

The Effects of Market Reform on Trading Costs of Public Investors:

Evidence from the London Stock Exchange

by

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Abstract

In October 1997, the London Stock Exchange removed the obligation of dealers to quote firm two-way prices for FTSE 100 index stocks, and allowed the public to compete directly with dealers in these stocks through the submission of limit orders. This article examines the effects of these market reforms on the trading costs of “public” investors, the targeted beneficiary of the reforms, and documents several interesting results. First, the *duly signed* average effective half-spread of public investors has decreased much more than the corresponding decrease in the *absolute* effective half-spread documented by Barclay et. al. (1998) for NASDAQ. This is because a sub-set of public investors trade through limit orders, and thereby earn the spread rather than pay it. Second, consistent with the change from obligatory to voluntary market making, there is a significant increase in the “positioning revenue” earned by dealers from a change in the price of a stock while they are carrying the stock in their inventory. As a result, the overall gain of public investors in terms of the realised half-spread is not significantly different from zero. Third, the cross-subsidisation across trade sizes has disappeared, leading to a significant decline in the average execution costs of small *public* trades and an increase for large *public* trades. Fourth, the market reforms have caused negative externalities for stocks not going through the new trading system. Finally, in the absence of the price stabilisation provided earlier by dealers, the inside half-spread has increased very sharply in the first hour of trading – a finding which highlights the need for special opening procedures for electronic order books.

The Effects of Market Reform on Trading Costs of Public Investors: Evidence from the London Stock Exchange

There has been a long-standing debate among market practitioners, regulators and academics, on the relative merits of quote driven dealer markets versus order driven auction markets. Until recently, the London Stock Exchange (hereafter LSE) and the NASDAQ were the two main equity markets organised as pure competitive dealer markets. In 1997, both these markets underwent significant market reforms: NASDAQ on January 20, 1997 and LSE on October 20, 1997. In both cases, an active dealer market continued to exist but the public began to compete directly with dealers through the submission of binding limit orders. However, the LSE reform represented a significantly greater move from a dealer-type market to an order driven market. Unlike NASDAQ, the dealers on LSE were no longer obliged to quote firm two-way prices as they did earlier. Their participation became entirely voluntary, and their quotes were no longer available to investors through publicly available price-display systems.

Barclay et. al. (1999) document the effects of these market reforms on the trading costs of NASDAQ stocks and Bessembinder (1998) compares relative trading costs on NASDAQ and NYSE after the reforms. In this paper, we investigate the effects of the LSE market reforms on the trading costs of *public* investors. We examine not only the stocks which underwent market reforms, but also a sample of stocks which were not included in the first phase of reform¹.

¹ This serves two purposes. First, it provides us an estimate of inter-temporal variation in trading costs caused by other market wide factors, such as changes in volatility, trading volume etc. Second, it enables examination of externalities on stocks not undergoing reform. It was not possible for Barclay et. al. (1999) to do this since the reforms on NASDAQ were quickly extended to all stocks. In contrast, on the LSE the extension of reform to stocks not included in the first phase has been very slow.

This (London based) study makes several major contributions to the existing (NASDAQ based) research in this area. First, our data distinguishes the trades done by dealers as principals from the trades done by individual or institutional “public” investors, or agents acting on their behalf. This allows us to analyse trading costs from the frame of reference of a public investor, the targeted beneficiary of these market reforms. It also enables us to examine the extent to which public investors, as against market intermediaries, act as liquidity suppliers rather than liquidity demanders, and thereby earn the spread instead of paying the spread, and the impact this has on the net trading costs of public investors as a whole². Existing US studies have analysed effective half-spreads earned (paid) by liquidity suppliers (demanders) without distinguishing whether the liquidity supplier (demander) was a market intermediary (dealer or broker or floor trader) or a public investor. We analyse trading costs faced by the end-users of the trading system, i.e. the individual or institutional public investors, without confounding our analysis by the costs faced by intermediaries. We find that the *duly signed* average effective half-spreads of public traders (as a group) has fallen after the market reform much more massively than the decrease in *absolute* effective half-spreads documented for NASDAQ by Barclay et. al. (1999). This is primarily because a large sub-set of public investors chose to post orders on the limit order book, rather than demand immediate execution, thereby earning the spread rather than paying it.

Second, we examine the impact of the change from “obligatory” market making to “voluntary” market making on the “positioning revenues” of dealers, i.e. revenues arising from a change in the price of a stock while the intermediary is carrying the stock in her inventory. Before the market reforms on the LSE, dealers were required to always stand

² We are not aware of any work that reports the trading costs of public investors *as a whole*. Keim and Madhavan (1995, 1996, 1998), Chan and Lakonishok (1993, 1997), Edwards and Wagner (1993), and Perold and Sirri (1993) use data on institutional trades and data from specific market intermediary firms and institutions to document the trading costs of a subset of public investors. We are also not aware of any work that examines

ready to buy and sell the stocks in which they made a market. These dealers could be expected to lose money, on average, in trading with more informed investors (Glosten and Milgram, 1985), and consistent with this expectation, Hansch et. al. (1999) and Sofianos (1995) document negative overall positioning revenues of obligatory market makers on LSE and NYSE respectively. However, after the reforms on LSE, dealers can be selective about the stocks and trades in which they choose to participate. Arguably, conditional on information at the time of the trade, their expected profits from any inventory they *choose* to hold should be greater than zero for risk averse traders³. In this context, unlike the existing studies examining the impact of market reforms, we also investigate the impact of the reform on positioning revenues of market intermediaries. We find that positioning revenues are significantly negative before the reforms, and continue to be significantly negative after the reforms for stocks that did not undergo trading system reform. However, consistent with the expectation of positive inventory holding profits for voluntary market makers, we find that average positioning revenues of dealers are positive for post-reform trades, whether executed through the voluntary dealer network or the electronic limit order book.

In view of the significant increase in positioning revenues, there is no significant change in the overall trading revenues of dealers even though the revenues they earn from the effective half-spread have significantly decreased. In other words, the overall gain of public investors, as measured by the average change in the *realised half-spread*, is not significantly different from zero, even though the average signed effective half-spread paid by public investors has reduced significantly because they have earned the spread through posting of limit orders.

specifically the *effects of trading system reforms* on the trading costs of any subset of public investors.

³ Bernhardt and Hughson (1997) show that since a limit order book is split against incoming market orders, equilibrium limit order schedules yield positive expected profits to agents posting them.

Third, we find that, on average, market participants, both intermediaries and public investors, who supply liquidity through posting of limit orders earn the spread but lose on the post-trade price change; and market participants who demand liquidity through market orders pay the spread but earn on the post-trade price change. This implies that, consistent with the results of Harris and Hasbrouck (1996) for NYSE stocks, and Berkman (1996) for EOE options, limit orders are subject to adverse selection risk. More importantly, we find no difference with respect to post-trade price changes between limit (or market) orders posted by market intermediaries and limit (or market) orders posted by public investors. In both cases we find that about sixty percent of the post-trade price change arises within 15 minutes of a trade, reflecting imminently “stale” limit orders being picked off, and the other forty percent arises over the rest of day. This suggests that “aggressor” market participants picking limit orders have superior short-term information.

Fourth, we quantify the effective cross-subsidisation of dealership services taking place across different size-categories of trades, and hence analyse changes in this cross-subsidisation caused by the market reform. As highlighted by Domowitz and Steil (1999), in the pure dealership London market prior to the market reform the profits of dealers in small trades were effectively subsidising trading costs of large trades. However, we find after the introduction of the limit order book, this cross-subsidisation has disappeared, leading to a significant decrease in the average execution costs of small *public* trades and an increase in the average execution costs of large *public* trades.

Fifth, we document negative externalities in terms of significantly wider inside half-spreads during the first hour of trading, significantly higher effective half-spreads, significantly higher realised half-spreads and significantly lower price improvement (relative to best

quotes) for stocks that did not undergo trading system reform. This suggests that the market reforms have led to changes in the pattern of cross- subsidisation and the flow of information across different categories of stocks.

Finally, we document very significant qualitative changes in the intra-day variation of the inside half-spread. In the quote driven pure dealership market, the inside half-spread displays no significant intra-day variation. This is arguably because of the price stabilisation provided by dealers. However, in the order driven system after the reform, in the absence of this price stabilisation, the inside half-spread is sharply higher in the first hour of trading, declines significantly over the first 60 minutes, and then steadily until the close. Our results clearly highlight the need for special order matching procedures at the open in order driven markets, since market participants appear to be reluctant to expose their limit orders immediately after market opening while the price uncertainty after a long non-trading interval is being resolved.

The rest of this paper is organised as follows. Section I outlines the market reforms and explains the motivation behind them. Section II describes the data used in our empirical work and outlines the empirical research design. Section III examines intra-day variation in inside half-spreads. Section IV presents the results of the trading system change on signed effective half-spreads defined from the frame of reference of an individual or institutional public investor. Section V similarly reports the impact on realised half-spreads and the adverse information component of realised half-spreads. Section VI analyses the positioning and trading revenues of market intermediaries over different post-trade intervals when public investors supply liquidity through limit orders or demand liquidity through market orders. Finally, our concluding remarks appear in Section VII.

I Brief History & Description of Market Reforms

A. *Brief History*

The London equity market had always been a pure dealership quote driven market. All trades were executed through competing dealers who were obliged to make firm two-way prices in the stocks they wished to make a market in. In 1997, the LSE introduced an order driven system for the most liquid stocks while retaining the dealer network in parallel. This reform was the biggest structural change in the history of the LSE⁴.

Several developments led to the introduction of this major market reform: First, the nineties saw a significant increase in the competitive pressures on the LSE from various directions. Many European exchanges introduced new trading systems to capture the market share in European equities from the LSE, though none of these represented structural changes like LSE's change from a dealership to an order driven market⁵. Second, alternative electronic networks such as Tradepoint established themselves in the UK, and the UK regulatory authorities removed the earlier restrictions on market makers that had prevented them from quoting, on other electronic networks, prices better than those they were quoting on LSE. Thus, these electronic networks had the potential of bringing buyers and sellers together well within the LSE spread. Finally, under Article 15.4 of EU Investing Services Directive, automated order matching systems located anywhere within Europe became potential competitors of LSE⁶.

⁴ A set of important changes made by the LSE in October 1986, known as the Big Bang, made transaction prices and quotes more transparent, allowed dual capacity trading, abolished fixed commissions and liberalised the entry of foreign firms. However, the Big Bang retained the pure dealership nature of the market. While quote display systems were computerised, the trade execution function was not automated.

⁵ Many European Exchanges introduced changes in their trading systems to make themselves more competitive: TSA by Amsterdam Stock Exchange in 1994; SWX by the Swiss Exchange in 1995; XETRA by Deutsche Borse AG in 1997; and NSC by the Paris Bourse in 1996 (see Demarchi and Foucault, 1998).

⁶ This article allowed European markets to enrol remote members in other EU countries without securing permission from the regulatory authorities in that country.

Market participants and researchers started comparing costs of trading the same stocks across different exchanges⁷. Although LSE served well the needs of large domestic institutional investors through its high depth⁸, it was widely perceived as a market with high trading costs for small retail investors and this high cost was attributed to the dealership nature of the market⁹. Since LSE and NASDAQ were the two main dealer markets in equities, the controversies created by the collusion allegations on NASDAQ (Christie and Schultz (1994), Christie, Harris and Schultz (1994)) added to the popular perception that LSE market makers were profiting unduly from the dealership system. And amid all these developments, LSE was perceived to be sitting still rather than doing something about the changed market conditions in the nineties.

B. *Nature of Market Reforms*

In October 1997, the exchange introduced a fundamental shift in the nature of the market by replacing the quote-driven manual trade execution system to an order-driven electronic trade execution system interacting with a network of dealers. In the new order-driven system, buyers and sellers could post limit orders or pick limit orders electronically (through their broker or a member firm), and they could *also* trade with dealers functioning as voluntary liquidity suppliers. Since order-driven systems seem to work better for liquid stocks, the change was introduced initially for the hundred highest market capitalisation stocks which

⁷ See Pagano and Roell (1990) and De Jong et. al., (1995) for comparison of quoted and inside spreads across LSE and European exchanges. Also see Werner and Kleidon (1996) for the analysis of UK and US trading of British cross-listed stocks.

⁸ Large institutional US investors were apparently not happy with the lack of transparency in the London market making system since it appears they were paying higher trading costs relative to domestic institutional traders. This is clear, for example, from the April 1999 newsletter of the *Plexus Group*, and the background note circulated by *Global Investor* for their July 1999 roundtable discussion in London on institutional trading.

⁹ The perception of high trading costs in the old dealer type London market is not entirely correct. Although the quoted half-spreads and inside half-spreads on LSE had been relatively high, the overall value-weighted average of effective half-spreads and the overall value-weighted average of realised half-spreads have been documented to be very low (Hansch et al (1999), Naik and Yadav (1999)). However, these effective and realised half-spreads differed significantly across different trade sizes, being large in magnitude for small trades, small in magnitude for medium-to-large trades, and increasing again in magnitude for very large trades.

were part of the FTSE-100 index. This coverage has been extended (albeit very slowly) to other stocks as new stocks have joined the FTSE-100 after quarterly market capitalisation reviews, and in some other special cases.

Relative to the market reforms on the NASDAQ, the reforms on LSE represented a significantly greater move from a quote-driven dealership market to an order-driven auction market. Unlike the NASDAQ, dealers were no longer obliged to quote firm two way prices as they did earlier, and their quotes were no longer available to investors through publicly available price-display systems. Dealers' participation became entirely voluntary, and the functions of price formation and liquidity creation were left to collective market forces. Yet, unlike other order driven markets like Paris and Frankfurt, LSE did not introduce special procedures for the market open. However, an active dealer market did continue to formally exist with limited obligations to interact with the order book.

C. *Expected Benefits*

Compared to the old dealer-market, the LSE expected the order book to result in lower trading costs of public investors because of several reasons. First, the new system would give public investors more choice, thus opening up the potential for a range of different trading strategies¹⁰. The ability to post limit orders also improved the bargaining power of public investors while negotiating with dealer firms. Second, the public investors were now able to observe the entire order book and have real-time knowledge of prices and quantities of trades executed on the order book. Third, order handling costs were expected to be lower due to automated order execution. Thus, the wider choice, greater transparency and lower order

¹⁰ The limit order book gives the public investor an important tool to influence the trading costs. Either the public trader can pay the inside half-spread and guarantee execution immediately, or she can try to earn that effective half-spread by being patient and posting a limit order on the electronic order book. Execution of a limit order is not guaranteed, but if it does execute, she can earn the spread instead of paying it.

processing costs were expected to significantly improve the competitiveness of the LSE¹¹.

D. After the Reform ...

Since October 20, 1997 trades in SETS stocks can be done either through the electronic order book or through the dealer network offering dealership services on a voluntary basis. About 20% to 30% of public trades go through SETS. Most of the public trading through SETS is in medium- sized trades in the £10,000 to one NMS size range¹². The rest are mainly executed through dealers. In general, the average trade size on the electronic order book increases significantly with firm size.

The proportion of inter-firm principal-to-principal trades that take place through the electronic order book is significantly greater than the proportion of *public* customer trades going through SETS. This is partially because the inter-dealer trades that used to be executed anonymously through the (since discontinued) Inter-Dealer-Broker (IDB) order-matching network in the old pure dealer market now go through SETS¹³. Less than 2% of the trades on SETS are executed directly between the agents of two public customers. Market intermediaries trading on their own account are the counter-parties in more than 98% of the public trades executed through SETS. Hence, dealers continue to play a major role in execution of trades though they do so voluntarily and are not obliged to do so.

¹¹ There is strong interest among regulators, practitioners, exchange members and market participants in analysing whether these expected benefits have materialized (see London Financial News, 5 October 1998).

¹²NMS is the “normal market size” of a particular stock. It is defined as being equal to approximately 2.5% of the average total daily trading volume in that stock over a reference three-month period. Thus, the trade execution difficulty for medium to large trades becomes more comparable across stocks when trade size is expressed in multiples of NMS.

¹³ See e.g. Reiss and Werner (1998, 1999) for a detailed analysis of inter-dealer trading on the LSE under the old dealership system.

II Data and Methodology

In order to examine the effect of market reform on the trading costs of public investors, we investigate three periods, each of three months duration. We use data from May 1998 to July 1998 (hereafter labelled '1998') to examine trading costs after the reform. We use two control periods before the market reform: August 1994 to October 1994 (hereafter labelled '1994') and February 1996 to April 1996 (hereafter labelled '1996').¹⁴ Changes in trading costs in non-SETS stocks during these periods act as a proxy for longer term market-wide movements over the three sample periods.

For each of these three periods, we analyse comprehensive time stamped trades', quotes' and limit orders' data provided by the London Stock Exchange. The data for 1994 and 1996 is for the pure dealership market prior to the market reform. The data for 1998 also includes data from the SETS electronic order book. In particular, it includes details of entry and execution of all orders on the electronic order book and execution of all trades off the order book in the SETS stocks.

Our trades' data indicates the dealing capacity of the Stock Exchange member firm reporting the trade, i.e., whether the firm acted as *principal* or as an *agent* in the particular transaction and whether the firm bought or sold in that trade. Hence, we do not have to use an arbitrary rule to decide if the trade was a public buy or a public sell. More importantly, this enables us to determine whether it was a Stock Exchange member firm or a public customer who was effectively supplying liquidity (and earning spreads) in the trade.

¹⁴ Our choice of periods is determined entirely by availability of the data from the LSE. Transactions' data from the pre-reform quote driven pure dealership market on the LSE has been used by various researchers to explore several interesting issues relating to trading costs. Reiss and Werner (1995) provide early evidence on the subject; Tonks and Snell (1995) analyse the components of the bid-ask spread; Gemmill (1996) and Board and Sutcliffe (1995) examine the impact of different transparency rules on trading costs; Hansch et. al. (1999) examine the effect of preferencing, internalization and best execution on trading costs; and Naik and Yadav

We analyse the impact of market reforms on four measures of trading costs:

- inside half-spread,
- signed effective half-spread which when aggregated across all public trades determines the spread revenue of market intermediaries,
- realised half-spread which when aggregated across all public trades determines the trading revenue of market intermediaries, and
- positioning half-spread which when aggregated across all public trades determines the positioning revenue of market intermediaries and represents the part of spread revenues they lose due to adverse selection.

Let p_t^i be the transaction price for the i^{th} trade executed at time t . Since transactions can potentially change the contemporaneous best limit prices in an order driven market, we measure best quotes or limit prices *one second before* the execution of the trade. We define a_t as the lowest ask quote or limit price to sell one second before time t , and b_t as the highest bid quote or limit price to buy one second before time t . Let m_t be the mid-price of best quotes or limit orders at time t , $m_t = (a_t + b_t)/2$. Let the subscript T denote the particular post-trade reference time used to estimate the “true” value of the stock.: in this paper T is taken as $t+15$, or $t+30$, or $t+60$, or the end of the day.

We define and analyse the following from spread variables:

- Inside Half-Spread IS_t as

$$IS_t = \frac{(a_t - b_t) / 2}{m_t}$$

(1999) investigate differences in the quality of execution offered by different dealers and different brokers.

- Signed Effective Half-Spread ES_t^i for the i^{th} trade as

$$ES_t^i = \frac{(p_t^i - m_t)}{m_t} \quad \text{for a public buy}$$

$$ES_t^i = \frac{(m_t - p_t^i)}{m_t} \quad \text{for a public sell}$$

- Realised Half-Spread RS_t^i for the i^{th} trade as

$$RS_t^i = \frac{(p_t^i - m_T)}{m_t} \quad \text{for a public buy}$$

$$RS_t^i = \frac{(m_T - p_t^i)}{m_t} \quad \text{for a public sell}$$

- Positioning Half-Spread PS_t^i for the i^{th} trade as $PS_t^i = RS_t^i - ES_t^i$. Thus,

$$PS_t^i = \frac{(m_t - m_T)}{m_t} \quad \text{for a public buy}$$

$$PS_t^i = \frac{(m_T - m_t)}{m_t} \quad \text{for a public sell}$$

Our analyses are based on time-weighted averaging of inside half-spreads IS_t , and value-weighted averaging over the relevant trade size categories of the other three spread variables ES_t^i , RS_t^i and PS_t^i .

Our data covers all stocks, but as SETS has been introduced and planned only for the top 350 stocks, we confine our analyses to the 245 stocks (among the FTSE350 stocks in 1998) for which we have data for *each* of the three periods above. These include 76 SETS stocks which we use to examine the impact of market reforms, and 169 non-SETS stocks which we use to estimate the extent of inter-temporal market-wide changes over the years. We measure each of the four spread variables in basis points (i.e., one-hundredths of a percentage point) and

However, the focus of this paper is totally different from earlier research in this area.

examine differences from 1994 to 1998, and from 1996 to 1998, for SETS stocks as well as for non-SETS stocks. The statistical significance of pair-wise differences in means over these sample periods is determined using standard t-tests.

We sort and analyse inside half-spreads based on the eight different hourly trading intervals within the day. We sort and analyse signed effective half-spreads, realised half-spreads and positioning half-spreads based on six different trade size bands defined in terms of the "normal-market size" (NMS) of the stock as follows: below £4000; from £4000 to £10000; from £10000 to £25000; from £25000 to one NMS; from one NMS to three NMS; and from three NMS to eight NMS. Since the SETS order book system is virtually unused for trades above eight NMS, we do not analyse trades above eight NMS in size.

Table I reports the distribution of trading volume across different trade size bands in each of the three sample periods. Panel A presents the value of shares traded and Panel B the corresponding number of shares traded. Both panels lead to similar inferences. Overall, there has been substantial growth in trading volume from 1994 to 1996, but not from 1996 to 1998. For non-SETS stocks, the cross-sectional distribution of trades across different trade size bands has not changed significantly from 1994 to 1996 or from 1996 to 1998. However, for SETS stocks, while the cross-sectional distribution of trades across different trade size bands has not changed significantly from 1994 to 1996, it has changed significantly from 1996 to 1998 (p-value of Chi-square statistic $\ll 0.001$). This is because, relative to 1996 or 1994, a substantially greater proportion of trades have taken place in the middle trade size ranges in 1998. In particular, 82% by value (and 52% by number) of all trades executed through the order book are in the £25000 to one NMS size range. This suggests a greater propensity on the part of market participants to split large trades and "work" the order through.

III Inside Half-Spread

For the dealer market in 1994 and 1996, and for non-SETS stocks in 1998, the inside half-spread is calculated from the best bid quote and the best ask quote. For SETS stocks in 1998, the inside half-spread is calculated from the best limit orders to buy and sell.

For each of the 245 sample stocks, we take 5-minute snapshots of the inside half-spread for each day in each of the three sample periods: 1994, 1996 and 1998. We then calculate average values of the inside half-spreads across different stocks and different 5-minute periods of the day. Table II reports these average inside half-spreads, separately for SETS stocks and non-SETS stocks (i.e. stocks not traded on the new order book system). The table also reports the change in inside half-spreads between 1994 & 1998, and 1996 & 1998, and gives the statistical significance of pair-wise differences in means over these sample periods using standard t-tests. Figure I and Figure II show the intra-day variation in average inside half-spreads of SETS and non-SETS stocks respectively over the trading day in each of the years 1994, 1996 and 1998.

Before we examine the changes in SETS stocks, it is useful to examine the changes in non-SETS stocks (which did not undergo market reform) to get an idea of the general market trend over these periods. The average inside half-spread of non-SETS stocks declined from 71 basis points in 1994 to 60 basis points in 1996 to 57 basis points in 1998, which indicates a general decline in inside half-spreads over time. The decline from 1994 to 1998 is large in magnitude and statistically highly significant (p-value $\ll 0.0001$) within each hourly interval of the day. The decline from 1996 to 1998 is small in magnitude and not significant for any hourly interval within the day but is statistically significant overall (p-value < 0.01).

Qualitatively, the changes are not different for different hours of the day. However, the average inside half-spread over the first hour is significantly higher than the average inside half-spread over the rest of the day. This difference is about 3 basis points in 1994 and in 1996 and about 5 basis points in 1998. Interestingly, the increase in this *difference* from 1994 to 1998 and from 1996 to 1998 is statistically significant (p-value<0.05).

In sharp contrast, Figure 1 shows the very significant qualitative and quantitative changes in the inside half-spread of SETS stocks (which underwent the market reform) from 1994 to 1998, or from 1996 to 1998.¹⁵ The overall average inside half-spread declined from 32 basis points in 1994 to 27 basis points in 1996 and 27 basis points in 1998. Even though there is little change from 1996 to 1998 in the *overall average* figure, there is a massive increase in average inside half-spread in the first hour of trading after the open, and a significant decrease in the average inside half-spread for the rest of the trading day.

In 1994 and 1996, there is virtually no intra-day variation in the average inside half-spread across different hours of the day. However, after the introduction of the electronic order book, the average inside half-spread in the first five minutes of trading in 1998 is more than 90 basis points - *more than three times the average inside half-spread over rest of the trading day*. The inside half-spread on the order book declines monotonically up to the close of trading on the day, but the average inside half-spread over the first hour of trading is still more than double the average inside half-spread over rest of the trading day, and the difference is statistically highly significant (p-value <0.0001). As a result, there is a large highly significant (p-value <0.0001) increase in average inside half-spreads in the first hour

¹⁵ The data for inside half-spread that we use for 1998 sample period is from May 1, 1998 to July 19, 1998. This is because the exchange changed the opening on 20 July 1998 from 8.30 am to 9.00 am. The results for the last 10 days of July are virtually identical to the rest of the 1998 period when the hours are measured from the new opening time.

of trading, from 28 basis points in 1996 (or 34 basis points in 1994) to 54 basis points in 1998. There is also a significant (p-value <0.01) increase in average inside half-spreads in the second hour of trading as we go from 1996 to 1998. However, since the inside half-spread on the order book declines steadily over the day, there is a significant decrease in average inside half-spreads (p-value <0.05) for the remaining hours of the day as we go from 1996 (or 1994) to 1998. If we exclude the first hour of the trading day, the average inside half-spread in 1998 is about 15% less than in 1996 and about 30% less than in 1994. In both cases the decrease is statistically highly significant (p-value <0.01), a finding totally consistent with that of Barclay et. al. (1999) for the NASDAQ stocks.

The figures in Table II are *time weighted* average inside half-spreads. We also calculate the average inside half-spreads *one second before* the execution of every public trade¹⁶, and find that the average of these trade-time inside half-spreads is about 10% to 40% lower (at different times of the day) than the figures we report for average *time weighted* inside half-spreads. This suggests that public traders do not usually trade at times when the inside half-spread is abnormally high. However, the intra-day variation is qualitatively very similar.

To summarise, we would like to emphasise two implications of the above findings. First, our results show that dealers fulfil a useful price stabilisation function. There exists extensive evidence that open-to-open returns are more volatile than close-to-close returns, and that this is related to the greater degree of price uncertainty at the open in view of the long non-trading interval that precedes the open (Stoll and Whaley (1990) and Amihud and Mendelson (1987; 1991)). The resolution of this price uncertainty takes place after commencement of trading. Limit orders effectively provide free options which other market participants can pick off,

¹⁶ In view of the way the inside half-spread is defined for the order driven market, we calculate the average inside half-spread *one second before* the execution of the trade as the trade itself can potentially change the

and our results are consistent with market participants in the order driven system being justifiably reluctant to expose their limit orders during the period for which this price uncertainty is being resolved after the open. On the other hand, in the pure dealer market system preceding the market reform, and for the stocks not subject to the reform, dealers are fulfilling a price stabilisation function and absorbing the shocks associated with the greater price uncertainty immediately after the market opening. After the reform, dealers on LSE are not expected to fulfil that stabilisation function leading to large intra-day variation in the inside half-spread.

Second, the introduction of the electronic limit order book for the heavily traded stocks in the market has generated negative externalities for the less liquid stocks for which no limit order book has been introduced. Even though there has been a (significant) 5% decline in the average inside half-spread from 1996 to 1998, the intra-day variation in this spread, as proxied by the difference between the first trading hour and other trading hours, has almost doubled. The increase in the difference is significant ($p\text{-value} < 0.05$). Clearly, dealers face greater risks in low market capitalisation low trading volume non-SETS stocks relative to high market capitalisation high trading volume SETS stocks, and hence it is not surprising that there exists significant intra-day variation in inside half-spreads even in 1994 and 1996. But the level of price stabilisation provided by market makers in 1998 to non-SETS stocks has significantly reduced, even though these stocks have not gone through reforms. We believe that this is driven by the large increase in the inside half-spreads of SETS stocks in the first hour. Since the “true” value could be anywhere within the best bid and the best ask, the greater uncertainty introduced by the large inside half-spreads of FTSE-100 index stocks

estimated inside half-spread.

makes it difficult for participants trading non-SETS stocks to infer where the “main market” is, or which way it is going.

Clearly, the size of the trades that could be executed at the inside half-spread in the pure dealer market in 1994 and 1996 differs from the size of the trades that could be executed at the inside half-spread on the limit order book in 1998. In 1994 and 1996, each market maker quote was typically firm up to the "normal-market size" (NMS) of the particular stock, and it was possible to "hit" several competing market makers in the stock at the same time. However, it is difficult to estimate the *true* depth of the SETS stocks in 1998 because the limit orders on the book and the dealers trading off the limit order book together constitute the depth in the SETS stocks. The depth of the limit order book as seen on the screen is only about one NMS. However, this is a misleading estimate of the true depth because of the existence of substantially greater, albeit non-quantifiable, hidden depth in the dealer network. Therefore, the schedule of effective half-spreads paid by different sized trades is a more meaningful indicator of true depth than the explicitly visible schedule of limit orders posted on the screen.

IV Signed Effective Half-Spreads for a Public Investor

While the inside half-spread is based on posted prices at which an investor *could* trade, the *effective half-spread* is based on the prices at which an investor *actually* trades. The inside half-spread can be different from the effective half-spread because trades can take place both within and outside the inside half-spread. The best ask and bid quotes and limit prices are valid only up to a specific trade size. Large buy (sell) trades may have to take place above (below) the ask (bid) price in order to attract liquidity suppliers to take on the additional risk involved. However, in less transparent regimes, large trades can at times get significantly

better prices than the ask or bid prices as dealers implicitly "purchase" the information contained in the order flow (Naik et. al., 1999). Dealers can also offer attractive transaction prices in order to restore their temporary inventory imbalances to normal levels (Hansch et. al., 1998). For either of these reasons, dealers may even "reach across the market" to buy (sell) above (below) the mid-price (Sofianos, 1995). Thus, under different market conditions, the effective half-spreads can be very different for different sized trades and for different counter-parties, a phenomenon well documented in Reiss and Werner (1996).

The effective half-spread of executed trades is calculated from the *duly signed* difference between the transaction price and the mid-price. We sign the effective half-spread from the perspective of a public customer. It is positive when the public customer pays the spread to a dealer supplying immediacy in a transaction. It is negative when the public customer earns the spread, for example, when a limit order posted by the customer is picked off by a dealer, or when a dealer buys (sells) blocks of stock above (below) the mid-price for inventory control or information reasons. In such transactions, the dealer is effectively seeking immediacy and paying the spread.

In contrast to our use of *duly-signed* effective half-spreads, major US studies (eg Barclay, 1997; Barclay et. al., 1999; Bessembinder, 1997, 1998; Christie and Huang, 1994; Christie et. al., 1994; and Huang and Stoll, 1996) are based on the *absolute value* of the difference between the trade price and the mid-price. This is because the data typically available in the US does not flag trade direction. This absolute value of effective half-spread generically measures the execution costs of "liquidity demanders" on the assumption that a liquidity demander always trades above the mid-price for a buy and below the mid-price for a sell and does not distinguish between market intermediaries and public investors. By using signed

effective half-spreads, we are able to distinguish the times when public investors act as liquidity suppliers from times when they act as liquidity demanders.

We calculate the signed effective half-spread for each trade in each of the three sample periods. We divide the 1998 trades in SETS stocks into two parts: those executed automatically through the order book, and those executed off the order book. For the purpose of our investigation, we consider only *public* trades in which a public customer (individual or institution), or the agent of a public customer, trades with a member firm trading as principal. We do not include the tiny fraction of public trades (less than 2%) in which a public customer (or her agent) trades directly with another public customer (or her agent)¹⁷. For the sub-set of direct customer-to-customer trades, the average of the signed effective spread would clearly be zero¹⁸.

We sort these trade-by-trade effective half-spreads into 48 cells based on the eight different hourly trading intervals within the day and the six different trade size bands indicated in section II. For each of the 245 sample stocks *separately*, we calculate the average signed effective half-spread in each of these (8×6), i.e. 48 classifications based on eight trading intervals and six trade size intervals. Our final inferences are based on the 245×8×6, i.e. 11760 average signed effective half-spreads so calculated and conducting statistical tests on the pair wise differences from 1994 to 1996 to 1998. This ensures that the inferences we report are not unduly influenced by clustering of trades (by number or by market value) in any particular trade size category or in any particular trading hour.

¹⁷ We do not also include inter-dealer trades since our analysis is confined to public investors who are not a counter-party in these trades.

¹⁸ Because of this, the signed effective spread measure is not necessarily appropriate for markets where a substantial proportion of trades are customer-to-customer trades executed through agents.

Table III reports the average signed effective half-spreads for different sized trades, separately for SETS stocks and non-SETS stocks, for each of the years 1994, 1996 and 1998. It also reports the change in average signed effective half-spreads between 1994 & 1998, and 1996 & 1998.

Table III has at least three interesting features. First, the average signed effective half-spread for trades executed through the order book in 1998 is either indistinguishable from zero or significantly negative, for all trade size bands. This is because public traders have often supplied liquidity to the market through posting of limit orders, thereby earning the spread rather than paying it. This has significantly reduced the *average* spread paid by public traders as a group. It is interesting in this context to examine the proportion of cases in which public investors are supplying liquidity through limit orders rather than demanding liquidity through market orders. We find that for small trades, i.e. less than £25000 in size, and for large trades, i.e. more than three NMS in size, public investors supply liquidity through limit orders in about two-thirds of all electronic order book trades and demand liquidity through market orders in the remaining one-third. For medium sized trades, i.e. between £25000 and three NMS in size, public investors supply liquidity through limit orders in about half the electronic order book trades and demand liquidity through market orders in the remaining half.

Second, the variation of average signed effective half-spread across different trade size bands is qualitatively similar in 1994 and 1996 for both SETS and non-SETS stocks but qualitatively different in 1998 particularly for SETS stocks. In 1994 and 1996, both for SETS and non-SETS stocks, effective half-spreads are large and significantly positive for relatively smaller trade sizes up to about £25000 in trade size. However, for larger trade sizes, effective

half-spreads become statistically indistinguishable from zero or significantly negative. This suggests that the level of prices being offered by dealers in these trade size bands are often based on their inventory control considerations or because they are effectively paying for the information contained in the (potentially informed) order flow. However, in 1998, for SETS stocks traded through the dealer network, average signed effective half-spreads are either indistinguishable from zero or are significantly negative for relatively smaller sized trades and significantly positive only for relatively large sized trades. In the earlier pure dealer system, there was cross subsidisation taking place: the revenues of dealers from small trades were subsidising their losses from large trades (Domowitz and Steil, 1999). Our results indicate that the competitive pressures of SETS for smaller sized trades have eliminated this cross-subsidisation.

Third, the effective half-spreads charged by dealers for non-SETS stocks have increased significantly (p-values $\ll 0.01$) across the board for all trade sizes. The average value-weighted effective spread has more than doubled from about 15 basis points in 1994 and 1996 to about 33 basis points in 1998, even though, as we saw in Section III, the average inside half-spread for these stocks in 1998 has declined by about 5% from 1996 and 20% from 1994. The majority of trades in the London quote driven dealer market have typically taken place within the spread, with dealers typically offering different levels of “price improvement” (with reference to quoted prices) for different trades dependent on the perceived information content of the trade, the level of their inventory and the nature of the client¹⁹. Our results indicate that the range of price improvement being offered by dealers in different types of trades in non-SETS stocks has decreased substantially after the introduction of the electronic order book in SETS stocks. This suggests that the dealers are making up for the profits “lost”

¹⁹ See e.g. Reiss and Werner (1995), Hansch et. al. (1999).

due to increased competition on SETS by changing higher effective half-spreads for non-SETS stocks. If this indeed is the case, then this potentially reflects a change in the pattern of cross-subsidisation in dealer services across different categories of stocks.

V. Positioning Half-spreads and Realised Half-spreads

The effective half-spread paid by public investors is the visible component of the execution cost at the time of the trade. It is a measure of execution cost on the assumption that the contemporaneous mid-price is the “true” value of the stock. On the other hand, the realised half-spread is a measure of execution cost on the assumption that the post-trade mid-price is the “true” value of the stock. The positioning half-spread is the difference between the two and reflects the post-trade price change. If a subset of public investors have superior information, then they will benefit, on average, from the post-trade price change, and hence the realised half-spread paid by them will be lower than the effective half-spread by the extent of the positioning half-spread.

The trading revenue of all market intermediaries over any particular period represents the total cost paid by public investors as a group for trading during that period. It is equal to the duly signed and value weighted sum of realised half-spreads across all public trades in that period. This trading revenue can be considered as the sum of two components — the spread revenue and the positioning revenue²⁰ — which similarly equal the duly signed and value weighted sum across all public trades of effective half-spreads and positioning half-spreads respectively. The positioning revenue represents the gain or loss made by the intermediary due to carrying of inventory. If the public investor sells the stock to the intermediary before a price fall or buys before a price rise, potentially because of superior information, then positioning

²⁰ See Sofianos (1995) and Hansch et. al. (1999).

revenues of market intermediaries will be negative.

Our investigation of market reform related changes in realised half-spreads and positioning half-spreads is motivated by many reasons. First, we expect that the reform related change from “obligatory” market making to “voluntary” market making should result in a significant change in the signed positioning half-spread of trades executed through dealers. Before the LSE reform, dealers were required to always stand ready to buy and sell the stocks in which they made a market, and could be expected to lose money, on average, in trading with more informed investors. Hence, we should observe negative overall positioning half-spreads before the reform. However, after the reform, dealers could be selective about the stocks and trades in which they choose to participate, and, conditional on information at the time of the trade, their expected profits from any inventory they *choose* to hold should be greater than zero for risk averse dealers.

Second, even if the effective half-spread decreases significantly as documented in Section IV above, overall trading costs as measured by the realised half-spread need not necessarily decrease since the positioning half-spread is expected to increase as a result of the reform. Hence, the actual change in realised half-spreads is an important empirical issue.

Finally, trades on LSE before the reform, as well as post-reform trades in non-SETS stocks, and post-reform trades in SETS stocks executed off the limit order book through the dealer network, are done over the phone and often involve negotiation particularly in the case of large trades. These negotiations are feasible only in trades through the dealer network and not in order book trades, and provide the dealers involved with some knowledge about the information content of the order flow that in turn determines the effective half-spread charged

by them for that trade²¹. Hence, even if there is little difference in the overall realised half-spread paid by public investors, the distribution of positioning half-spreads (and effective half-spreads) across different trade-size categories can potentially be different after the reform for trades executed through the order book and trades executed through the dealer network.

We calculate the positioning half-spread as the *duly signed* relative change in mid-price from the time of the trade up to a reference time after the trade. The mid-price at this reference time is an empirical proxy for the “true” post-trade value of the stock. Following Easley et.al. (1997) we first assume that the end of day price is a good proxy and value each stock in inventory at the mid-price at the end of the day. We then also repeat the computations using mid-prices prevailing 15 minutes, 30 minutes and 60 minutes after the trade. In the same way, we calculate the realised half-spread as the *duly signed* difference between the transaction price and the mid-price at the reference time after the trade, relative to the mid-price at the time of the trade.

Both the positioning half-spread and the realised half-spread are signed from the frame of reference of a public investor as distinct from market intermediaries. The positioning half-spread is signed positive when the public investor suffers an adverse post-trade price change and negative when the public investor benefits from the post-trade price change. The realised half-spread is signed positive when the public investor pays the spread and negative when she

²¹ For instance, the dealer can potentially learn whether the counter-party is an individual investor or an institutional investor, and if it is an institutional investor, whether it is an “active” manager or an index tracker. The dealer may also be able to learn if the trade is the entire order or a small part of a large order being worked into the market. The effective spread charged by the dealer would depend on the assessed information content. For example, for a given sized order, the dealer would be expected to charge the manager of a passively managed index fund a different effective half-spread than the manager of an actively managed hedge fund. In this context, it is important to note that dealers can often “purchase” the information in trades with high information content through competitively priced executions, with the aim of using the information for their other trading activities (Naik et. al., 1999).

earns the spread²².

We make inferences on changes in positioning half-spreads and realised half-spreads in the same way as in Section IV. Tables IV and V report the average positioning half-spread and the average realised half-spread for different sized trades, separately for SETS stocks and non-SETS stocks, for each of the years 1994, 1996 and 1998. The tables also report changes between 1994 & 1998, and 1996 & 1998. These tables offer several interesting results.

First, Table IV shows that, in the pure dealer system prior to the market reform, the average positioning half-spreads were significantly negative in each size band both for SETS stocks and for non-SETS stocks. This is consistent with losses made, on average, to informed traders by market makers who were obliged to quote and trade on firm two way prices. For the non-SETS stocks which have continued to trade exclusively in a dealership market after the market reform, these average positioning half-spreads continue to be significantly negative in each size band after the market reform in 1998. However, after the market reform, the positioning half-spreads of SETS stocks are positive overall for trades in the dealer network and also for the trades through the limit order book in which market intermediaries trading on their own account are counter-parties. In both cases, the overall change in positioning half-spreads from 1996 to 1998, and 1994 to 1998, is significantly positive. This is consistent with the expectation of positive inventory holding profits of market makers given the voluntary nature of market making after the reform. In this context, for the largest trade sizes (greater than one NMS) there is also a significant difference in positioning half-spreads and effective

²² For example, consider a trade where a public investor bought one share at 101 pence at a time when the mid-price was 100 pence. After, say, one hour the mid-price moved to 105 pence. Then, she paid an effective half-spread of 100 basis points, her realised half-spread is -400 basis points and her positioning half-spread is -500 basis points. As the public investor purchased the share before a price rise: even if she paid a positive effective half-spread, she gained (potentially due to superior information) by more than the effective half-spread and her realised half-spread turned out to be negative.

half-spreads between trades through the dealer network and trades through the order book. These are the trade size bands where dealers executing trades in the dealer network are most likely to be able to partially infer the information content of the order flow when they negotiate with the public investor involved.

Second, Table V clearly shows that, for SETS stocks, the overall average realised half-spread for order book trades in 1998 is not significantly different from that in 1994 or 1996. The average signed effective half-spread paid by public investors for order book trades has reduced very significantly by about 18 basis points relative to 1996, because they have, on average, earned the spread through successful execution of their limit orders. However, at the same time, the positioning half-spread (shown in Table IV) has increased significantly by about 19 basis points relative to 1996. Hence, the overall total gain of public investors, as measured by the average realised half-spread, is not significantly different than zero. In contrast, for non-SETS stocks, the realised half-spread has increased significantly from 1994 to 1998, and 1996 to 1998 in almost every trade size category. This is because effective half-spreads have increased significantly but overall positioning half-spreads have not changed significantly.

Third, Table V confirms the changes (inferred from the effective half-spreads) in the cross subsidisation across trade sizes which has taken place for SETS stocks after the reform. The overall realised half-spread across all trades in 1998 is not significantly different from that in 1996 but the realised half-spread for small trades has become significantly lower and that of large trades has become significantly higher both for order book trades and trades through the dealer network.

VI. Positioning Half-Spreads and Trading Half-Spreads over Different Post-Trade Intervals for Trades in which Public Investors Demand and Supply Liquidity

In the context of the results of the previous section, we further investigate three questions that arise from these results:

1. Do market intermediaries earn their positive positioning revenues in the order book system just because they pick up limit orders that are just about to become stale due to changing market prices²³?
2. Is there any difference between the realised half-spread and positioning half-spread of public investors when they provide liquidity through market orders and when they demand liquidity through market orders?
3. Are public investors, on average, differentially informed than market intermediaries?

To examine the first question, we calculate the realised half-spread and the positioning half-spread earned over different post-trade intervals by market intermediaries trading with public investors through the order book. To do this, we estimate the realised half-spread and the positioning half-spread by valuing the stock in inventory at the mid-point of best prices after 15 minutes, after 30 minutes and after 60 minutes of trade execution, and compare these with the end-of-day realised half-spread and positioning half-spreads. To examine the other two questions, we divide the realised half-spread and the positioning half-spread generated by order book trades into two components: that generated by public investors while supplying liquidity through posting of limit orders, and that generated by public investors while demanding liquidity through market orders.

The results are reported in Table VI for positioning half-spreads and Table VII for realised half-

²³ This could be because market intermediaries arguably have greater proximity to market trading information relative to public investors.

spreads. In both tables, Panel A presents results for trades in which public investors supply liquidity through posting of limit orders, and Panel B presents results for trades in which public investors demand liquidity through the use of market orders. We also calculate the effective half-spread for each trade and the inside half-spread *one second before* the trade. Tables VI and VII also present the average values of the effective half-spread and the inside half-spread for that particular subset of trades.

Table VI Panel A and Table VII Panel A show that public investors who have earned the spread by supplying liquidity through limit orders have effectively faced a significantly negative, but very small, realised half-spread. Public investors supplying liquidity through limit orders earn, on average, 21.4 basis points of effective half-spread but lose, on average, 26.1 basis points in positioning half-spread because of the change in price from the time of the trade up to the end of the day. Market intermediaries who pick these orders pay the effective half-spread involved but still earn 4.7 (26.1–21.4) basis points on average. A significant fraction (17 basis points) of the positioning half-spread is earned by market intermediaries within 15 minutes of the trade. A total of 21.7 basis points are earned within 60 minutes of the trade, and the remaining, a statistically significant 4.4 (26.1–21.7) basis points, is earned over the rest of the day. Thus, market intermediaries do appear to earn a substantial fraction of their positive positioning half-spread in the order book system because they picked off limit orders that became stale within 15 minutes of the trade due to changing market prices.

That said, it is important to note that the overall value-weighted average values are dominated by relatively large trades in excess of £25000. Small trades (up to £25000) involving public investors supplying liquidity through limit orders do lose some of the effective half-spread earned due to adverse post-trade price movements, but, on average, the public investors still

earn a realised half-spread from 8.4 to 14.3 basis points. These limit orders also seem to be the ones that are not imminently stale at the time of the trade (as measured by 15 minute positioning half-spread of market intermediaries as a fraction of the effective half-spread paid by them).

Table VI Panel B and Table VII Panel B show that market intermediaries have, on average, broken even on trades in which they have supplied liquidity to public investors through limit orders²⁴. Public investors demanding liquidity through market orders pay, on average, 21.2 basis points of effective half-spread but earn, on average, 23.5 basis points in positioning half-spread because of the change in price from the time of the trade up to the end of the day. Market intermediaries who supply liquidity earn the effective half-spread involved but still lose 2.3 (21.2-23.5) basis points on average. A significant fraction (14.3 basis points) of the positioning half-spread is lost by market intermediaries within 15 minutes of the trade. A total of 18.3 basis points is lost within 60 minutes of the trade, and the remaining, a statistically significant 5.2 (23.5-18.3) basis points, is lost over the rest of the day. Thus, market intermediaries do appear to lose a substantial fraction of their positioning half-spread in the order book system because public investors picked off limit orders that became stale within 15 minutes of the trade due to changing market prices.

Once again, it is important to note that the overall value-weighted average values are dominated by relatively large trades in excess of £25000. Small trades (up to £25000) involving public investors demanding liquidity through market orders do gain some of the effective half-spread paid due to favourable post-trade price movements but still on average, pay a realised half-spread from 6.2 to 14.7 basis points.

²⁴ If market intermediaries are able to fully hedge the market risk of their inventory positions, their total trading revenues should be about 20 basis points.

Importantly, there is no significant difference in the results and conclusions irrespective of whether it is the public investor or the market intermediary who is demanding or supplying liquidity. In both cases, the overall average realised half-spreads are close to zero. On average, the market participant whose limit order is picked off earns the spread but loses on the post-trade price changes till the end of the day; and the market participant who picks off the limit order pays the spread but earns on the post-trade price changes till the end of the day.

VII. Conclusions

This article examines the effects on public investor trading costs of the market reforms and documents several interesting results. First, we find that the average *duly signed* effective spread of public investors (as a group) has fallen after the market reform much more substantially than the change in the *absolute* effective spread documented for NASDAQ stocks by Barclay et. al. (1999). This is primarily because the public investors in aggregate have supplied liquidity instead of demanding liquidity.

Second, consistent with the change from obligatory to voluntary market-making, dealer positioning revenues generated from holding of inventory, have increased significantly and become positive. As a result, while average signed effective half-spreads faced by public investors have reduced very significantly, the overall gain in terms of the total realised spread is not significantly different than zero.

Third, on average, public investors who supplied liquidity through limit orders earned the spread but lost due to post-trade price movements up to the end of the day; and public investors

who demanded liquidity through market orders paid the spread but benefited from post-trade price changes up to the end of the day. Though most of the positioning half-spread arises within 15 minutes of a trade, a significant fraction arises over the rest of day arguably due to superior information of the participants picking limit orders. The conclusions are very similar irrespective of whether it is public investor or the market intermediary who is supplying liquidity or demanding liquidity.

Fourth, we observe that in the pure dealership market prior to the reform, small trades were paying a higher effective half-spread than large trades consistent with the view that small trades were subsidising large trades prior to the reform. However, after the reform, we find a significant decrease in the average effective half-spread of small *public* trades and an increase in the average effective half-spread of large *public* trades, suggesting elimination of cross-subsidisation across trade sizes.

Fifth, we document negative externalities across almost all trade sizes for stocks not undergoing the reform. These are in the form of wider inside half-spreads during the first hour of trading, higher signed effective half-spreads, higher realised half-spreads and lower price improvement (relative to best quotes).

And finally, we find that, in the absence of the price stabilisation provided by dealers, the inside half-spread after the reform becomes very wide at the open: averaging about three times in magnitude at the open than before the reform. It declines sharply over the first hour of trading, and then steadily until the close. In contrast, the inside half-spread in the quote driven pure dealership system displays no significant intra-day variation. Our results suggest that market participants in the order driven system are reluctant to expose their limit orders

after the market opening while the price uncertainty after a long non-trading interval is being resolved. This result makes a strong case for special opening procedures in order driven markets.

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Table I
Distribution of Trading Volume across Different Trade Sizes

The London Stock Exchange Trading System Reform in 1997 consisted of the introduction of SETS, an electronic order book, interacting with the existing network of competing dealers. This table presents the volume of trading in different trade sizes in three periods in 1994, 1996 and 1998, each of three months duration. Panel A gives the value of shares traded and Panel B the number of trades. Trading volume is reported separately for stocks which underwent trading system reform (SETS stocks), and those which did not (non-SETS stocks). Trade size classifications in London are based on NMS (normal market size) which is approximately 2.5% of the average daily trading volume in the security. During the sample period, the minimum size required for a trade to go through SETS was £4000 or 500 shares whichever is lower. Corresponding proportions of the total trading volume across different trade sizes are given in parentheses.

Panel A: Value of Shares Traded in Million Pounds

Trade size Classification	Non-SETS Stocks			SETS Stocks			
	1994	1996	1998 (Dealers)	1994	1996	1998 (Dealers)	1998 (Order Book)
Trades < £4000	91 (0.8%)	301 (1.6%)	233 (1.2%)	506 (0.9%)	1440 (1.7%)	1042 (1.4%)	43 (0.2%)
£4000-£10000	127 (1.1%)	499 (2.6%)	407 (2.1%)	605 (1.0%)	2364 (2.8%)	1924 (2.6%)	304 (1.6%)
£10000-£25000	197 (1.8%)	470 (2.4%)	558 (2.8%)	710 (1.2%)	2301 (2.8%)	1675 (2.3%)	1271 (6.5%)
£25000-1NMS	733 (6.6%)	852 (4.4%)	671 (3.4%)	12849 (21.9%)	14006 (16.7%)	16510 (22.7%)	15948 (81.9%)
1NMS-3NMS	2485 (22.4%)	2451 (12.6%)	2521 (12.8%)	23202 (39.5%)	18461 (22.1%)	17465 (24.0%)	1817 (9.3%)
3NMS-8NMS	2338 (21.0%)	3069 (15.8%)	2599 (13.2%)	10433 (17.8%)	18661 (22.3%)	13060 (18.0%)	85 (0.5%)
8NMS-25NMS	3448 (31.0%)	7276 (37.5%)	6710 (34.0%)	7965 (13.6%)	21431 (25.6%)	13782 (19.0%)	0 (0.0%)
Trade size > 25NMS	1690 (15.2%)	4490 (23.1%)	6022 (30.5%)	2421 (4.1%)	4991 (6.0%)	7223 (9.9%)	0 (0.0%)
Total	11108	19409	19720	58691	83657	72681	19469

Panel B: Number of Shares Traded in Millions

Trade size Classification	Non-SETS Stocks			SETS Stocks			
	1994	1996	1998 (Dealers)	1994	1996	1998 (Dealers)	1998 (Order Book)
Trades < £4000	56919 (50.4%)	160239 (45.4%)	129102 (43.2%)	321243 (60.8%)	729685 (49.1%)	507001 (46.5%)	21708 (7.1%)
£4000-£10000	19996 (17.7%)	80133 (22.7%)	63666 (21.3%)	96976 (18.3%)	375981 (25.3%)	303923 (27.8%)	42458 (13.9%)
£10000-£25000	8572 (7.6%)	30677 (8.7%)	35193 (11.8%)	38255 (7.2%)	150109 (10.1%)	110084 (10.1%)	77529 (25.4%)
£25000-1NMS	5124 (4.5%)	16521 (4.7%)	14412 (4.8%)	42682 (8.1%)	158475 (10.7%)	131078 (12.0%)	157566 (51.6%)
1NMS-3NMS	10437 (9.2%)	32002 (9.1%)	25891 (8.7%)	18185 (3.4%)	43028 (2.9%)	25769 (2.4%)	5954 (1.9%)
3NMS-8NMS	5084 (4.5%)	13953 (4.0%)	12317 (4.1%)	7193 (1.4%)	18331 (1.2%)	8657 (0.8%)	116 (0.0%)
8NMS-25NMS	5530 (4.9%)	15453 (4.4%)	13899 (4.7%)	3715 (0.7%)	11090 (0.7%)	4511 (0.4%)	0 (0.0%)
Trade size > 25NMS	1325 (1.2%)	4124 (1.2%)	4259 (1.4%)	231 (0.0%)	766 (0.1%)	437 (0.0%)	0 (0.0%)
Total	112987	353102	298738	528480	1487466	1091460	305328

Table II

Inside Half-Spreads around Trading System Reforms

Inside half-spreads are measured as the difference, relative to the mid-price, of the best bid and the best ask price for the quote driven system, and the best limit order on the buy side and the best limit order on the sell side for the order driven system. The inside half-spreads are estimated for each stock at the end of each five-minute interval. This table is based on calculating cross-sectional averages across stocks over different hourly periods. The table reports average inside half-spreads over three periods: 1994 and 1996 before the reform, and 1998 after the reform. These inside half-spreads are reported separately for stocks which underwent trading system reform (SETS stocks), and those which did not (non-SETS stocks). All figures below are in basis points, ie units of 0.01%. The parentheses contain t-statistics (wherever relevant) for hypotheses that the average of the corresponding pair-wise differences is equal to zero. * and ** indicate significance of the t-statistic at the 5% and 1% level respectively.

Time Interval	Non-SETS Stocks					SETS Stocks				
	1994	1996	1998	Difference Between 1994 and1998	Difference Between 1996 and1998	1994	1996	1998	Difference Between 1994 and1998	Difference Between 1996 and1998
08:30-09:30	73.6	62.6	61.5	12.1**	1.1	34.0	27.6	54.1	-20.2**	-26.6**
09:30-10:30	72.4	61.5	56.5	15.9**	5.0	32.6	26.8	28.0	4.6	-1.2**
10:30-11:30	72.0	62.1	56.8	15.2**	5.3	33.3	27.2	23.3	10.0**	3.9
11:30-12:30	71.8	60.5	57.8	14.0**	2.7	32.5	27.4	22.6	9.9**	4.8
12:30-13:30	71.1	59.7	58.5	12.6**	1.3	32.7	27.8	21.5	11.2**	6.3*
13:30-14:30	68.9	57.6	55.7	13.2**	1.8	30.7	25.6	21.1	9.6**	4.5**
14:30-15:30	68.9	58.6	55.6	13.3**	3.0	31.1	25.7	21.0	10.1**	4.8*
15:30-16:30	69.5	58.7	54.0	15.5**	4.7	29.9	25.9	21.5	8.4**	4.4*
All	71.0	60.2	57.0	14.0**	3.2**	32.1	26.7	26.9	5.3	-0.2**
(First hour – Other hours)	2.9**	2.8**	5.1**	-2.2	-2.3*	2.2	1.0	31.4*	-29.3**	-30.5**
Other hours	70.6	59.8	56.4	14.2**	3.4*	31.8	26.6	22.7	9.1**	3.9**

Table III

Signed Effective Half-Spreads around Trading System Reform

For each trade involving a public investor, we calculate effective half-spread as the *duly-signed* difference between the trade price and the mid-point of the best buy quote/limit price and the best sell quote/limit price one second before the trade, expressed as a proportion of the mid-price. The signed effective half-spread is signed from the frame of reference of public investors as distinct from market intermediaries. It is signed positive when the public investor pays the spread and negative when she earns the spread. We sort these trade-by-trade effective half-spreads into 48 cells based on eight different hourly trading intervals within the day and the six different trade size bands indicated below. For each of the 245 sample stocks separately, we calculate the average value-weighted effective half-spread in each of the 48 classifications based on trading interval and trade size. Our final inferences are based on value-weighted averaging of the 11760 average effective half-spreads so calculated and conducting statistical tests on the pair-wise differences from 1994 to 1996 to 1998. All figures below are in basis points, i.e. units of 0.01%. These effective half-spreads are reported separately for stocks that underwent trading system reform (SETS) stocks and those that did not (non-SETS stocks). * and ** indicate significance of the t-statistic at the 5% and 1% level respectively.

Trade Classification	Non-SETS Stocks					SETS Stocks							
	1994	1996	1998	Difference Between 1998 and 1994	Difference Between 1998 and 1996	1994	1996	1998 (Dealers)	1998 (Order Book)	Difference Between 1998 (Dealers) and 1994	Difference Between 1998 (Order Book) and 1994	Difference Between 1998 (Dealers) and 1996	Difference Between 1998 (Order Book) and 1996
Trades < £4000	59.6	46.6	57.9	-1.7**	11.3**	34.7	28.5	-1.1	-45	-35.8**	-79.7**	-29.6**	-73.5**
£4000-£10000	44.5	40.3	54.0	9.5*	13.7**	28.8	24.5	-11.4	-49.7	-40.2**	-78.5**	-35.9**	-74.2**
£10000-£25000	24.3	29.3	47.4	23.1**	18.1**	18.6	17.9	-21.8	-30.5	-40.4**	-49.1**	-39.7**	-48.4**
£25000-1NMS	1.1	2.9	35.4	34.3**	32.5**	3.8	10.1	-11.5	1.1	-15.3	-2.7**	-21.6	-9.0**
1NMS-3NMS	22.9	19.8	29.9	7.0**	10.1**	-0.7	7.6	10.7	-17.5	11.4**	-16.8	3.1**	-25.1
3NMS-8NMS	5	5.9	25.7	20.7**	19.8**	-7	2.4	17	-48.2	24.0**	-41.2	14.6**	-50.6
All	15.3	15.3	33.0	17.6**	17.7**	0.5	7.9	-0.2	-9.8	-0.7	-10.3**	-8.1	-17.7**

Table IV

Positioning Half-Spreads around Trading System Reform

For each trade involving a public investor, we calculate the positioning half-spread as the *duly signed* relative change in mid-price from the time of the trade up to the end of the day. The positioning half-spread is signed from the frame of reference of a "public" investor as distinct from market intermediaries. It is signed positive when the public investor suffers an adverse post-trade price change and negative when the public investor benefits from the post-trade price change. We sort these trade-by-trade positioning half-spreads into 48 cells based on eight different hourly trading intervals within the day and the six different trade size bands defined as indicated below. For each of the 245 sample stocks separately, we calculate the average value-weighted positioning half-spread in each of the 48 classifications based on trading interval and trade size. Our final inferences are based on value-weighted averaging of the 11760 average positioning half-spreads so calculated and conducting statistical tests on the pair-wise differences from 1994 to 1996 to 1998. All figures below are in basis points, i.e. units of 0.01%. These positioning half-spreads are reported separately for stocks that underwent trading system reform (SETS) stocks and those that did not (non-SETS stocks). * and ** indicate significance of the t-statistic at the 5% and 1% level respectively.

Trade Classification	Non-SETS Stocks					SETS Stocks							
	1994	1996	1998	Difference Between 1998 and 1994	Difference Between 1998 and 1996	1994	1996	1998 (Dealers)	1998 (Order Book)	Difference Between 1998 (Dealers) and 1994	Difference Between 1998 (Order Book) and 1994	Difference Between 1998 (Dealers) and 1996	Difference Between 1998 (Order Book) and 1996
Trades < £4000	-4.8	-4.1	-12.0	-7.2**	-7.9**	-2.3	-1.4	20.1	45.7	22.4**	48.0**	21.5**	47.1**
£4000-£10000	-8.0	-5.7	-15.9	-7.9**	-10.2**	-3.7	-1.8	23.2	44.9	26.9**	48.5**	25.0**	46.7**
£10000-£25000	-10.0	-7.6	-21.4	-11.4**	-13.8**	-5.6	-4.0	24.3	23.0	30.0**	28.6**	28.4**	27.0**
£25000-1NMS	-8.8	-8.3	-13.0	-4.2	-4.7	-8.7	-6.1	15.6	1.3	24.3**	9.9	21.7**	7.3
1NMS-3NMS	-12.0	-11.6	-19.8	-7.8**	-8.3**	-11.5	-9.6	-8.1	26.0	3.4	37.5**	1.5	35.6**
3NMS-8NMS	-13.0	-12.1	-16.3	-3.3	-4.2	-10.4	-9.0	-19.8	90.1	-9.4	100.5**	-10.8	99.1**
All	-11.5	-10.5	-17.5	-5.9	-7.0	-9.9	-7.9	2.9	11.0	12.9**	21.0**	10.8**	18.9**

Table V

Realised Half-Spreads around Trading System Reform

For each trade involving a public investor, we calculate the realised half-spread as the *duly signed* difference between the transaction price and the mid-price at the end of the day, relative to the mid-price at the time of the trade. The realised half-spread is signed from the frame of reference of a public investor as distinct from market intermediaries. It is signed positive when the public investor pays the spread and negative when she earns the spread. We sort these trade-by-trade realised half-spreads into 48 cells based on eight different hourly trading intervals within the day and the six different trade size bands defined as indicated below. For each of the 245 sample stock separately, we calculate the average value-weighted realised half-spread in each of the 48 classifications based on trading interval and trade size. Our final inferences are based on value-weighted averaging of the 11760 average realised half-spreads so calculated and conducting statistical tests on the pair-wise differences from 1994 to 1996 to 1998. All figures below are in basis points, i.e. units of 0.01%. These realised half-spreads are reported separately for stocks that underwent trading system reform (SETS) stocks and those that did not (non-SETS stocks). * and ** indicate significance of the t-statistic at the 5% and 1% level respectively.

Non-SETS Stocks						SETS Stocks							
Trade Classification	1994	1996	1998	Difference Between 1998 and 1994	Difference Between 1998 and 1996	1994	1996	1998 (Dealers)	1998 (Order Book)	Difference Between 1998 (Dealers) and 1994	Difference Between 1998 (Order Book) and 1994	Difference Between 1998 (Dealers) and 1996	Difference Between 1998 (Order Book) and 1996
Trades < £4000	54.8	42.5	46.0	-8.7**	3.6*	32.4	27.1	19.0	0.7	-13.4**	-31.6**	-8.1**	-26.4**
£4000-£10000	36.6	34.7	38.2	1.7	3.6*	25.2	22.7	11.8	-4.9	-13.4**	-30.0**	-10.9**	-27.5**
£10000-£25000	14.2	21.8	26.0	11.8**	4.2	13.0	13.8	2.5	-7.6	-10.5**	-20.6**	-11.3**	-21.5**
£25000-1NMS	-7.7	-5.4	22.4	30.1**	27.9**	-4.8	4.0	4.1	2.3	8.9**	7.1*	0.1	-1.7
1NMS-3NMS	10.8	8.2	10.1	-0.7*	1.9**	-12.2	-2.0	2.6	8.4	14.8**	20.6**	4.6	10.4
3NMS-8NMS	-8.1	-6.3	9.4	17.5**	15.7**	-17.4	-6.6	-2.8	41.8	14.6**	59.3**	3.8	48.5**
All	3.7	4.8	15.5	11.8**	10.8**	-9.4	0.0	2.7	1.2	12.1	10.6	2.7	1.2

Table VI Panel A

Positioning Half-Spread Over Different Post-Trade Intervals when Public Investors Supply Liquidity to Market Intermediaries through Limit Orders

For each trade in which an individual or institutional public investor supplies liquidity through a limit order, we calculate the positioning half-spread as the *duly signed* relative change in mid-price from the time of the trade up to a reference time after the trade. In this table, the reference time corresponds to post-trade intervals of 15 minutes, 30 minutes, 60 minutes and the end of the day. The effective half-spread is calculated as the *duly-signed* difference between the trade price and the mid-price one second before the trade, expressed as a proportion of the mid-price. Both the positioning half-spread and the effective half-spread are signed from the frame of reference of a public investor as distinct from market intermediaries. The positioning half-spread is signed positive when the public investor suffers an adverse post-trade price change and negative when the public investor benefits from the post-trade price change. The effective half-spread is signed positive when the public investor pays the spread and negative when she earns the spread. The inside half-spread is calculated as the difference between the best bid-ask quotes/limit prices one second before the trade, expressed as a proportion of the mid-price. All figures below are in basis points, i.e. units of 0.01%. * and ** indicate significance of the t-statistic at the 5% and 1% level respectively.

Trade Classification	Average Effective Half-Spread	Average Inside Half-Spread at time of trade	Positioning Half-Spread For Different Post-Trade Intervals						
			Time of trade t to (t+15 min)	Time of trade t To (t+30 min)	Time of trade t to (t+60 min)	Time of trade t to end of day	(t+15min) to End of day	(t+30min) to end of day	(t+60min) to end of day
Trades<£4000	-30.1	27.7	15.3**	14.4**	18.4**	21.7**	-6.4*	-7.2*	-3.3*
£4000-£10000	-26.7	25.5	13.5**	14.1**	13.8**	15.6**	-2	-1.5	-1.8
£10000-£25000	-24.3	23.2	11.7**	12.4**	13.6**	10.0**	1.7	2.4	3.6
£25000-1NMS	-20.6	19.5	17.0**	19.0**	21.3**	24.6**	-7.6**	-5.6**	-3.4**
1NMS-3NMS	-24.1	20.9	19.3**	30.1**	29.4**	48.1**	-28.8**	-18.0**	-18.7**
3NMS-8NMS	-41.3	28.5	53.6**	62.5**	95.1**	144.7**	-91.0**	-82.1**	-49.6**
All	-21.4	20.0	17.0**	19.7**	21.7**	26.1**	-9.2**	-6.5**	-4.5**

Table VI Panel B

Positioning Half-Spread Over Different Post-Trade Intervals when Public Investors Demand Liquidity from Market Intermediaries through Market Orders

For each trade in which an individual or institutional public investor demands liquidity through a market order, we calculate the positioning half-spread as the *duly signed* relative change in mid-price from the time of the trade up to a reference time after the trade. In this table, the reference time corresponds to post-trade intervals of 15 minutes, 30 minutes, 60 minutes and the end of the day. The effective half-spread is calculated as the *duly-signed* difference between the trade price and the mid-price one second before the trade, expressed as a proportion of the mid-price. Both the positioning half-spread and the effective half-spread are signed from the frame of reference of a public investor as distinct from market intermediaries. The positioning half-spread is signed positive when the public investor suffers an adverse post-trade price change and negative when the public investor benefits from the post-trade price change. The effective half-spread is signed positive when the public investor pays the spread and negative when she earns the spread. The inside half-spread is calculated as the difference between the best bid-ask quotes/limit prices one second before the trade, expressed as a proportion of the mid-price. All figures below are in basis points, i.e. units of 0.01%. * and ** indicate significance of the t-statistic at the 5% and 1% level respectively.

Trade Classification	Average Effective Half-Spread	Average Inside Half-Spread at time of trade	Positioning Half-Spread For Different Post-Trade Intervals						
			Time of trade t to (t+15 min)	Time of trade t to (t+30 min)	Time of trade t to (t+60 min)	Time of trade t to end of day	(t+15min) to end of day	(t+30min) to end of day	(t+60min) to end of day
Trades<£4000	22	20.4	-8.2**	-8.7**	-5.4*	-7.3*	-0.9	-1.4	2.0
£4000-£10000	19.5	18.9	-9.0**	-9.7**	-12.1**	-10.1*	1.1	0.4	-2.0
£10000-£25000	19.9	18.7	-10.6**	-12.1**	-11.7**	-13.7**	3.1**	1.6**	2.0**
£25000-1NMS	21.1	19.3	-14.5**	-15.4**	-18.2**	-23.1**	8.7**	7.7*	4.9*
1NMS-3NMS	23.9	21.2	-16.9**	-25.2**	-24.9**	-34.7**	17.8**	9.5**	9.8**
3NMS-8NMS	14.1	14.1	-9.3**	-26.6**	-16.5**	-72.3**	62.9	45.7	55.7
All	21.2	19.5	-14.3**	-16.1**	-18.3**	-23.5**	9.2**	7.5**	5.2**

Table VII Panel A

Realised Half-Spread Over Different Post-Trade Intervals when Public Investors Supply Liquidity to Market Intermediaries through Limit Orders

For each trade in which an individual or institutional public investor supplies liquidity through a limit order, we calculate the realised half-spread as the *duly signed* difference between the transaction price and the mid-price at a reference time after the trade, relative to the mid-price at the time of the trade. In this table, the reference time corresponds to post-trade intervals of 15 minutes, 30 minutes, 60 minutes and the end of the day. The realised half-spread is signed from the frame of reference of a public investor as distinct from market intermediaries. The effective half-spread is calculated as the *duly-signed* difference between the trade price and the mid-price one second before the trade, expressed as a proportion of the mid-price. Both the realised half-spread and the effective half-spread are signed positive when the public investor pays the spread and negative when she earns the spread. The inside half-spread is calculated as the difference between the best bid-ask quotes/limit prices one second before the trade, expressed as a proportion of the mid-price. All figures below are in basis points, i.e. units of 0.01%. * and ** indicate significance of the t-statistic at the 5% and 1% level respectively.

Trade Classification	Average Effective Half-Spread	Average Inside Half-Spread at time of trade	Realised Half-Spread For Different Post-Trade Intervals						
			Time of trade t to (t+15 min)	Time of trade t to (t+30 min)	Time of trade t to (t+60 min)	Time of trade t To end of day	(t+15min) to end of day	(t+30min) to end of day	(t+60min) to end of day
Trades<£4000	-30.1	27.7	-14.8**	-15.7**	-11.7**	-8.4*	-6.4	-7.2	-3.3*
£4000-£10000	-26.7	25.5	-13.2**	-12.6**	-12.9**	-11.1**	-2.0	-1.5	-1.8
£10000-£25000	-24.3	23.2	-12.6**	-11.9**	-10.7**	-14.3**	1.7	2.4	3.6
£25000-1NMS	-20.6	19.5	-3.6**	-1.6	0.6	4.0	-7.6	-5.6	-3.4**
1NMS-3NMS	-24.1	20.9	-4.8**	6.0	5.3*	24.0**	-28.8	-18.0	-18.7**
3NMS-8NMS	-41.3	28.5	12.3**	21.2**	53.8**	103.4**	-91.0	-82.1	-49.6**
All	-21.4	20.0	-4.4**	-1.7**	0.3**	4.7**	-9.2	-6.5	-4.5**

Table VII Panel B

Realised Half-Spread Over Different Post-Trade Intervals when Public Investors Demand Liquidity to Market Intermediaries through Market Orders

For each trade in which an individual or institutional public investor demands liquidity through a market order, we calculate the realised half-spread as the *duly signed* difference between the transaction price and the mid-price at a reference time after the trade, relative to the mid-price at the time of the trade. In this table, the reference time corresponds to post-trade intervals of 15 minutes, 30 minutes, 60 minutes and the end of the day. The realised half-spread is signed from the frame of reference of a public investor as distinct from market intermediaries. The effective half-spread is calculated as the *duly-signed* difference between the trade price and the mid-price one second before the trade, expressed as a proportion of the mid-price. Both the realised half-spread and the effective half-spread are signed positive when the public investor pays the spread and negative when she earns the spread. The inside half-spread is calculated as the difference between the best bid-ask quotes/limit prices one second before the trade, expressed as a proportion of the mid-price. All figures below are in basis points, i.e. units of 0.01%. * and ** indicate significance of the t-statistic at the 5% and 1% level respectively.

Trade Classification	Average Effective Half-Spread	Average Inside Half-Spread at time of trade	Realised Half-Spread For Different Post-Trade Intervals						
			Time of trade t to (t+15 min)	Time of trade t to (t+30 min)	Time of trade t to (t+60 min)	Time of trade t To end of day	(t+15min) to end of day	(t+30min) to end of day	(t+60min) to end of day
Trades<£4000	22	20.4	13.8**	13.3**	16.7	14.7	-0.9	-1.4	2.0
£4000-£10000	19.5	18.9	10.5**	9.8**	7.4**	9.4	1.1	0.4	-2.0
£10000-£25000	19.9	18.7	9.3**	7.8**	8.2**	6.2**	3.1**	1.6**	2.0**
£25000-1NMS	21.1	19.3	6.6**	5.7*	2.9*	-2.0	8.7**	7.7*	4.9*
1NMS-3NMS	23.9	21.2	7.0**	-1.3	-1.0	-10.8*	17.8**	9.5**	9.8**
3NMS-8NMS	14.1	14.1	4.8*	-12.4**	-2.4**	-58.1**	62.9	45.7	55.7
All	21.2	19.5	6.9**	5.2**	3.0**	-2.3**	9.2**	7.5**	5.2**

Figure 1.

Inside Half Spread for SETS Stocks

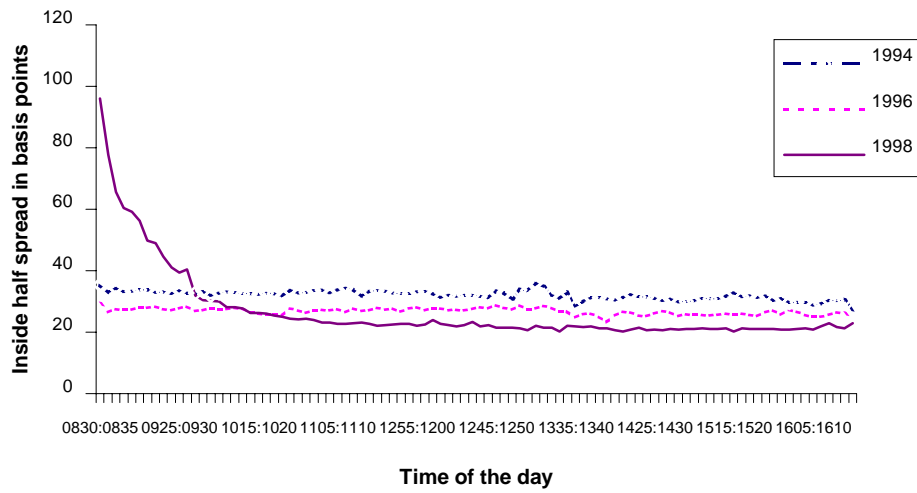


Figure 2.

Inside Half Spread for Non-SETS Stocks

