_i + d_1NQ_i + e_1NS_i + \varepsilon_{1i} \quad (11),$$

$$ES_i = a_2 + b_2\sigma_i + c_2TV_i + d_2NMS_i + e_2NS_i + \varepsilon_{2i} \quad (12),$$

first on the total sample, second on the sub-sample of the stocks actually traded in the CN.

The results displayed in equations (13), (14), (15) and (16) show that the unexecuted order flow in the CN does not significantly harm liquidity.

On the whole sample:

$$QS_i = 20,659 + 0,924 \sigma_i - 1,113 TV_i - 6,88 \cdot 10^{-2} NQ_i - 2,01 \cdot 10^{-4} U_i + \varepsilon_i \quad (13),$$

(31,031)
(27,228)
(-25,113)
(-3,083)
(-4,391)

$$(R^2 = 61,5\%)$$

$$ES_i = 19,782 + 0,865 \sigma_i - 0,897 TV_i - 0,443 NMS_i + 1,937 \cdot 10^{-5} U_i + \varepsilon_i \quad (14).$$

(25,956)
(20,032)
(-10,442)
(-3,73)
(0,327)

$$(R^2 = 48,6\%)$$

On the sub-sample (562 stocks):

$$QS_i = 7,145 + 0,683 \sigma_i - 0,304 TV_i - 9,74 \cdot 10^{-2} NQ_i - 4,887 \cdot 10^{-4} U_i + \varepsilon_i \quad (15),$$

(7,314)
(19,656)
(-5,308)
(-6,968)
(1,472)

$$(R^2 = 62\%)$$

$$ES_i = 7,561 + 0,538 \sigma_i - 0,167 TV_i - 0,417 NMS_i + 2,9 \cdot 10^{-4} U_i + \varepsilon_i \quad (16).$$

(4,507)
(9,579)
(-1,05)
(-2,423)
(0,538)

$$(R^2 = 18,5\%)$$

5.6. Market impact

Testing H5, we find no significant impact of X_i on $\frac{\sigma_i}{DTV_i}$: crosses through POSIT have no significant effect on the global market impact of trades. Yet, regression (17) indicates that they reduce temporary market impact and validates H6.

$$\sigma(VWAP)_i = -1,78 + 0,116 \sigma_i + 0,1 QS_i + 4,171 \cdot 10^{-3} NT_i \quad (17).$$

(-8,918)
(11,876)
(16,504)
(4,761)

$$+ 0,114 TV_i - 3,85 \cdot 10^{-2} X_i + \varepsilon_i \quad (R^2 = 43,4\%)$$

(9,685)
(-2,928)

However, this negative effect is mainly due to market makers crosses, as shown in regression (18).

$$\sigma(VWAP)_i = -1,784 + 0,115 \sigma_i + 9,987 \cdot 10^{-2} QS_i + 4,2 \cdot 10^{-3} NT_i + 0,107 TV_i \quad (18).$$

(-8,942)
(11,806)
(16,416)
(4,794)
(9,747)

$$- 6,28 \cdot 10^{-2} XM_i - 1,21 \cdot 10^{-2} XI_i + \varepsilon_i \quad (R^2 = 43,5\%)$$

(-3,081)
(-0,565)

H7, tested in regression (19), is rather similar to H6, except that it focuses on short-term volatility around fundamental value, as the dependent variable reports hourly return volatility to open-to-close return volatility. According to the estimates, the excess of short-term volatility over long-term volatility decreases with the share of order flow executed in the CN.

$$\frac{\sigma^2(h)_i}{\sigma^2(oc)_i} = 1,259 - 3,29.10^{-2} TV_i + 3,363.10^{-3} NT_i + 1,031.10^{-2} QS_i + (-1,17.10^{-2} NQ_i - 1,19.10^{-2} X_i + \varepsilon_i) \quad (19).$$

(19,674)
(-8,382)
(8,705)
(6,347)
(R² = 26,4%)

(-5,036)
(-2,834)

5.7. Informed trading and efficiency

Another issue of interest is the informational content of orders submitted to the CN. One may fairly wonder whether orders anonymously submitted to POSIT convey more information than orders executed on the market. In order to test this hypothesis (H8), as shown in regression (20), average daily returns are regressed on market buy and sell trade volumes and on the relative amounts of buy and sell orders submitted to POSIT by institutional investors on the one hand, by market makers on the other hand.

$$R_i = a + bBTV_i + cSTV_i + dSBI_i + eSSI_i + fSBM_i + gSSM_i + \varepsilon_i \quad (20).$$

The results of the regression displayed in equation (21) are somehow disappointing. The R² coefficient is very low, which means that buying and selling trade volumes are not efficient control variables for R_i .

$$R_i = -7,29.10^{-2} + 7,081.10^{-2} BTV_i - 7,21.10^{-2} STV_i + 1,442.10^{-3} SBM_i - 1,15.10^{-4} SSM_i + 2,278.10^{-4} SBI_i - 7,63.10^{-7} SSI_i + \varepsilon_i \quad (21).$$

(-1,386)
(4,19)
(-4,224)
(3,106)
(-2,334)
(R² = 2,4%)

(1,84)
(-0,158)

Yet, average returns are significantly related to the POSIT order flow coming from market makers: they are positively (negatively) related to the relative amount of buy (sell) orders submitted by market makers into the CN. However, we can not conclude to a predictive power on returns of these variables, as the regression is run on average or aggregated measures over the whole period. For further interpretations, a analysis on stock by stock temporal series will be carried out.

Finally, in order to test H9, i.e. the effect of the CN activity on price discovery, the coefficients in regressions (22) and (23) are estimated:

$$NQ_i = a_1 + b_1 NT_i + c_1 TV_i + d_1 NMS_i + e_1 \sigma_i + f_1 QS_i + g_1 S_i + \varepsilon_{1i} \quad (22),$$

$$NQ_i = a_2 + b_2 NT_i + c_2 TV_i + d_2 NMS_i + e_2 \sigma_i + f_2 QS_i + g_2 X_i + \varepsilon_{2i} \quad (23).$$

Equations (24) and (25) lay out the results:

$$NQ_i = -5,217 + 0,112 NT_i + 0,269 TV_i + 0,511 NMS_i + 0,124 \sigma_i - 9,44.10^{-2} QS_i + 7,039.10^{-6} S_i + \varepsilon_{1i} \quad (24),$$

0
(35,143)
(4,418)
(6,517)
(3,503)
(R² = 71,4%)

(-4,287)
(0,672)

$$NQ_i = -3,329 + 0,113 NT_i + 0,257 TV_i + 0,465 NMS_i + 0,135 \sigma_i \quad (25).$$

$$-9,52 \cdot 10^{-2} QS_i + 0,183 X_i + \varepsilon_{2i} \quad (R^2 = 71,7\%)$$

(-4,662) (35,451) (4,281) (5,881) (3,857)
(-4,378) (3,853)

They show that invisible submissions to POSIT do not slow down the discovery of prices and conversely, executions in POSIT accelerate quote revisions, which validates H9b.

Yet, we may still wonder if the acceleration of quote revisions actually make price adjustments faster (H10). Testing the impact of S_i and X_i on SP_i in regressions (26) and (27), we confirm that submissions to POSIT do not slow down the discovery of prices, but we can not validate H10a: though the effect of X_i on SP_i is negative, it is not significant.

$$SP_i = 5,324 - 0,153 TV_i + 1,174 \cdot 10^{-2} NT_i + 4,768 \cdot 10^{-2} QS_i - 4,08 \cdot 10^{-2} NQ_i \quad (26),$$

$$+ 3,742 \cdot 10^{-6} S_i + \varepsilon_{1i} \quad (R^2 = 20,3\%)$$

(16,419) (-7,732) (6,06) (5,827) (-3,52)
(0,805)

$$SP_i = 5,297 - 0,15 TV_i + 1,139 \cdot 10^{-2} NT_i + 4,646 \cdot 10^{-2} QS_i - 3,81 \cdot 10^{-2} NQ_i \quad (27).$$

$$- 3,74 \cdot 10^{-2} X_i + \varepsilon_{2i} \quad (R^2 = 20,4\%)$$

(16,422) (-7,595) (5,85) (5,678) (-3,262)
(-1,766)

Yet, it is worth denoting that, splitting X_i in its two components XM_i and XI_i , there is a significantly negative effect of XM_i upon SP_i (regression 28): we may then assess that market makers' trading in the CN accelerate the discovery of prices.

$$SP_i = 5,306 - 0,151 TV_i + 1,103 \cdot 10^{-2} NT_i + 4,585 \cdot 10^{-2} QS_i - 3,49 \cdot 10^{-2} NQ_i \quad (28).$$

$$- 6,72 \cdot 10^{-2} XM_i - 6,43 \cdot 10^{-3} XI_i + \varepsilon_i \quad (R^2 = 20,5\%)$$

(16,422) (-7,595) (5,85) (5,678) (-3,262)
(-1,99) (-0,186)

6. Conclusion

We do not find that trading through a CN create additional adverse selection costs, conversely to what predicts information-based theoretical models on multi-system trading. Our results assess that, when a CN operates on a dealership market, the competition effect dominates the fragmentation effect. Moreover, the CN is used as a liquidity-providing system reducing inventory costs. Finally, executions through the CN accelerate quote revisions, and facilitates the discovery of prices for market makers.

Appendix 1: Order constraints available in POSIT

To control over unpredictable match outcomes, a range of constraints can be applied to either individual stocks, pairs of stocks or to single or dual direction lists.

Price constraints

Price limits may be attached to an order to protect against adverse price movements in the market between the time the order is sent and the match time. The constraint simply indicates whether your order is available for the match pool, but does not generate any external information. The only price at which a match can occur in POSIT is at the mid-point of the current bid/offer spread. For example, if a price limit on a buy order is 450 and the ruling mid price is 452, then the order does not participate in the match. If the mid price was 448, then the order would be included in the match and executed at 448, but not at 450. This constraint is at individual stock levels and may only be applied in the currency of the primary price quote.

Minimum shares

The ability to set a minimum number of shares to trade out of a total order size per stock or for all stocks in a portfolio or list is available in POSIT. Clients may wish to receive no fills of less than 25,000 across a list for example. For a particularly large order, of say 1 million shares, a minimum fill of 250,000 in that line alone may be required.

Minimum value

Like the minimum share constraint above, it may be appropriate, particularly for a list of stock with varying prices, to set a minimum value, of say £50,000 per stock. This constraint can be set in any currency that is held on the system, such as British Pounds, US Dollars, Euros, etc.

Cash imbalance

For a portfolio, list or pair of orders, a cash imbalance constraint is available relating to the maximum amount that buy orders can exceed sell orders or vice versa, both in absolute value terms and by shares, if appropriate. This constraint is particularly useful for (a) generally in managing the results of unpredictable match outcomes, (b) ensuring that available cash for investment as a result of, say, a restructuring is not compromised but overbuying or (c) ensuring that any necessary cash is raised, where required. For example, the constraint may be that buy orders on a list cannot come into operation until £5m of sales has been achieved.

References

- Barclay, Michael J., Terrence Hendershott and D. Timothy McCormick, 2001, "Electronic Communications Networks and Market Quality," Simon School of Business, University of Rochester and Economic Research, NASD Inc., working paper.
- Battafalio, Robert, J. Greenes and Robert Jennings, 1997, "Do Competing Specialists and Preferencing Dealers Affect Market Quality?," *The Review of Financial Studies*, v10, 4, 969-993.
- Chordia, Tarun, Richard Roll and Avanidhar Subrahmanyam, 2000, Order Imbalance, Liquidity, and Market Returns, working paper.
- Chowdry, Bhagwan and Vikram Nanda, 1991, "Multimarket Trading and Market Liquidity," *The Review of Financial Studies*, v4, 3, 483-511.
- Hamilton, James H., 1979, "Marketplace Fragmentation, Competition, and the Efficiency of the Stock Exchange," *The Journal of Finance*, v34, 1, 171-187.
- Hendershott, Terrence and Haim Mendelson, 2000, "Crossing Networks and Dealer Markets: Competition and Performance," *The Journal of Finance*, v55, 5, 2071-2115.
- Kyle Albert. S., 1989, "Informed speculation with imperfect competition," *The Review of Financial Studies*, v56(187), 317-356.
- Lee, Charles M. C. and Mark A. Ready, 1991, "Inferring Trade Direction from Intraday Data," *The Journal of Finance*, v46(2), 733-746.
- London Stock Exchange, 2001, *Regulatory Guide, Domestic equity market, traditional options market and AIM (excluding SETS)*.
- London Stock Exchange, 2001, *Regulatory Guide, Stock Exchange Electronic trading Service (SETS)*.
- Mendelson, Haim, 1987, "Consolidation, Fragmentation, and Market Performance," *Journal of Financial and Quantitative Analysis*, v22, 2, 189-207.