Who Benefits from the Addition of a Limit Order Book? A Comparison of Trading Platforms for Small Cap Stocks in London

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December 2005

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Abstract
We compare trade execution costs during 2005 for two hundred small cap stocks that switched to trading on a hybrid limit order book with market makers (SETSmm) from a competing market maker mechanism (SEAQ) at the instigation of the London Stock Exchange. We show that, on average, the companies had lower transactions costs on SETSmm, but that a substantial proportion of stocks faced higher costs. We find that much of the cross section variation in changes to transactions costs can be explained by a small number of factors. We show that while transaction costs have fallen for most stocks, so have immediately available depths. We finally test how market prices reacted to the change in trading platforms and find some evidence that stock prices rose in anticipation of the migration to SETSmm.

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I. Introduction

The quest to find the most appropriate trading platform for securities is by no means over. Exchanges regularly innovate in attempts to improve the trading environment for their existing client securities and to attract new ones. Equity markets around the world include pure limit order platforms, competing market maker systems, hybrid systems where a dealer also maintains a limit order book.

The academic literature is replete with papers comparing transaction costs and efficiency levels across exchanges or across trading platforms. In this paper we examine the impact of the London Stock Exchange's decision to shift almost two hundred securities from a competing market maker system (SEAQ) to a hybrid system of market makers plus limit order book (SETSmm). This natural experiment affords certain advantages over the existing literature. First, the change in the trading platform was exogenous as far as the listing companies are concerned. Several previous studies have considered security transaction costs for companies that themselves chose to change trading mechanisms. The endogeneity of the decision biases the results towards finding gains from the migration. In this paper we study a whole segment of the London market which the exchange decided to shift wholesale, according to market capitalisation and without selecting groups of stocks that it thought would benefit from the move. It is, within the transaction costs and liquidity literature, as pure an event as has been studied so far. Second, while some studies have located natural experiments such as ours, the scale of the operation studied here is almost unique. The London Stock Exchange will relocate around 500 small to medium cap stocks from SEAQ to SETSmm in three tranches. Here, we primarily study the second tranche, and examine both the average effect on transaction costs and liquidity provision afforded by the move, and the cross section variation in costs and liquidity.

We find that on average across almost 200 stocks, trading costs for all transaction sizes are lower on the market maker augmented limit order book (SETSmm) system than on the competing market making (SEAQ) system. However, this average masks a wide dispersion, and between one-third and one-half of individual companies see higher transaction costs on SETSmm, depending on the size of the deal. We model the cross section variation in transaction cost gains and losses and find that a small number of predetermined firm-specific factors are capable of explaining most of the observed variation. We then show that while transaction costs may be lower on SETSmm, liquidity provision in terms of depth is quite low for our sample of firms. Accordingly, an increased number of smaller transactions take place on the SETSmm system which can take advantage of the narrower spread at the top of the order book (typically provided by non-market making liquidity suppliers). Larger transactions, however, have to rely on liquidity supplied by market-makers. These larger transactions are also cheaper to execute on SETSmm than on SEAQ despite being executed mainly against market-maker liquidity in both cases. We argue that this is because the minimum contractual depth supplied by market makers is much lower in SETSmm than on SEAQ, allowing each market maker to quote narrower spreads. The move from SEAQ to SETSmm then does not have a clear impact on liquidity. Transaction costs are lower but available depth is also lower. We examine stock price reactions to the move to provide insight into whether the market perceived the move to be beneficial. Unfortunately, the evidence from stock prices is also not clear.

The paper proceeds as follows. We discuss the existing literature and our research design in the next section. Section III briefly describes the different trading environments studied. Section IV provides evidence on average transaction costs on SEAQ and SETSmm while Section V examines the cross section distribution of changes in transaction costs between the two systems. Section VI looks at the depth available on the SETSmm system and Section VII examines the market reaction to the stocks' migration between trading systems. Section VIII concludes.

II. Related Studies and Research Design Issues

Perhaps because of their very distinct mechanisms, transactions costs on the NASDAQ dealer market and NYSE's hybrid specialist-auction market have been a focal point for academic investigation. Huang and Stoll (1996), Bessembinder and Kaufman (1997) match stocks on the two exchanges by market capitalisation and compare trade execution costs, finding significantly higher costs on NASDAQ. Venkataraman (2001) studies a different pair of exchanges – the NYSE and the pure limit order book driven French stock market. Matching stocks using a more sophisticated algorithm than market capitalisation alone, he finds the NYSE to offer significantly lower trade execution costs.

No matter how well such studies match the stocks, differences in transaction costs cannot be attributed solely to the different trading mechanisms since listing requirements and risk characteristics of the stocks will not be perfectly aligned. A separate strand of the literature considers stocks that trade on more than one platform, either because of cross listing or because the stocks switch platform.

De Jong, Nijman and Roell (1995) compare transaction costs for French stocks traded both in Paris and London (on the competing market maker system of SEAQ International). They find that Paris offers lower transaction costs for small orders, but that the London market is deeper and provides immediacy for larger trades. Duffour and Noel (2005) consider the choice faced by investors trading large cap stocks in London. Transactions can be executed via the SETS limit order book system (described in Section III below) or via a competing market maker system. They find that while the order book for large stocks offers high liquidity, deals with market makers receive sufficient price improvement to make trading off-SETS an attractive alternative.

Transaction costs for stocks switching between US exchanges have been extensively compared (see Kadlec and McConnell, 1994; Clyde, Schultz and Zaman, 1997; Barclay, Kandel and Marx, 1998). Results generally suggest that switching from NADAQ to NYSE reduces transaction costs, consistent with competing explanations. First, since the decision to switch is taken by the company concerned and they presumably are at least partially intent on reducing their transaction costs. If a stock is traded on an inappropriate platform, then the company will switch when it locates a more appropriate one and transaction costs could be expected to fall. On the other hand, shifting platforms is usually associated with a marketing drive and heightened publicity. Conceivably, it is this increased awareness in the stock that drives the fall in transaction costs (see Marsh, 2005).

This paper is relatively novel in that it examines firms that switch between trading platforms but not at their own instigation. The London Stock Exchange, after consultation, decided to migrate stocks wholesale from a NASDAQ-like competing market maker system to a limit order book augmented by market makers. The migration is taking place in tranches and in this paper we examine the effect of the shift of the second batch. This provides the second advantage of our paper. A handful of other papers have examined exogenous shifts in trading systems, but usually only for a relatively small number of stocks. In our case, we have almost 200 stocks migrating at the same time.

Nimalendran and Petrella (2003) examine the effect of switching from a pure limit order book to a hybrid market maker plus limit order book system on transactions costs for thinly traded firms in Italy. The hybrid system performs better but the whole study is subject to the endogeneity critique as the switching is at the instigation of the firms. Amihud, Mendelson and Lauterbach (1997) look at the effect of exogenous (exchange driven) changes in trading platforms on stock prices for 100 Israeli stocks spread over a seven year period. Henke and Lauterbach (2003) study migrations for 44 Polish stocks, 24 of which were exchange-initiated and 20 firm-initiated. They show distinctly different gains for these two groups.

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III. Trading Environments

A. SEAQ

The Stock Exchange Automated Quotation system (SEAQ) is a dealership trading system on the London Stock Exchange (LSE) based on two-way continuous quotes supplied by two or more competing market makers. The number of competing market makers differs widely depending on the stock. Reiss and Werner (1996) document an average of 12.6 dealers for stocks in the FTSE-100, 6.2 market makers for mid cap stocks and 4.7 for small cap stocks.

Each market maker has to quote firm two-sided prices in a minimum size of one normal market size (NMS). NMS varies across stocks but corresponds to roughly 2.5% of the daily volume of a stock rounded down to certain common node points. Any market maker can execute public orders regardless of his prevailing quote, but must at least match the best posted prices when executing. Orders larger than one NMS can be negotiated freely between the market maker and investors.

B. SETS and SETSmm

The Stock Exchange Trading System (SETS) is the limit order book system for trading large stocks on the LSE. This system was introduced alongside a modified SEAQ platform for large stocks in 1997. The choice of trading platform is essentially unrestricted for retail and institutional investors. The off-SETS dealer market is close to an "upstairs" market where orders are executed against dealer inventories or shopped. However, dealers are no longer required to quote firm prices or to quote in a minimum order size. The competition between SETS and the dealership market is considered in Duffour and Noel (2005). Currently, over 200 stocks trade on SETS. These include all FTSE 100 constituent stocks, constituent reserves, the most liquid FTSE 250 stocks.

SETSmm is the platform used for trading mid cap and liquid small cap stocks on the LSE and is the basic anonymous SETS order book system augmented by one or more market makers. Market makers are obliged to provide continuous[2] bid and offer prices on the order book using identified committed principal (CP) orders, but can also trade off-order book should the investor so wish. CP orders are subject to a specified maximum spread and minimum size which approximates to one-quarter NMS. Market makers can also enter anonymous orders into the system in addition to their CP orders. The chosen mnemonic, SETSmm, makes it clear that the market makers are expected to play a secondary role compared to the limit orders contained in the SETS system.

Stocks have been moved at the instigation of the LSE from SEAQ to SETSmm in batches since its introduction in 2003. Around 200 of the largest stocks not traded on SETS

[2] CP orders must be replenished within a specified period – initially 60 seconds, subsequently reduced to 30 seconds.

started trading on SETSmm in November 2003.[3] Following a successful review of SETSmm, the LSE proposed that the next 200 stocks by market capitalisation move from SEAQ to SETSmm in July 2005. This second batch of migrating stocks is the basis of our study. A further batch of 100 small cap stocks and 50 AIM stocks will migrate to SETSmm in December 2005.

IV. Average Transaction Costs for SEAQ and SETSmm

A. Measures of Transaction Costs

The simplest measure of transaction costs is the quoted bid-ask spread. Quoted half-spreads (*QS*) can be computed as

$$QS_{it} = 100\left(A_{it} - B_{it}\right)/\left(2 \times M_{it}\right),$$

where A_{it} is the posted ask price for security i at time t, B_{it} is the corresponding posted bid price, and M_{it} is the quote midpoint calculated as the mean of A_{it} and B_{it}. This is the percentage cost of making a one-way trade at the posted quote excluding commission costs.

However, it is well known that many trades take place away from the quoted price. Some trades see price improvement by market makers and take place inside the quote, while others, especially trades larger than the depth at the quote, take place outside the quoted spread. The most common measure of transaction costs that takes in to account this deviation of price away from the quote is the effective half-spread (*ES*) defined as

$$ES_{it} = 100\left|P_{it} - M_{it}\right|/M_{it},$$

where P_{it} is the transaction price for security i at time t, M_{it} is the midpoint as described above but interpreted as a proxy for the pre-trade value of the asset. The effective half

[3] The transaction costs impact of the first batch of stocks to migrate is analysed in Board and Wells (2005).

spread is an estimate of the percentage execution cost actually paid (and of the gross revenue paid to the supplier of immediacy).

Both SEAQ and SETSmm use market makers. As noted above, however, each market maker on SEAQ has to quote a depth of one NMS, while on SETSmm they need only quote depth of one-quarter NMS. SEAQ market makers should have wider spreads since they are more exposed when trading against better informed traders. This is a cost of trading and would be reflected in the effective spread.

B. Empirical Findings

We use trade, price and quote data covering the months April 2005 to September 2005 inclusive, and supplied by the London Stock Exchange.[4] The data includes price and volume details for every trade executed alongside the best prices available when each trade occurred. We use data from 1 April 2005 – 30 June 2005 for the pre-migration (SEAQ) period, and from 18 July 2005 – 30 September 2005 for the post-migration (SETSmm) period. The first two weeks of July are excluded from the analysis so as not to contaminate the results with the end of SEAQ trading (the final day of SEAQ trading was 8 July 2005) and the first few days of SETSmm trading (trading began on 11 July 2005).

The effective half-spread is an estimate of the percentage execution cost actually paid by a trader, and of the gross revenue to the supplier of immediacy. Clearly, the execution cost could depend on the size of the transaction – a larger deal could be expected to incur a larger trading cost – so we do not simply group all transactions together. Further, we need to aggregate costs across our sample of stocks. We therefore place transactions in seven different transaction size categories based on multiples of NMS:

[4] We thank an anonymous sponsor for financial assistance.

Table 1 Transaction size categories

Category	Size
1	<0.25NMS
2	0.25 – 0.5NMS
3	0.5 – 0.75NMS
4	0.75 – 1NMS
5	1 – 1.25NMS
6	1.25 – 1.5NMS
7	>1.5NMS

We calculate transaction costs before and after the migration to SETSmm. During the SETSmm period we can identify those deals taking place on the order book (codes AT and UT) and those taking place off the order book (code O), and so compute average transaction costs for the SETSmm system as a whole and for these different segments of SETSmm. These average transaction costs are given in the top half of Table 2.[5] Costs on SEAQ are around 60 basis points for all but the largest deals. After migration to SETSmm, average transaction costs fall to 40-50 basis points, although again larger deals are more expensive. On order book costs are significantly lower than SEAQ costs, and relatively constant for all but the smallest deals, which are noticeably cheaper. Off-order book transactions are marginally cheaper than SEAQ costs and constant for all but the largest deals.

The bottom part of Table 2 gives the total number of trades in each trade size category. The total number of transactions on SEAQ equate to approximately 3,190 trades per day. On SETSmm, the number of daily trades has risen to 4,560.[6] Alongside this increase in the number of trades, there is also a shift towards smaller sized trades on SETSmm. Trades below 1 NMS make up almost 74% of total trades on SETSmm, up from 63% on SEAQ. We return to this pattern in Section V.C.

[5] Note that in this table averages are computed by adding up the transaction costs of all trades in a trade size category and dividing it by the value of all trades. Companies therefore receive different weights in the calculation.

[6] We do not regroup trades on SETSmm. Therefore a single large trade that executes simultaneously against several different counterparties in the order book counts as several different trades. This, therefore, overstates the number of distinct transactions on SETSmm.

Table 2 Changes in transaction costs and trade sizes

Panel A: Average transaction costs					
Category	Size	SEAQ	SETSmm	On order book	Off order book
1	<0.25NMS	0.6640	0.3920	0.2864	0.5088
2	0.25 – 0.5NMS	0.6263	0.4410	0.3888	0.5179
3	0.5 – 0.75NMS	0.6151	0.4223	0.3504	0.5157
4	0.75 – 1NMS	0.5668	0.4253	0.3280	0.5168
5	1 – 1.25NMS	0.5873	0.4108	0.3208	0.5128
6	1.25 – 1.5NMS	0.6177	0.4915	0.3765	0.5744
7	>1.5NMS	0.8825	0.6146	0.3244	0.6310

Panel B: Total numbers of trades					
Category	Size	SEAQ		SETSmm	
1	<0.25NMS	69,705	34.7%	104,132	38.7%
2	0.25 – 0.5NMS	28,350	14.1%	53,332	19.8%
3	0.5 – 0.75NMS	19,329	9.6%	29,960	11.1%
4	0.75 – 1NMS	8,853	4.4%	11,491	4.3%
5	1 – 1.25NMS	12,724	6.3%	16,306	6.1%
6	1.25 – 1.5NMS	5,723	2.8%	6,625	2.5%
7	>1.5NMS	56,202	28.0%	47,345	17.6%
	Total	200,886		269,191	

In summary, we can say that on average, the July 2005 move from SEAQ to SETSmm has been beneficial in terms of transaction costs. Transactions of all sizes are cheaper on SETSmm, irrespective of whether they were carried out on or off the order book, although gains for trades on the order book are larger. The gain for transactions of 0.25NMS to 1.5NMS is between 12-20 basis points, and the gains for both very small and very large transactions are even higher.

V. Cross Section Variation in Changes in Transaction Costs

A. Cross Section Distributions of Changes in Transaction Costs

On average transaction costs for those companies moving onto SETSmm in July 2005 fell when compared to SEAQ-based transaction costs incurred in the period just prior to the migration. Averages can, however, hide significant variation. In their study of stocks migrating between SEAQ and SETSmm in 2003, Board and Wells (2005) note that while on average costs fell, a small proportion of companies saw an increase in transaction costs following the migration. Table 3 details the average ratio of post- to pre-migration costs, the proportion of companies with ratios less than one, and the proportion of companies with ratios greater than one for our sample of companies. Compared to Board and Wells, our sample of smaller, less liquid securities includes a larger proportion of companies facing increased costs.

Table 3 Ratios of post- to pre-migration transaction costs

Size	Average Ratio	Proportion Ratio <1	Proportion Ratio > 1
<0.25NMS	0.939	0.640	0.360
0.25 – 0.5NMS	0.920	0.645	0.355
0.5 – 0.75NMS	0.903	0.673	0.327
0.75 – 1NMS	0.934	0.629	0.371
1 – 1.25NMS	0.904	0.711	0.289
1.25 – 1.5NMS	1.091	0.565	0.435
>1.5NMS	1.168	0.546	0.454

For each trade size, there is a significant proportion of companies for which transaction costs increase after the migration, even though, on average, companies benefited from the move to SETSmm. Around 36% of companies see increased transaction costs for deals in categories 1–4 (i.e. for deals up to 1NMS). This figure dips to 29% for deals between 1–1.25NMS, but rise to 45% for deals greater than 1.25NMS. More than half of the companies see higher transaction costs for deals larger than 1.25 NMS.[7]

When considering larger categories of transactions at the individual firm level, we must mention the caveat that relatively few such large trades occurred for many of our firms in the SEAQ and/or SETSmm periods. Our measure of transaction costs for large deals is likely to be much less precise than for smaller deals which happened much more frequently. Furthermore, the largest transaction category is open-ended and as likely to contain more heterogeneous transaction sizes than the other more tightly defined categories, making pre- and post-migration comparisons more difficult.

The following charts plot the ratio of post-migration to pre-migration costs for our sample of companies for a selection of different sized deals. A ratio greater than one

[7] Note that this is influenced by the method of averaging. In this table, we compute the ratio for each company in each deal size category and then take a simple average across the companies. An alternative method would be to compute the ratio for all deals in each deal size category and take the average. This would give different companies different weightings and may lead to different conclusions.

suggests transaction costs rose following the move to SETSmm. Note that in each chart, the companies are ordered by the value of the ratio.

We note above that, on average, transaction costs are lower on SETSmm than on SEAQ. However, for a large group of companies – around one-third of the sample – the move to SETSmm has increased transaction costs. This proportion is substantially higher than noted for the previous batch of (larger, more liquid) stocks that migrated in November 2003. In the next sub-section we investigate the factors determining this distribution of changes in transaction costs.

Chart 1 Distribution of relative transaction costs, <0.25 NMS

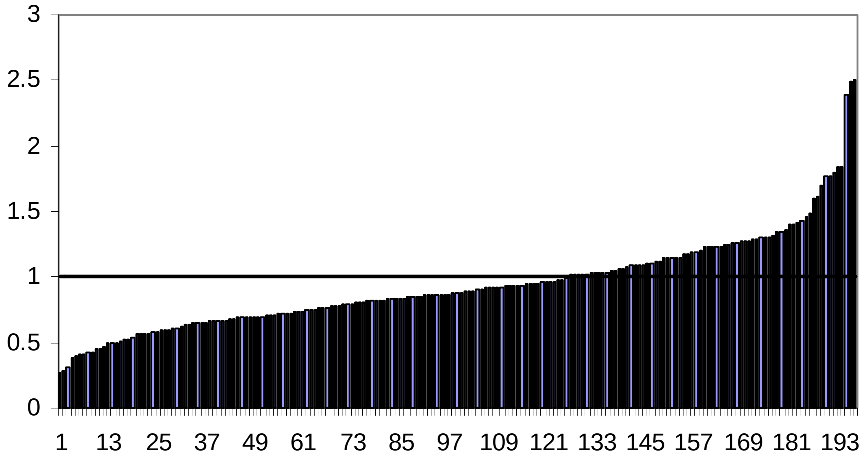


Chart 2 Distribution of relative transaction costs, 0.5—0.75 NMS

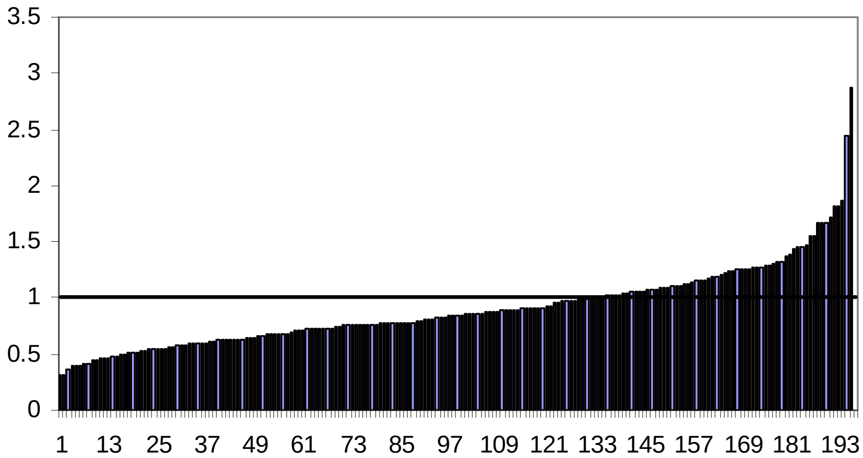
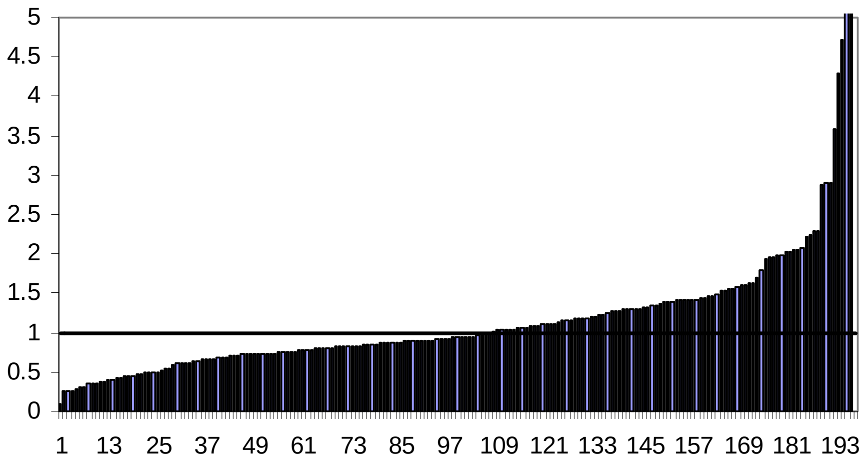


Chart 3 Distribution of relative trading costs, >1.5 NMS



B. Factors Determining Changes in Transaction Costs

The cross section variation in the effect of migration from SEAQ to SETSmm invites the question of whether there are identifiable firm-specific characteristics which determine the change in transaction costs between trading systems for companies. In this section we present the results of a regression analysis. The variable of interest is the ratio of SETSmm cost to SEAQ cost for each company and computed for each trade size category.[8] We denote this variable *relX* where *X* denotes the number of the trade size category used to group trades (so, for example, *rel3* is the ratio of post- to pre-migration transaction prices for trades of between 0.5 – 0.75 NMS). Figure 4 plots SEAQ and SETSmm transaction costs for deals in size category 1.

From a review of the literature on transaction costs, and from conversations with academics and practitioners close to the London equity market, we identify four measurable firm-level characteristics as being likely determinants of transaction costs:

- Market capitalization – measured by the logarithm of the market capitalisation of each firm as of the end of 2004 (denoted *lmcap*)
- Trading volume – measured by the logarithm of the value of all trades in each company during the first three months of 2005 (denoted *lvol*)
- Share price – measured by the logarithm of the share price as of the end of 2004 (denoted *lprice*)
- Returns volatility – measured by the standard deviation of the monthly returns of each company over the period January 2000 to December 2004 (denoted *vollong*)

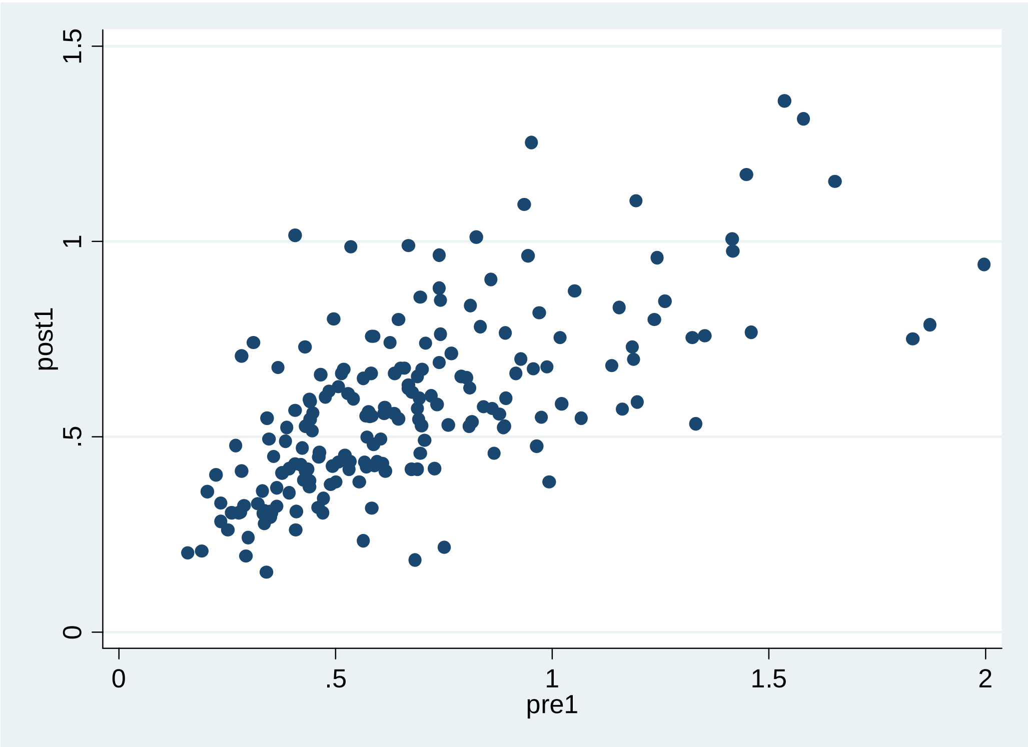
In addition we include the following:

- The turnover in each company's shares, measured by the volume traded in the first three months of 2005 divided by the market capitalisation at the end of 2004 (denoted *to*)

[8] We also examined the percentage change in transaction costs between the two systems (that is, [post1-pre1]/pre1). The regressions gave very similar results so we only present those for the transaction cost ratios. Those using percentage cost changes are available on request.

- The NMS of the share (denoted *nms*)
- The average monthly return on the shares over the period January 2000 – December 2004 (denoted *retlong*)
- The average monthly return on the shares over the first three months of 2005 (denoted *retshort*).
- The logarithm of the estimated transaction cost of the firm in the SEAQ system (denoted *lpreX* where *X* is the number of the trade size category used to group trades)

Figure 4 Cross plot of pre-migration (SEAQ) transaction costs against post-migration (SETSmm) transaction costs for deals up to 0.25 NMS



We first regress the relative cost of trading up to 0.25NMS of each company (*rel1*) on all of the explanatory variables. We then successively drop variables that are not statistically significant until we arrived at a parsimonious specification with just a few variables that were able to explain the relative transaction costs of our sample of companies. We then repeat the exercise using the relative cost of transactions in the next trade size category, and so on.

In each case, some companies have to be excluded from the analysis because one or more of the explanatory or dependent variables is not available, or is sufficiently abnormal that its inclusion might significantly bias the results. The tables note the number of companies used in the regressions. We also experiment with excluding investment trust companies, whose shares often behave differently to ‘normal’ companies, although this has only slight effects on our findings. In the interest of completeness we include trusts in our sample for the results given here.

Table 4 Determinants of relative transaction costs

	rel1	*rel2*	*rel3*	*rel4*	*rel5*	*rel6*	*rel7*
Constant	1.9557	1.7717	1.7715	1.9817	2.1268	1.7871	1.0519
	(6.97)	(10.34)	(6.70)	(6.81)	(5.47)	(2.98)	(5.27)
lpreX	-0.3883	-0.3850	-0.4181	-0.4376	-0.3568	-0.6242	-0.6245
	(9.46)	(10.68)	(11.62)	(12.29)	(9.23)	(9.09)	(4.98)
lvol	-0.1321	-0.1123	-0.1101	-0.1417	-0.0493	-0.1584	-0.0698
	(5.54)	(7.00)	(4.90)	(5.94)	(1.71)	(3.33)	(1.69)
lprice	-0.0997	-0.0902	-0.0996	-0.1263	-0.0889	-0.1194	
	(2.97)	(4.19)	(3.10)	(3.61)	(2.78)	(1.67)	
vollong				1.0878		3.2211	
				(2.36)		(2.07)	
retshort				-0.7800			
				(1.98)			
lmcap					-0.1336		
					(1.67)		
to					-0.0083		
					(1.88)		
nms							0.0113
(times 100)							(1.69)
R^2	0.482	0.516	0.452	0.4985	0.289	0.249	0.144
No. of companies	193	193	192	191	193	188	192

Note: The figures in parentheses give the robust *t*-statistics which are valid in the presence of arbitrary heteroscedasticity. Variables significant at the 10% level are retained in the parsimonious specification.

The results show that for transactions up to 1 NMS, the cost of trading on SETSmm relative to the cost of trading on SEAQ is lower for companies with:

- Higher costs of trading on SEAQ

- Higher trading volumes (in the pre-migration period)
- Higher share prices

Additional factors are sometimes also relevant, depending on the size of transaction being considered. For transactions in size category 4, for example, the relative cost of trading is also lower for companies with higher returns in the recent past, and for less volatile companies. These factors are capable of explaining almost 50% of the cross-section variation in relative trading costs.

The negative sign on pre-migration (SEAQ) trading costs suggests that firms that were relatively expensive to trade on SEAQ tended to see the largest proportional gains from moving to SETSmm, other things equal. The coefficient on this variable is essentially unchanged for all transaction sizes up to 1.25 NMS. More liquid stocks – those with higher volumes traded in the recent past – also see larger gains from the move to SETSmm, as do stocks with higher prices. This latter point probably reflects the influence of binding minimum tick rules for shares with lower prices.

For larger trades, the only factor that strongly influences the *change* in trading costs is the *level* of trading costs on the SEAQ system. Two other factors – NMS and trading volumes – are marginally significant. However, our ability to explain variations in changes in transaction costs is much lower for large trades. These appear to be mainly influenced by non-firm specific factors or, as noted above, the problem might stem from the calculation of transaction costs when relatively few such transactions actually occur.

We ran some additional regressions with two extra variables:

- A count of the number of market makers quoting prices for each firm (denoted *countmm*)
- The logarithm of the sum of the depths quoted by these market makers (denoted *ltotdepth*)

The count of market makers, and the depth in which they were quoting, were determined from a snapshot taken on one day before the move to SETSmm by an anonymous broker. Unfortunately, only 120 companies from the sample were included. Nevertheless, for this smaller sample, these variables prove generally quite important, suggesting that – as with the pre-migration transaction cost – the nature of the market for the shares *before* the migration is still important for the cost of trading *after* migration. It is entirely possible that as time progresses this effect weakens.

There are some variables we would have liked to have included but for data limitations. Foremost among these was the free float for each company. Further work might usefully incorporate this factor, but given the general insignificance of the other size proxy – the market capitalisation of the companies – we doubt that its exclusion had a major impact on our results.

We have identified a small number of factors that can be measured before the move to SETSmm that are significantly related to the change in transaction costs following the migration. The single most important factor is the cost of transactions before the migrationion. Companies that were expensive to trade on SEAQ tended to gain the most from the move. In addition, securities that were liquid on SEAQ and companies whose share price (in pounds) was high also tended to gain the most.

C. Depth Available on the SETSmm System

The trading costs discussed above represent just one dimension of liquidity. The depth available is another. In this section, we compute measures of the depths available in the SETSmm limit order book, and compare these with benchmark estimates of depths in the SEAQ system.

Unfortunately, it is difficult to know precisely the depth available on the pre-migration SEAQ system. Each competing market maker on SEAQ had to quote continuously in at least 1 NMS on both sides of the market, but they were allowed to quote in a greater depth if they wished, this greater depth being known as the “screen size”. We know, therefore, that at least 1 NMS was always available at the most competitive quote, and that at least 2 NMS was available at a possibly wider spread since at least two market makers had to both be quoting in at least 1 NMS each at all times. While the potentially time-varying screen size is not available to us, we do have a snapshot of the number of market makers actively quoting for a limited number of stocks in our sample. For these stocks, we know the number of market makers, who must quote at least 1 NMS each, and hence a lower bound on the total depth available.

The limit order book system is more amenable to depth analysis. Using data on every entry to the SETSmm system in the 18 July – 30 September 2005 period, we reconstruct the SETSmm order book for each stock through the full trading day and note the proportion of time that an order of a given size could be instantaneously executed. Specifically, we sample the order book each 15 minutes during the continuous trading section of SETSmm (8am through 4:20pm) and examine whether there is sufficient depth available on both sides of the market to transact orders of 0.5NMS, 1 NMS, 2 NMS or 5 NMS. We also examine the nature of the parties providing the depth. We differentiate committed principal (CP) orders, submitted by identified market makers as part of their obligation as market makers, from non-CP orders, submitted by non-market makers or by market-makers wishing to remain anonymous. We then compute the proportion of time that orders of the above sizes could be transacted using just CP-provided depth, or just non-CP-provided depth.

The average proportions across all stocks are given in Table 5 below. Table 5 shows, for example, that on average across the full set of stocks in July an order of 1 NMS could be executed on the order book 73.5% of the time. Just using CP orders, a deal of a similar size could have taken place 71% of the time, whereas if CP orders were excluded the deal could have only occurred 16.4% of the time.

Especially for smaller orders (0.5 – 1 NMS) the numbers using the total order book and using just CP orders are relatively close. This suggests that the additional depth provided by non-CP orders typically occurs when the CP portion of the order book is already relatively deep. Non-CP orders alone can only cope with a relatively small 0.5 NMS order around 30% of the time. As the order size gets larger, the ability of non-CP orders alone to support the order declines to almost zero. However, for larger deals the non-CP orders are helpful in complementing CP-provided depth.[9]

Table 5 Proportion of time orders of a given size could be executed on both sides of the order book using the total order book, just CP orders and just non-CP orders

	July			August			September		
	Total	CP only	Excl. CP	Total	CP only	Excl. CP	Total	CP only	Excl. CP
0.5 NMS	75.4%	72.8%	23.4%	74.6%	70.7%	27.9%	75.5%	72.4%	30.7%
1 NMS	73.5%	71.0%	16.4%	72.3%	69.5%	19.1%	74.0%	71.1%	20.1%
2 NMS	63.8%	59.6%	8.1%	64.6%	58.8%	9.2%	65.9%	59.8%	10.1%
5 NMS	31.8%	26.8%	2.2%	33.0%	27.4%	2.6%	33.6%	26.5%	3.6%

We also computed spreads at each of these depths in the order book, conditional on sufficient depth existing on both sides of the order book. Since sufficient depth exists relatively infrequently for large orders we focus in this section on the spreads offered for smaller orders.

Average spreads across all stocks at a depth of 0.5NMS are given in Table 6 using all of the order book, only CP orders and only using non-CP orders. Spreads using only non-CP orders are usually slightly larger than spreads using only CP orders. However, spreads using the full order book are noticeably narrower. This suggests that the order book can be characterised as follows:

- CP orders supply relatively significant depth because of the obligations on market makers, but they charge a relatively wide spread
- The additional liquidity supplied by non-CP orders is effective in narrowing spreads at the top of the order book
- However, the additional liquidity does not supply very much depth, and by 0.5 NMS non-CP spreads are already slightly wider than CP spreads

[9] The percentages are rising through the sample period, suggesting that SETSmm might not have quite achieved steady state, but the rate of increase is slow enough to give comfort that these numbers are meaningful.

Table 6 Spreads at 0.5 NMS using the full order book, only using CP orders and only using non-CP orders

	July	August	September
Full Order Book	0.0201	0.0181	0.0183
CP Orders Only	0.0246	0.0234	0.0234
Non-CP Orders Only	0.0254	0.0255	0.0330

The obligations of market makers to supply minimum depths of CP orders on the order book part of SETSmm ensures transactions can take place essentially always at 0.25 NMS (the minimum supplied by one market maker), and most of the time at depths up to 1 NMS. This contractual depth is supplemented by discretionary depth supplied by non-CP orders. This additional liquidity is often quite competitively priced – such that it significantly narrows the spread at the top of the book – but is not typically very deep, and most of the liquidity on the order book is supplied by market makers for most stocks.

It is not surprising, therefore, that the lower panel of Table 2 noted both an increase in the number of trades and a shift towards smaller trades on the SETSmm system. There has been a clear reduction in costs for small trades, making them more attractive, and there has been a loss of immediate liquidity, making larger deals difficult if not impossible to execute on the order book. Of course, SETSmm still gives investors the opportunity to execute off order book. We noted in Table 2 that even for large trades, off order book transaction costs on SETSmm are, on average, lower than on SEAQ. However, we also show that the absolute number of large trades per day and the number of large trades as a proportion of total trades is lower on SETSmm, suggesting that there has been a move away from executing large trades on the SETSmm hybrid system as a whole. Since liquidity on the order book will replenish it is possible to work larger orders on SETSmm by making several smaller transactions. The tight spreads at the top of the order book suggest that such a strategy is optimal, but a clear answer to this question needs better data than we have available. In particular, we can only observe trades that actually took place and have no knowledge of trades that an investor would have liked to complete but could not for lack of liquidity.

We are not able, therefore, to answer the question of whether the migration to SETSmm has improved liquidity. On average, transaction costs appear to have fallen but so has immediately available depth. For some stocks, we can say that transaction costs have risen and that liquidity is lower on SETSmm. However, our two imperfect proxies for liquidity point in different directions when we analyse the stocks as a whole. In the next section we examine the share price reaction of our sample of companies to see whether this can reveal the net effect on liquidity.

D. Market Reaction to the Change of Trading Platform

If liquidity is improved (worsened) by the move to SETSmm, then we might hope than an efficient stock market would be able to determine this either in advance or around the time of the migration, and that the effect would be revealed by an increase (decrease) in the share prices of the migrating companies. The fact that this is the second batch of companies to migrate is potentially helpful, because the market would have the experiences of the first batch to use in making judgement about the impact of subsequent migrations.

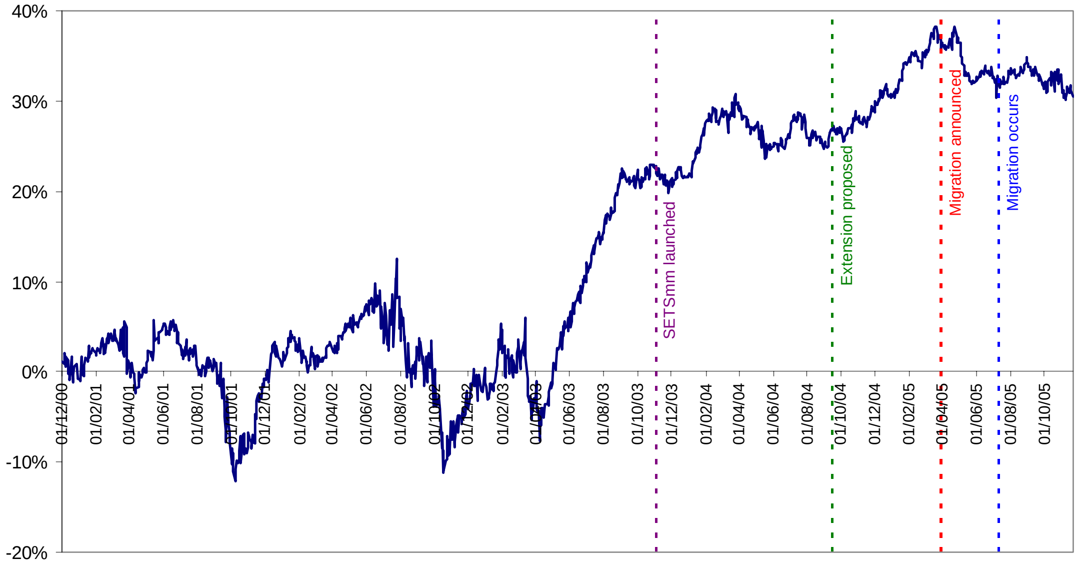
We adopt a relatively standard event study approach, but face a slight complication over how to compute excess returns. While we know when migration actually took place – 11 July 2005 – we might expect the market to price the impact of the migration before this. If we use the CAPM to compute expected returns for our stocks we have to use data from a period not contaminated by the market's reaction to the event to compute the betas. Data from a period after the event are simply not available. If we could pinpoint when the market might have first predicted the event we could use data from before this to compute betas. Unfortunately, as we discuss in more detail below, the market's reaction could have been as much as two and a half years before the actual migration. As our companies are small cap stocks whose characteristics are likely to chance over such long periods, we are not comfortable in using potentially out-of-date betas.[10] Instead we take the naïve approach of simply deducting the market movement (proxied by the FTSE All Share index) from the returns to our sample of companies. This is equivalent to assuming a beta of unity for each stock or, since we use equally weighted portfolios of stocks, to

[10] This prior period is also dominated by the bear market period, and again we are uncomfortable with using such extreme conditions to calculate betas.

assuming a portfolio beta of unity. Experimenting with different implied beta values does not change the basic message from our analysis.

We use daily data from the start of January 2001. On each day we compute the average daily return from an equally weighted portfolio of the shares that were listed on that day (several of our stocks joined the LSE after the start of our sample) and subtract the return from the FTSE All Share index to get our measure of daily excess returns. We then cumulate these until the end of our data in November 2005. The resulting series is plotted in Figure 5.

Figure 5 Cumulated excess returns around SETSmm events



Initially, we note some non-events. First, there is essentially no reaction around the actual migration. The excess return on 11 July is -0.82% and the cumulated excess return for 4–15 July, the two weeks around the migration, is -0.81%. Neither is statistically significant. Second, there is no reaction on the day of the official press release announcement of the migration on 29 March 2005. The excess return on the day is 0.51%, also statistically insignificant.

There are, however, two interesting periods of large positive excess returns. In September 2004, the LSE released a document called "Trading in London: Building on Success" which first explicitly proposed moving the small cap stocks traded on the LSE from SEAQ to SETSmm, and which detailed the gains achieved by the first batch of stocks to migrate. The six months following this announcement coincides with a cumulated excess return of around 10% on our portfolio of stocks. Further back, we note that the first batch of stocks began trading on SETSmm on 3 November 2003. The accompanying document noted that this had happened "after an extensive period of market consultation". The six months before the launch coincides with a 25% cumulated excess return on our portfolio of stocks.

While by no means conclusive evidence that the migration to SETSmm is the cause of these periods of excess returns, they are suggestive. However, the same analysis does not suggest that the market could discriminate between winners and losers from the transition. Cumulated excess returns from "winner stocks" – those whose ratio of transaction costs for the smallest deals are below 0.8 – are insignificantly different from those of "loser stocks" – cost ratios greater than 1.2.

Conclusions

We have analysed the effect of the migration of some 200 small cap stocks in the UK from a competing market maker system to a hybrid limit order book plus competing market maker system. We found the following:

1. Transaction costs on average are significantly lower on the hybrid system.
2. Transaction costs increased following the migration for around one-third of companies, even for small transaction sizes. The majority of companies faced higher transaction costs on the hybrid system for large transaction sizes.
3. Depth on the order book is much less on the hybrid system and, in the main, appears to be predominantly supplied by market makers. There is significant limit order book depth from non-market makers only when market maker depth is also substantial.

4. The additional non-market maker liquidity is very competitively priced and lies at the top of the order book. This drives some of the reduction in transaction costs.
5. Market maker obligations are much lighter on the hybrid system, typically demanding minimum depths one-quarter the size demanded on the pure market maker system. This reduces the depth on the order book but allows market makers to price their quotes more aggressively, which also contributes to the reduction in transaction costs.
6. The reduction in transaction costs comes with reduced immediate depth. An event study of stock prices suggests no reaction to the actual migration, nor to the official announcement of the migration. However, two periods of consultation between the exchange and market participants are associated with significant increases in stock prices. While not definitive, they suggest that the migration to the hybrid system might have been seen as beneficial by financial markets.

References

Amihud, Y., H. Mendelson and B. Lauterbach (1997) „Market microstructure and securities values: Evidence from the Tel Aviv Stock Exchange“, *Journal of Financial Economics*, 45, 365—390.

Bessembinder, H. and H. Kaufman (1997) „A comparison of trade execution costs for NYSE and NASDAQ-listed stocks,“ *Journal of Financial and Quantitative Analysis*, 32, 287—310.

Board J. and S. Wells (2005) "Review of the evidence and issues relating to the performance of the SETSmm system and the impact of extending SETSmm," available at: http://www.londonstockexchange.com/NR/rdonlyres/F2A39578-61A6-466B-8E2B-58042F37116E/0/IndependentReviewFeb05.pdf

De Jong, F., T. Nijman and A. Roell (1995) "A comparison of the cost of trading French shares on the Paris Bourse and on SEAQ International," *European Economic Review*, 39, 1277—1301.

Duffour, A. and D. Noel (2005) "The cost of trading on competing parallel markets: SETS vs dealers in London", *mimeo*, ISMA Centre, University of Reading.

Henke, H. and B. Lauterbach (2003) "Firm-initiated versus exchange-initiated transfers to continuous trading: Evidence from the Warsaw Stock Exchange," *mimeo*, Europa University Viadrina.

Huang, R. and H. Stoll (1996) "Dealer versus auction markets: A paired comparison of order execution costs on NASDAQ and the NYSE," *Journal of Financial Economics*, 41, 313—357.

Marsh, I. (2005) "Advertising for liquidity on daytime TV," *mimeo*, Cass Business School.

Nimalendran, M. and G. Petrella (2003) "Do 'thinly-traded' stocks benefit from specialist intervention?" *Journal of Banking and Finance*, 27, 1823—1854.

Reiss P. and I. Werner (1996) "Transaction costs in dealer markets: Evidence from the London Stock Exchange," in A. Lo (ed.) *The Industrial Organisation and Regulation of the Securities Industry*, University of Chicago Press.

Venkataraman, K. (2001) “Automated versus floor trading: An analysis of execution costs on the Paris and New York exchanges,” *Journal of Finance*, 56, 1445—1485.