

The Competitiveness of the London Market: A Study of Trading Behavior of Market Makers

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Abstract

This study examines trading activities of market makers for 25 FTSE-100 component stocks to assess the competitiveness of the London Stock Exchange (LSE). The results show that market makers can obtain relatively large shares of public order flows through posting competitive prices with significant quote depths. Market share leaders do not rely on preferenced trading in securing public order flow on the London market because preference trading is limited to small-sized trades. Trading profitability of LSE market makers is not driven by their market share; rather they are rewarded with higher spread margins for assuming trading risks. The overall findings from the study indicate that the LSE is a competitive dealership market.

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1. Introduction

The quality of dealership markets largely depends on whether market makers really compete for investors' order flow by quoting competitive prices at which they are willing to buy (at bid price) and sell (at ask price). A competitive dealership market will drive the bid-ask spread to the level of marginal cost of market making. The competitiveness of dealership markets, however, has been a widely debated issue in recent years. For instance, although the number of market makers for the actively traded stocks often reaches 30 to 60, market makers' quoting processes exhibit imperfect competition on the Nasdaq market [Christie, Harris, and Schultz (1994), Christie and Schultz (1994), and Huang and Stoll (1996)].¹

The quality of trading execution on the London Stock Exchange (LSE) market has been carefully examined by two major studies by Hanson, Naik, and Viswanathan (HNV) (1998, 1999). In the first paper, HNV compile evidence that: (i) a significant relation is observed between inventory changes and quote changes; and (ii) market makers posting competitive quotes execute a large proportion of the public order flow, which is also supported by Lai (1999 and 2001). In the second paper, HNV report that: (i) preferenced orders amount to as much as 71% of total trade; but (ii) preferenced order flow does not necessarily make market makers' trading profitable. HNV conclude that their findings are inconsistent with either the "collusion" hypothesis or the "quote-are-free-option" hypothesis but provide support to the hypothesis that there are costs of negotiating quotes and that customers have trading relationships with market makers.

¹ With the implementation of the Securities and Exchange Commission (SEC) order handling reforms between January and April 1997, Barclay, Christie, Harris, Kandel, and Schultz (1999), Weston (2000), and Chung and Van Ness (2001) report that transaction costs on the Nasdaq market declined substantially. These findings attest to a less-than-perfectly competitive environment prior to the 1997 SEC order handling reforms, including: limit order display rule; display of electronic communication network quotes; reduction in the minimum quote size; and relaxation of the excess spread rule.

HNV's overall findings from the two studies raise at least two interesting questions. First, with trading activities dominated by preferred trades, how can a close link exist between inventory changes and quote changes?² As suggested by Reiss and Werner (1998), when a substantial fraction of customer order flow is preferred, market makers cannot move their bid-ask quotes to attract public order flow. Hence, Reiss and Werner (1998 and 1999) investigate the role of interdealer trades in managing market makers' extreme inventories and the impact of adverse selection on their choice of interdealer trading system. With their focus on interdealer trading, however, Reiss and Werner's analyses do not address the relation between inventory changes and quote changes. They rather focus on the relation between unanticipated extreme inventory changes and interdealer trades.

The second question is why London market makers do not capitalize on preferred trades for their profitability. This question leads to more questions on London market makers. For example, are preferred trades applicable to all market makers regardless of their market shares? Another related question is "are preferred trades prevailing in all categories of trades regardless of their trade sizes?" The London market is an institutional market that distinguishes itself from the retail-oriented Nasdaq market. Given the drastic difference between the two markets, the usual definition of preferred trades in reflection of dominantly small-sized trades on the Nasdaq market may not be so relevant to the London market dominated by large-sized trades as one perceives.

Consequently, we propose a new definition of preferred trades that reflect London's idiosyncratic feature of a wholesale market. In addition to the usual requirement that dealers' quotes are not on the inside, our definition imposes a second requirement that the trade size is not greater than quote size. In London, market makers are required to match the best quotes for orders that do not exceed the quote size. For orders greater than the quote size, however,

² With internalized trades included, about 88 percent of public orders may be impeded from competition of market makers [HNV (1999)].

no such rule is imposed and the prices can be negotiated freely.³ Therefore, it is quite possible that: (i) the large size orders tend to be non-preferenced; and (ii) quote depths represent a critically important consideration for traders. More importantly, the large trades with the size greater than quote depths tend to be misclassified as preferenced in the London market if the traditional definition of preferenced trades by Stoll (1996), Godek (1996), and HNV (1999) is applied. By imposing the second classification criterion, we can minimize this misclassification problem. Our definition of preferenced trades is built on two criteria covering both price and quantity as opposed to the traditional definition based on a single criterion of price only. In this study, we also presents the results based on the traditional definition to ascertain that our findings are robust regardless of how preferenced trades are defined.

Assessing the competitiveness of any market is a broad, open-ended question that involves multiple facets of market characteristics. Hence, without a specific focus, it is a difficult empirical question to address. This paper's approach is unique in that it focuses on the relation between market share of London market makers and their trading behavior from the viewpoint of market competitiveness. Market share of individual market makers is the focal point of this paper such that if the London dealership market is competitive, then: (i) the competition in both price quotes and quote depths among market makers should be important determinants of the market shares of market makers; (ii) preferenced trades should not be a major factor in determining the market share of market makers; and (iii) the profitability of LSE market makers should be driven by not monopoly power but risk-taking.

Our overall findings indicate that the LSE is a competitive dealership market with the following characteristics:

³ Huang and Stoll (2001) suggest the importance of negotiations among dealers in the London market. They report that market makers set wider quotes and larger depths but negotiate trades for smaller quantities and smaller spreads. As a result, trade clustering is less than quote clustering in London.

- Market makers obtain a relatively large share of public order flows by posting competitive prices with great quote depths, which suggests both price and quantity dimensions are important.
- Market share leaders do not rely on preferenced trading in securing public order flow because preferenced activities are largely limited to small-sized trades. Even if the traditional definition of preferenced trades is used for empirical analyses, preferenced trading is not the critical factor differentiating market share leaders and followers.
- A higher profitability enjoyed by market share leaders is attributed to not monopoly power but risk-taking.

The remainder of the paper is organized as follows. Section II introduces theories, past evidence, and three hypotheses to be tested in examining the market competitiveness. Section III discusses the background and data on London market makers. Section IV presents empirical findings. Section V concludes the paper.

2. Theories, Past Evidence, and Testable Hypotheses

2.1 Hypothesis on the Relationship between Market Share and Quoted Prices and Quantities

The relation between market share and competitive quotes has been extensively studied. For example, the theoretical models of dealership markets developed by Ho and Stoll (1983) and Kandel and Marx (1997, 1999) are built on the assumption that the market maker improving quotes earns all of the non-preferenced public order flow. The inventory model developed by Ho and Stoll (1983) assumes that market makers control their inventories through the adjustment of their quotes. They predict that the distribution of inventories is strongly related to the quote placement behavior of market makers. This prediction is supported by HNV (1998) and Lai (2001). However, Christie and Schultz (1994), Christie, et al. (1994),

Huang and Stoll (1996), and HNV (1999) question the competitiveness of dealership markets based on their observations of either the Nasdaq or the LSE market.⁴

Using individual market makers' quoting behavior on the London market, we focus on the relation between market share and competitive quotes. One unique aspect of this study is the explicit consideration of quote-depths (quantity) in addition to traditional bid and ask quotes (price) considering the well-known fact that London market makers infrequently adjust their price quotes.⁵ Competing in depths does not necessarily mean that quoted depths are revised frequently as long as the quoted depths are relatively large. Hence, a quote can be very competitive in depth without making frequent revisions. In a retail market like Nasdaq, a good competition strategy for market makers would be to quote better prices for smaller quantities. However, in an institutional market like LSE, a good competition strategy for market makers would be to accommodate large trades that from institutional investors. Thus, the first hypothesis states:

H1: A market maker gains market share of trading through both competitive price quotes and quote depths.

2.2 Hypothesis on the Relation between Market Share and Preferred Trades

The adverse impact of preferred trades on the execution quality of stock trading in dealership markets has received considerable attention. Battalio and Holden (1996), Dutta and Madhavan (1997), Kandel and Marx (1999) indicate that preferred and internalized arrangements have negative consequences for the quality of execution in a dealership market; market makers do not possess the incentives to improve the best quotes because it does not

⁴ With public limit orders competing with Nasdaq market makers since January 1997, Weston (2000) reports a net reduction in the average number of market makers, which indicates reduced market-maker rents and improved competition among dealers. Likewise, similar market reforms in London implemented in October 1997 caused a substantial decline in trading costs [Naik and Yadav (1999) and Taylor, van Dijk, Franses, and Lucas (2000)].

⁵ Although academic literature had paid limited amount of attention to quote depths when compared with price quotes, practitioners have long recognized quote depths as a decision-making tool of market makers [Mann and Seijas (1991), Lee, Mucklow, and Ready (1993), and Jennings (1994)]. A recent study by Bacidore, Battalio, and Jennings (2002) demonstrate that price improvement can be misleading if quoted depths are overlooked.

necessarily guarantee the execution of incoming orders, which, in turn, leads to inferior execution [Christie and Schultz (1994), Christie, et al. (1994), Huang and Stoll (1996), Barclay (1997), Bessembinder and Kaufman (1997)]. As a result, preferencing and internalization have recently come under considerable regulatory scrutiny. For the LSE market, HNV (1999) report preferred trades pay higher spreads but they do not generate higher profits for market makers. Hence, they rely on the “costly search and trading relationship” hypothesis to explain this observation rather than the collusive behavior among market makers.

Two unique features of the LSE should be noted. First, the competition of quoted prices among market makers is severely limited as indicated by infrequent revision of quoted prices by market makers. Quoted prices do not vary frequently among market makers within a given stock [Lai (2001) and Board, Sutcliffe, and Vila (2000)]. Instead, the variations in quoted depths are large, which indicates a significant role of the quantity quoted by market makers and further that London market makers compete for the public order flows based on both price and quantity quotes. Second, unlike the Nasdaq market, preferred trading activities are largely confined to small-sized trades as illustrated in the latter part of this paper.

In reflection of the above features of the London market, we highlight the relation between market share and preferred trading using a new definition of preferred trades based on two criteria covering both *price* and *depth* as opposed to the single criterion of *price*. The traditional definition based on “price” only may be adequate for the retail-dominated Nasdaq market, but we believe that the two-criteria based definition is more relevant to the institution-dominated London market. With both price and quantity explicitly recognized, preferred trades play an insignificant role in differentiating market leaders from market followers. Hence, it leads to the second hypothesis on the relation between market share and preferred trades:

H2: Preferred trades should not be a major factor in determining market share of trading if the LSE market is competitive.

2.3 Hypothesis on the Role of Monopoly in the Relation between Market Share and Trading Profitability

The sources of trading profits earned by LSE market makers and their impact on market shares are the main focus of third hypothesis. Glosten (1989) suggests that a monopolistic specialist acts strategically to maximize his profit. Empirical evidence is somewhat ambiguous. Hasbrouck and Sofianos (1993) find that NYSE specialists are good short-term traders but undistinguished long-term speculators. However, Neuberger and Hansch (1996) observe that London market makers do trade strategically by combining gainful and money-losing trades. HNV (1999) report that London market makers make money on small trades, break-even on large trades, but lose money on medium-sized trades. They further report that preferenced trades do not entail profits for market makers.

In order to gain a better understanding of profit pictures for London market makers, we compare trading profits among three groups of market makers: the group with largest market share, the group with smallest market share, and the middle group. For example, if the group with the largest market makers exercises monopoly power, one would expect that the leading market makers earn profits across all trades of differing sizes since monopoly power would not be exercised in a discriminatory manner. If, on the other hand, the leading market makers earn profits only from large-sized trades, then their profitability must be explained by something else. Deducting from this logic, we propose the compensation for risk-taking by market makers as a possible explanation since large-sized trades are riskier than small-sized trades. Based on their analysis of interdealer trades, Reiss and Werner (1998) observe that market makers are rewarded by greater revenues for taking greater inventory risks. Their finding is useful for our understanding of the institutional nature of the London market. Hence, we propose the third hypothesis on the relation between market share and trading profitability:

H3: *If the London market is a competitive dealership market, market share leaders should earn relatively higher profitability by taking high trading risk.*

3. Background and Data Description on LSE Market Makers

3.1 Data Description

Since 1986, the LSE operated as a dealership market and permitted LSE members to register as market makers in any stock. They are obliged to post two-way quotes on the Stock Exchange Automated Quotation (SEAQ) systems, which are available to all LSE members. The SEAQ screen specifies the market maker's name and his posted quotes and quantities for which his quotes are firm. The minimum size that the market maker can quote is the normal market size (NMS). Although the NMS varies from stock to stock, it corresponds roughly to 2.5% of average daily volume for a given stock. Any market maker regardless of his current posted quotes and quantities can execute public orders; however, the market maker must at least match the best quotes on the SEAQ screen when executing (best execution). If the order is larger than the quoted size, no such rule applies and price can be negotiated freely between the market maker and investors. Similar to the Nasdaq market, arrangements by brokers sending order flows to any market maker are legal.

Any LSE member who does not register as a market maker can also act as a broker-dealer. As a broker-dealer, he is free to trade either on behalf of clients or on his own account. Although there is no requirement for him to deal through market makers, in practice, he usually does. Traders are also free to deal off-exchange. Although detailed statistical information is unavailable, off-exchange trading is generally believed to be rare on the London market. Market makers can trade with each other directly or through the intermediation of an inter-dealer broker (IDB); though, only market makers can deal through the IDB. Actually, the IDB system is comparable to a central limit order book, providing anonymous electronic matching services similar to the Electronic Communication Network system on the Nasdaq market. Market makers can submit the orders, indicating quantities and prices to the IDB. The bid and

offer published on the IDB screen are available only to market makers. The trading is anonymous.⁶

The LSE databases used in this study are the same as those used by HNV (1999), but for a different period, between March 1995 and May 1995, with the exception of broker codes.⁷ Since every transaction and quote by all market makers appear in the data, we can examine actual trading behavior of individual market makers for a given stock. Specifically, information provided by the data affords us to calculate the market share of trading for every market maker, to classify quotes into the competitive quotes and non-competitive quotes, and to distinguish the preferenced trades from non-preferenced trades. The information further allows us to build the inventory position series and calculate the trading profit margins for every market maker in the sample stocks. For this study, 25 FTSE-100 component stocks are randomly selected. The final list of 25 stocks is presented in Table 1 with SEAQ stock codes specified.

[Insert Table 1]

Table 2 provides descriptive statistics of the 25 FTSE-100 stocks in the sample during the three-month study period covering 61 trading days. The average number of market makers for a given stock amounts to 17. This number is much smaller than 30 to 60 recorded for actively traded stocks on the Nasdaq market. An average of 7,035 quote revisions accrued for a given stock, which is equivalent to seven daily quote revisions per market maker. In other words, a typical LSE market maker will hold his quotation for over one hour before making the next move. Quite a contrast to the high frequency of quotes revisions on the Nasdaq market where actively traded stocks experience average daily quote revisions of more than 70. The LSE trading is also much less active than the Nasdaq market. The 21,046 trades recorded by 17 market makers for a period of 61 trading days is equivalent to only about 20 trades per

⁶ For greater details of IDB markets, please refer to Reiss and Werner (1998).

⁷ In the absence of broker codes, we are unable to sort the reported trades into internalized and non-internalized types.

market maker per trading day. However, LSE's average trade size of over 15,000 shares is large for the Nasdaq standard.

[Insert Table 2]

Additional details on market makers' quoting behavior are reported in Table 3. Bid-ask spreads quoted by London market makers do not change often throughout a trading day, which implies that the market makers are slow in updating their quotes during trading time. Similar results are also reported by HNV (1998) and Lai (2001).

On the LSE market, the inside spread is about one-half of the quoted spread (2.86 vs. 5.69), suggesting that market makers usually post competitive quotes only at one side. Though market makers infrequently change their quotes, they are willing to accept large public orders. The time-weighted average quote depth exceeds 76,000 shares, a significant number as compared to the average quote size on the Nasdaq market. This sizable quote depth reflects the characteristic of the London market as an institutional market; and it may serve as an effective tool for market makers competing for the public order flow, which will be examined in greater details.

[Insert Table 3]

Table 4 documents the characteristics of trades executed by market makers. As summarized in the first five columns, approximately 80 percent of actual trades belong to the categories under 10,000 shares. However, over 92 percent of trading volume belongs to the category of 10,000 shares or more as shown in the last five columns. This unique feature of LSE trades will certainly influence the market making process as elaborated in the later sections.⁸

[Insert Table 4]

⁸ De Jong, Nijman, and Röell (1995) and Degryse (1999) demonstrate the success of the LSE market in capturing wholesale trade based on French and Belgian stocks, respectively.

Table 5 presents summary statistics for five key variables computed for market makers in each of the 25 sample stocks. The five variables include: (i) market share of trading; (ii) time-length of competitive quotes; (iii) quote depths; (iv) preferenced trades; and (v) trading profitability. In addition to mean, minimum, maximum, and standard deviation, we also report combined statistics for three market makers with the largest market shares of trades (to be referred to as Top 3 market makers) and the remaining market makers (referred to as REST).⁹

3.2 Key Measurement Variables

Market Share of Trading: Panel A of Table 5 reports summary statistics for the market share of trading.¹⁰ Clearly, the trading volume is unevenly distributed across market makers for the 25 sample stocks. For example, the average market share of trading in B.A.T. Industries (BA) 5.88 percent with a total of 17 market makers registered (as shown in Table 2). The market maker with the largest market share executes about 26 percent of the total traded volume. On the contrary, the market maker with the least market share only accounts for less than 0.25 percent. The trading activity, as depicted on the table, is heavily concentrated on only a few market makers on the LSE. For BA, Top 3 market makers execute 49 percent of total turnover, while the remaining 51 percent is left with 14 market makers. Similar patterns exist across all sample stocks.

Time-Length of Competitive Quotes: We consider a quote “competitive” if it remains either at the inside ask price or the inside bid price. Since market makers on the LSE infrequently revise their quotes, a quote remains competitive for only part of its effective time. For this reason, we

⁹ The selection of Top 3 market makers is arbitrary. We have also performed analysis by creating two groups (Top 4 market makers vs. the remaining market makers as well as Top 5 market makers vs. the remaining makers) to find that our conclusions remain unchanged.

¹⁰ Market maker j 's market share (MS_{js}) of trading in stock s is defined as:

$$MS_{js} = (BV_{js} + SV_{js}) / \sum_{j=1}^N (BV_{js} + SV_{js}),$$

where, BV_{js} and SV_{js} are market maker j 's total buying and selling volume over the entire sample period, respectively; and N is the number of market makers in stock s .

calculate the length of time market maker's quotations remain competitive.¹¹ Panel B of Table 5 presents summary statistics for the time-length of competitive quotes. The mean time-length is 43 percent, indicating that market makers generally post their competitive quotes less than 50 percent of time. Different market makers exhibit large differences in their competitiveness of quotes. The time-length for the most competitive market maker exceeds 80 percent (see BTA, GAS, RR, and WLY), while the least competitive market makers record less than one-third of 1 percent (see GLAXO). The difference in the relative time-lengths reported for Top 3 market makers and the remaining market makers is substantial: Top 3 market makers consistently post more competitive quotes than the remaining market makers (57 vs. 43 percent).

Quote Depths: In order to properly measure quote competitiveness of individual market makers, we also focus on quote depths. Our motivation is simple and straightforward because London market makers compete on both price and quantity. As illustrated in the latter part of this study, London market makers with larger market shares of trading do post better prices and larger quote depths. Thus, we compute the time-weighted average of quote depth for each market maker over the entire sample period. As presented in Panel C of Table 5, a typical market maker is willing to accept public orders with at least 76,000 shares at his quoted prices. Given the average price of £5 recorded for the sample stocks, this depth is equivalent to over £380,000, which is a strong indication of the institutional feature of the London market. Top 3 market makers are willing to accommodate an incoming order as large as over 86,000 shares, which is 20 percent greater than the size of the remaining market makers. Greater quote depths observed for Top 3 market makers also imply higher trading risks due to potential inventory imbalance and adverse selection. In contrast, in a retail market like Nasdaq, a good competition strategy for market makers would be to quote better prices for smaller quantities.

[Insert Table 5]

¹¹ The relative time-length of quotes remaining competitive is defined as: $CQ_{js} = INT_{js} / T_{js}$, where, INT_{js} denotes the time market maker j 's quotes remain competitive for stock s and T_{js} denotes market maker j 's total quoting time. Thus, CQ_{js} serves as a direct measure of a market maker's competitiveness.

Preferred Trading: Preferred trading activities are measured with the ratio of the number of preferred trading shares to the total volume executed by a market maker. We impose the following two criteria to identify preferred trades for a market maker: (i) the price quote is not located on the inside; and (ii) the trade size is not greater than quote size. The latter condition is introduced in view of the nature of the LSE market dominated by institutional investors and large-sized trades. With this new definition of preferred trades introduced, we uncover that preferred activities are largely confined to small-sized trades. As a result, preferred trades cannot distinguish between market leaders and followers. As far as we understand, this study is the first one to recognize the importance of the quantity dimension of a market maker's quote in the London market.

Summary statistics for the relative preferred trading activity are reported in Panel D of Table 5.¹² On average, 33 percent of total trading volume is preferred to specific market makers. Preferred trading volume contributes 20 percent and 36 percent of total trading volume of Top 3 market makers and the remaining market makers, respectively. This finding is interesting because it implies that LSE market makers with larger market shares do not necessarily depend on the preferencing arrangements to gain their market shares of trading. For the purpose of comparison and for the robustness check of our results later, we also report, in the last row, the size of preferred trades relative to total volume when the traditional definition of preferred trades is used. Note that the percentage of preferred trading under the traditional definition amounts to 56% for the 25 sample stocks. Preferred trades dealt by Top 3 market makers and the remaining market makers are 60% and 65% of the respective total volume. Without the second requirement on quote depth imposed in our definition, the

¹² The relative size of preferred trading activities (PT_{js}) for market maker j in stock s is defined as:

$$PT_{js} = PV_{js}/TV_{js},$$

where PV_{js} and TV_{js} denote preferred trading volume and total trading volume of market maker j in stock s over the entire sample period.

traditional definition tends to overstate the magnitude of preferenced trades relative to total trades, especially for large size trades as shown at the bottom of Panel D.¹³ Even with the use of the traditional definition, this paper's findings still hold as illustrated later---concentrated market-making activities among market share leaders are not attributed to preferenced arrangements.

Trading Profitability: To measure the trading profitability of a market maker, we calculate total profit margin, spread margin, and position margin following the definitions introduced by Neuberger (1992), Sofianos (1995), and, more recently, HNV (1999). Panel E of Table 5 reports summary statistics for three profit measures. Overall trading profitability dramatically differs across market makers. On average, market makers suffer from losses from market making with an average margin of 13 basis points. Top 3 market makers, however, earn small profits, while the remaining market makers lose money in the magnitude of 16 basis points. Since the profit margin is the sum of the spread margin and the position margin, Panel E also presents summary statistics on both types as summarized in Sections 2 and 3. London market makers generally earn positive spread margins but negative position margins with means of 9 and -22 base points, respectively. Negative overall positioning revenues on the LSE and NYSE markets are attributed to the requirement of obligatory market-making as documented by HNV (1998) and Sofianos (1995), respectively. Naik and Yadav (1999) find a significant increase in the "positioning revenue" after the London market reforms were implemented in October 1997. Under these market reforms, London market makers are no longer obliged to quote firm two-way prices unlike Nasdaq counterparts.

¹³ To confirm our prediction, we have decomposed the trading volume of large size category with 10,000 shares or more into two components depending on whether the trade volume is less than or greater than quoted depth. The results indeed confirm that large trades with the size greater than quoted depths are more likely classified into preferenced trades. We find that: 55% of large size trades with 10,000 shares or more but with trade size less than quoted depth are preferenced, while 65% of large size trade with 10,000 shares or more but trade size greater than quoted depth are preferenced.

The source of Top 3 market makers' higher profit margins is their spread margins. No difference in position margins, however, is observed between the two subgroups, which implies no difference in trading skills. On the basis of HNV's (1999) findings that effective spreads on preferred trades are higher than those on non-preferred trades while internalized trades receive better execution than non-internalized trades, Menyah and Paudyal (2000) suggest that preferencing leads to higher inventory risks and costs, which market makers recover through higher effective spreads.

We also believe that the observed differences in trading profitability (especially spread margins) among London market makers should be interpreted as the evidence that they are rewarded for their risk-taking trading behavior in the presence of high inventory cost and asymmetric information cost, which is consistent with Reiss and Werner's (1998) findings. Menyah and Paudyal (2000) indeed find that the asymmetric information cost component dominates realized spreads on the London market. Their estimates reveal that on average 30 percent of the spread is the order processing cost, 23 percent is inventory cost and 47 percent is the asymmetric information cost.¹⁴

4. Empirical Findings: Differential Behavior of Market Makers

In order to highlight differing trading behavior among the LSE market makers, we classify them into 10 groups based on the market share of trading with Group 1 market makers having the largest relative market shares and Group 10 market makers having the smallest shares. We standardize four key variables measuring time-lengths of quotes remaining competitive, quote depths, preferred trading, and trading profitability to control for the cross-sectional heterogeneity across 25 stocks in the sample. The standardized variables are then used as dependent variables in the following regression model:

¹⁴ Snell and Tonks (1998), however, find little evidence in support of the existence of asymmetric information but strong evidence of inventory control considerations. Their findings are also inconsistent with the U.S. market studies by Hasbrouck (1988) and Madhavan and Smidt (1991). Snell and Tonks' sample include 10 liquid London stocks over a two-week period. It is not clear whether their findings are period-specific or applicable to other periods.

$$V_{js} = \alpha_0 + \alpha_1 D_1 + \alpha_2 D_2 + \alpha_3 D_3 + \alpha_4 D_4 + e_{js}, \quad j=1, \dots, N, \quad s=1, \dots, 25. \quad (1)$$

where D_1, \dots, D_4 are dummy variables that are defined in the following manner: $D_1 = 1$ if the market maker belongs to Group 1 (market makers with the largest market share) or 0 otherwise; $D_2 = 1$ if the market maker belongs to Group 2 or 0 otherwise; $D_3 = 1$ if the market maker belongs to Group 9 or 0 otherwise; $D_4 = 1$ if the market maker belongs to Group 10 (market makers with the smallest market share) or 0 otherwise; e_{js} denotes a random disturbance term; and j and s denote market maker and stock, respectively. This approach focuses on statistical differences between the middle groups (Group 3 through Group 8) and the groups at the top and the bottom. The intercept measures the average standardized measurement variable of market makers within the middle groups. Regression results are summarized in Table 6.

4.1 Differences in Time-Lengths of Competitive Quotes

Regression results for the competitive quotation ratios are shown in Panel A of Table 6. The estimated coefficients for D_1 and D_2 are 1.43 and 0.94, respectively, which indicate that market makers within Groups 1 and 2 have longer time-lengths of competitive quotes than the average length estimated for the middle groups. The market makers executing relatively large number of shares, therefore, post competitive quotes much longer than others. In contrast, the coefficients of dummy variables D_3 and D_4 are negative and significant, implying that, market makers with smaller market shares of trading are not as competitive as others.¹⁵

4.2 Differences in Quote Depths

Regression results for quotation depths are summarized Panel B of Table 6. The coefficients for D_1 , D_2 , D_3 , and D_4 are 0.34, 0.17, -1.01 and -1.31, respectively, and they are all

¹⁵ With regard to the relation between market share and the time-length of competitive quotes, causality may run either way if participating market makers know in advance the distribution of order flow. While we believe this is unlikely because order flow is totally segmented on the London market, we conducted a simple test. When a market maker changes his quotes, we count the number of quote revisions by other market makers in the next five minutes of trading. Given this five-minute window, we count the number of quote revisions of Top 3 market makers to compare with other market makers. No significant differences

significant. Market makers with large market shares of trading not only remain competitive longer but also offer greater depths than the middle groups to gain a greater fraction of the public order flow. The results from the regression strongly support our first hypothesis that market makers gain market share of trading through both competitive price quotes and quote depths.

During the study period, the LSE allowed the so-called reduced-size-market-makers (RSMM) to quote in half the NMS, even though RSMMs oftentimes chose to quote in NMS. The existence of RSMMs may bias the results in favor of the first hypothesis. According to the LSE, however, this arrangement was designed to accommodate *two* market makers based in Scotland that functioned rather like odd-lot brokers and these Scottish market makers no longer exist. Their trading volume was not significant enough to cause any distortion during the study period.¹⁶

Considering price quotes only, HNV compile the evidence that market makers on the best bid (ask) side execute 6.6% (5.3%) more public orders. The reported results in Panels A and B suggest that London market makers have a strong incentive to post competitive quotes in terms of both price and quantity. This contrasts with the findings of Christie and Schultz (1994) on the Nasdaq market prior to the 1997 market reforms. They report that Nasdaq market makers have no incentive to post competitive quotes due to order flow preferencing.

[Insert Table 6]

4.3 Differences in Preferred Trading

Regression results for the preferred trading are reported in Panel C of Table 6. Two sets of regression results are reported. Regression I results are based on our definition of preferred trades and Regression II results are obtained when the traditional definition of preferred trades are used. Regression I results disclose that the coefficients estimated for

are observed between the numbers of quote revisions between two subgroups of market makers, which suggest the reverse causality is highly unlikely.

the top two groups with largest market shares are negative but significant, while those estimated for bottom groups with smallest market shares are positive and significant. The results imply that preferenced trading is more prevalent among the market makers with smaller market shares. More importantly, the market makers with larger market shares do not appear to rely on preferenced trading arrangements in securing public order flow on the London market.

A question, however, remains as to why a negative relationship exists between the market share of trading and the preferenced trading activity on the LSE especially for market makers with large market shares. From the size distribution of preferenced and non-preferenced trades as summarized in Table 7, the London market exhibits its own idiosyncratic feature in that a large proportion of preferenced trades fall into the small size categories. Preferenced trades account for over 55% of the trades for small-size categories under 1,000 shares, while they account for less than 13% of the large-size category of 10,000 shares or more. Since large-sized trades predominantly influence the relative market share of trading in terms of volume, an increase in trading volume is accompanied with the decline of the proportion of preferenced trading volume.

[Insert Table 7]

Regression II results indicate that all coefficients are insignificant. These results imply that no difference is found between market makers with large and small market shares even if the traditional definition is used to identify preferenced trades. This finding is in support of the second hypothesis since preferenced trading is not the critical factor differentiating market share leaders and followers.

4.4 Differences in Trading Profitability

Panel D of Table 6 presents the regression results for the overall profit margin, spread margin, and position margin. Overall profit margins are positive and significant only for the

¹⁶ We are grateful to Stephen Wells, former LSE Chief Economist, on this point.

market makers with large market shares of trading. In contrast, the estimated coefficients for the variables D_3 and D_4 are negative but not different from zero. As displayed in the last two regressions in Panel D, this higher profitability is attributed to spread margins, not position margins. No variability exists in position margins among different groups of market makers sorted by market share. Since position margin usually measures the ability of a market maker with superior information or sophisticated trading skills to time the securities price movement, large market share on the LSE market does not necessarily imply higher position margins.

An important question then is why LSE market makers with large market shares are able to achieve higher spread margins than the average market makers. Two possible reasons may be cited: (i) monopoly power of a certain group of market makers; and (ii) reward for high risk-taking. If a certain group of market makers enjoy monopoly power, one may expect that this group would be able to consistently charge large spread margins regardless of the size of trades. If not, the reward for risk-taking hypothesis will better explain. To examine this issue, spread margins are computed for Top 3 market makers and the remaining market makers in the trades of different size categories. Table 8 reports the result. For the trades under 5,000 shares, the spread margins do not differ significantly between Top 3 market makers and the remaining market makers.¹⁷ However, the differences emerge when trade size increases above 5,000 shares or more. Top 3 market makers obtain significantly higher spread margins than the others. For example, given a trade in the 5,000 to 10,000 shares range, the spread margin difference is 12 basis points, which is significantly different from zero. For those trades in excess of 10,000 shares, the difference between these two groups reaches 24 basis points. Because positive spread margins earned by Top 3 market makers do not consistently appear

¹⁷ One may argue that a good trading strategy for market makers would be to quote better prices for small-sized trades. However, this strategy would be good if and only if small-sized trades dominate in the market-making process. The reality of the London market is that large-sized trades account for more than 90 percent of total trading volume. Even though the Table 8 results suggest that market makers can gain from greater spread margins on trades smaller than 5,000 shares, these trade account for mere 5 percent or less of trading volume as exhibited in Table 4.

across the trades of all sizes, monopolistic power does not appear to be the main cause of the observed profits for the market makers with large market shares. Since market makers with large market shares of trading earn relatively greater spread margins and the large trades are more likely associated with high trading risks, the second reason appears to be a better explanation. Additionally, the observed position margins for large-sized trades cannot be attributed to preferenced trading which prevails among small-sized transactions.

[Insert Table 8]

4.5 Cross-Sectional Regression Approach

In order to assess the relation between market shares of trading and the four key variables (measuring time-lengths of quotes remaining competitive, quote depths, preferenced trades, and profitability), the following cross-sectional regressions are used. The only difference between two regression models is that two components of trading profits, spread margins and position margins, are explicitly recognized in equation (3) in lieu of total profits in equation (2).

$$MS_{js} = \alpha_0 + \alpha_1 CQ_{js} + \alpha_2 QD_{js} + \alpha_3 PT_{js} + \alpha_4 TP_{js} + \varepsilon_{js}; \quad (2)$$

$$MS_{js} = \beta_0 + \beta_1 CQ_{js} + \beta_2 QD_{js} + \beta_3 PT_{js} + \beta_4 SM_{js} + \beta_5 PM_{js} + \mu_{js} \quad (3)$$

where,

MS_{js} = market share of market maker j in stock s ;

CQ_{js} = length of time that quotes remain competitive;

QD_{js} = quote depth;

PT_{js} = preferenced trading;

TP_{js} , SM_{js} , and PM_{js} denote total profit margins, spread margins, and position margins;

and ε_{js} and μ_{js} are random disturbance terms.

All variables are standardized to purge cross-sectional heterogeneity across stocks. Panel A of Table 9 presents the regression results for equation (2) and Panel B summarizes the

results for equation (3). Two sets of regression results are presented in each Panel. Regression I results are based on our definition of preferred trades and Regression II results are based on the traditional definition of preferred trades.

Regression I results are consistent with the predictions under the three hypotheses. Significantly positive coefficients estimated for two variables measuring time-lengths of quotes remaining competitive (CQ) and quote depths (QD) indicate that the market makers who issue competitive quotes with greater depths can gain larger proportion of public orders in support of the first hypothesis.

One should be careful in interpreting the negative coefficient for the preferred trading (PT) variable. The negative coefficients do not indicate that the market makers who have the best relationships with brokers will gain smaller proportion of trading volume; rather, it should be interpreted that London market makers with larger market shares do not rely on preferred trading to increase their share of public order flow. The negative coefficients estimated are in support of the second hypothesis, indicating a marginal role of preferred trades in determining the market share, especially for market makers of larger market shares. Statistically insignificant coefficients estimated for the position margin (PM) variable imply that the degree of trading skills and market shares are not directly related or that market makers with larger market shares do not necessarily possess better trading skills than the remaining market makers. As was confirmed in the previous section, spread margins determine the trading profitability. A positive and significant coefficient estimated for spread margins indicate that market share of trading is positively related to spread margins. Combining with the regression results based on equation (2), market makers with high trading volume gain relatively higher trading profitability as compensation for their risk-taking, which is consistent with the third hypothesis.

[Insert Table 9]

Regression II results indicated that the coefficient estimated for the preferred trading variable is no longer significant, which implies that preferred trades as identified by the traditional definition are unable to impact on market share, confirming that they are not the major factor in determining the market share. We consider this finding is again in support of the second hypothesis.

5. Conclusions

In this study, we have examined competitiveness of the LSE on the basis of trading activities across different market makers for 25 FTSE-100 component stocks. Specifically, the relations between market share of individual market makers and their price- and quantity-setting behavior, preferred trading activities, and trading profitability.

A strong, positive relationship is observed between the market share of trading and the competitiveness of quotes. Top 3 market makers post competitive quotes with 55 percent of their quoting time, while this percentage for the remaining market makers is only 41 percent. In addition, the average quote depth from Top 3 market makers is approximately 20 percent deeper than that of other market makers.

The average ratios of preferred trading volume to total turnover are 20% for Top 3 market makers and 36% for the remaining market makers. Regression results suggest a negative relationship between the market share of trading and the preferred trading volume, which demonstrates an idiosyncratic feature of the London market where the majority of preferred trades are small-sized transactions. Most importantly, market makers that execute a relatively large proportion of public order flow do not necessarily depend on the preferencing arrangements with brokers in contrast to the Nasdaq market. Empirical evidence suggests that market makers with large market shares of trading enjoy higher profit margins than the average market makers; and, further, that this profitability is attributed to not position margins but spread margins. This result is interpreted as the compensation for risk-taking

associated with large-sized trades rather than monopoly power enjoyed by the market makers with a large market share.

In conclusion, the LSE is a competitive dealership market characterized by the following:

- LSE market makers obtain a relatively large share of public order flows through posting competitive prices with great quote depths.
- Because preferenced trading is limited to small-sized trades, market share leaders do not rely on it in securing public order flow on the London market.
- A higher profitability is observed for the market makers with larger market shares. This profitability is explained by risk-taking, not monopoly power.

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Table 1. The List of 25 FTSE-100 Companies in the Sample

Company Name	SEAIQ ID
ARGOS	ARG
B.A.T. INDUSTRIES	BATS
BARCLAYS	BARC
BRITISH AEROSPACE	BA.
BRITISH AIRWAYS	BAY
BRITISH GAS	GAS
BRITISH PETROLEUM CO	BP
BRITISH STEEL	BS
BRITISH TELECOMMUNICATIONS	BTA
BTR	BTR
CABLE & WIRELESS	CW
CADBURY SCHWEPPE	CBRY
GLAXO WELLCOME	GLXO
GRANADA GROUP	GAA
HANSON	HNSN
HSBC HLDGS	HSBA
NATIONAL POWER	NPR
NATIONAL WESTMINSTER BANK	NWB
PEARSON	PSON
ROLLS-ROYCE	RR
RTZ CORP	RTZ
UNITED UTILITIES	UU
WHITBREAD	WTB
WOLSELEY	WLY
ZENECA GROUP	ZEN

Table 2. Descriptive Statistics

This table presents descriptive statistics for 25 sample stocks over the entire study period, March 1995 – May 1995. Price is the average daily closing prices over the study period. The following abbreviations are used: MM = market maker; QR = quote revisions, and IQ = inside quote changes.

Company	Price (pence)	No. of MMs	No. of QRs	No. of IQs	No. of Trades	Trading Volume (million shares)
ARG	425	13	3007	633	3797	57.76
BA	523	17	6988	1529	6373	148.44
BARC	673	17	13073	2893	26939	279.98
BATS	492	17	8147	2661	27231	362.11
BAY	411	20	8748	1467	15813	326.41
BP	443	20	6662	1894	25705	650.04
BS	176	18	3974	1054	11715	614.97
BTA	394	19	9982	1633	92124	642.54
BTR	341	18	7187	1967	33628	601.93
CBRY	474	18	6733	1504	14378	184.80
CW	421	20	7216	1873	20405	330.60
GAA	589	17	5764	1507	7291	121.29
GAS	302	19	7117	1308	46312	516.06
GLXO	767	20	10341	3770	40878	546.24
HNSN	239	19	6769	2072	25766	663.43
HSBA	828	20	10157	3113	15799	276.24
NPR	467	19	4977	1207	16557	266.56
NWB	538	17	12309	2730	20642	273.17
PERSON	606	15	5186	1449	7608	90.49
RR	188	16	4470	876	11574	389.65
RTZ	803	17	7264	1959	17283	161.14
UU	585	14	3102	1194	9449	88.81
WLY	364	8	2229	987	4144	114.56
WTB	594	17	5998	1497	7143	97.09
ZEN	936	19	8478	2120	17593	165.41
Mean	503	17	7035	1796	21046	318.79

Table 3. Quoting Activities of Market Makers for 25 Sample Stocks

This table reports summary statistics for quoting activities by market makers (MMs). Quoted spread by MMs is the time weighted average bid-ask spread for individual market makers in each stocks over the study period. Inside spread is the time weighted average of inside bid-ask spread. Quote depth is the time-weighted average of the number of shares market makers commit to execute at the quoted prices in each stock.

Company	Quoted Spread by MMs (pence)			Inside Spread (pence)	Daily No. of QR by MMs			Quote Depths
	Mean	Min	Max		Mean	Min	Max	
ARG	4.00	4.00	4.00	2.61	4	4	6	27790
BA	7.06	7.00	8.00	4.13	7	6	9	46069
BARC	5.00	5.00	5.00	3.00	14	12	18	66772
BATS	7.00	7.00	7.00	2.99	9	6	13	47300
BAY	4.05	4.00	5.00	2.25	8	6	11	91715
BP	5.00	5.00	5.00	1.91	6	4	10	181768
BS	3.00	3.00	3.00	1.22	4	3	6	174873
BTA	3.00	3.00	3.00	1.64	10	7	13	93761
BTR	5.00	5.00	5.00	2.10	7	5	11	85754
CBRY	5.00	5.00	5.00	2.89	7	5	13	49675
CW	7.00	6.99	7.00	3.25	7	5	9	93422
GAA	7.01	7.00	7.19	3.55	6	5	8	47248
GAS	3.00	3.00	3.00	1.68	7	6	10	171830
GLXO	8.88	7.00	10.00	2.81	9	5	17	48998
HNSN	3.00	3.00	3.00	1.15	7	4	11	171881
HSBA	8.50	7.00	10.05	3.14	9	4	18	48502
NPR	4.60	4.00	7.00	2.33	5	2	7	92868
NWB	5.00	5.00	5.00	2.95	14	11	18	65038
PERSON	10.00	10.00	10.00	4.82	6	5	8	23161
RR	3.00	3.00	3.00	1.87	5	4	7	93574
RTZ	7.00	7.00	7.00	3.89	8	6	10	35407
UU	10.00	10.00	10.00	5.35	4	3	6	41161
WLY	5.00	5.00	5.00	3.32	5	4	9	26456
WTB	5.10	5.00	6.68	2.89	7	5	12	40149
ZEN	7.00	7.00	7.00	3.75	8	6	11	38291
Mean	5.69	5.52	6.04	2.86	7	5	11	76139

Table 4. Distribution of Trade Size

This table reports summary statistics for executed trades by market makers. Panel A reports the distribution of trades in terms of the number of transactions. Panel B reports the distribution in terms of trading value.

Company	<u>Panel A: Number of Trades</u>					<u>Panel B: Trading Value</u>				
	Below 500	501~ 1,000	1,001~ 5,000	5,001~ 10,000	Over 10,000	Below 500	501~ 1,000	1,001~ 5,000	5,001~ 10,000	Over 10,000
ARG	36.00	17.50	20.40	5.80	20.30	0.51	0.83	2.79	3.17	92.70
BA	30.80	10.90	18.50	7.50	32.20	0.26	0.35	1.84	2.71	94.84
BARC	36.40	25.50	21.70	3.90	12.40	0.90	1.67	3.77	2.95	90.71
BATS	17.90	22.20	35.30	7.20	17.50	0.35	1.15	5.12	4.04	89.34
BAY	39.70	14.30	18.40	5.10	22.50	0.38	0.50	1.86	2.05	95.22
BP	25.80	17.70	28.50	6.60	21.40	0.21	0.47	2.21	1.87	95.24
BS	20.10	19.20	26.70	6.70	27.30	0.14	0.28	1.08	0.93	97.58
BTA	39.30	27.20	24.50	2.40	6.60	1.45	2.65	6.20	2.55	87.15
BTR	12.90	23.70	38.50	7.10	17.80	0.20	1.01	4.39	3.01	91.39
CBRY	22.20	26.30	27.40	5.60	18.40	0.37	1.18	3.38	2.80	92.28
CW	16.50	21.60	35.70	7.60	18.60	0.28	0.97	4.57	3.53	90.65
GAA	25.10	17.20	24.00	7.70	26.10	0.30	0.68	2.87	3.46	92.69
GAS	39.80	24.30	23.90	2.80	9.20	0.83	1.37	3.49	1.72	92.60
GLXO	30.70	25.10	21.40	5.50	17.20	0.67	1.37	3.32	3.32	91.32
HNSN	10.30	15.20	46.40	7.90	20.10	0.12	0.45	3.81	2.29	93.33
HSBA	35.20	18.40	18.20	6.30	21.90	0.44	0.70	2.00	2.67	94.20
NPR	59.20	11.90	11.60	2.90	14.40	0.81	0.49	1.44	1.37	95.90
NWB	27.70	22.80	26.10	5.90	17.60	0.56	1.14	3.64	3.26	91.40
PERSON	19.50	20.40	28.70	8.10	23.30	0.38	1.09	4.54	4.84	89.15
RR	45.70	8.50	14.60	5.50	25.70	0.26	0.17	0.91	1.22	97.44
RTZ	33.70	23.60	23.20	4.60	14.90	1.01	1.77	5.00	3.72	88.50
UU	33.40	25.00	23.80	4.40	13.40	0.88	1.82	4.89	3.74	88.67
WLY	7.90	18.10	31.40	9.50	33.10	0.08	0.50	2.52	2.69	94.21
WTB	31.90	24.40	20.00	4.80	18.80	0.67	1.24	2.90	3.08	92.13
ZEN	44.50	19.40	15.10	4.70	16.40	1.11	1.37	3.18	3.83	90.51
Mean	29.69	20.02	24.96	5.84	19.48	0.53	1.01	3.27	2.83	92.37

Unit: %

Table 5. Summary Statistics for Market Makers in Key Measurement Variables

Panel A: Market Share of Trading

Panel A reports summary statistics for market share of trading (MS) variable. MS is defined as $MS_{js} = (BV_{js} + SV_{js}) / \sum_{j=1}^{N_s} (BV_{js} + SV_{js})$, $j=1, \dots, N_s$. MS_{js} denotes the market maker j 's market share of trading in stock s , and BV_{js} and SV_{js} denote the market maker j 's total purchasing volume and selling volume in stock s over the study period, respectively. N_s denotes the number of market makers in stock s . Top 3 is the average market share of top three market makers with the largest shares. Rest is the average market share of the remaining market makers.

Unit: %

Company	Mean	Min	Max	Std Dev	Top 3	Rest
ARG	7.69	0.45	31.54	9.52	64.49	35.51
BA	5.88	0.25	25.81	6.60	49.35	50.65
BARC	5.88	0.55	19.78	5.21	43.60	56.40
BATS	5.88	0.40	16.48	4.84	41.81	58.19
BAY	5.00	0.26	20.44	5.69	49.70	50.30
BP	5.00	0.37	18.72	4.89	40.53	59.47
BS	5.56	0.12	23.61	6.93	55.60	44.40
BTA	5.26	0.65	16.63	4.98	41.05	58.95
BTR	5.56	0.37	16.42	5.23	43.15	56.85
CBRY	5.56	0.48	17.61	6.05	46.06	53.94
CW	5.00	0.47	16.91	4.16	36.11	63.89
GAA	5.88	0.19	19.30	6.60	49.43	50.57
GAS	5.26	0.44	14.75	4.90	40.82	59.18
GLXO	5.00	0.74	10.15	3.24	27.92	72.08
HNSN	5.26	0.72	16.54	4.35	37.93	62.07
HSBA	5.00	0.01	18.01	5.09	42.13	57.87
NPR	5.26	0.21	16.53	5.30	44.73	55.27
NWB	5.88	0.43	17.58	4.77	40.19	59.81
PERSON	6.67	0.79	22.75	7.29	54.30	45.70
RR	6.25	0.26	15.48	5.83	43.86	56.14
RTZ	5.88	0.27	24.92	6.34	48.79	51.21
UU	7.14	0.76	21.28	7.12	53.70	46.30
WLY	12.50	1.92	25.45	8.57	63.08	36.92
WTB	5.88	0.30	22.83	6.25	48.73	51.27
ZEN	5.26	0.39	17.05	4.74	40.15	59.85
Mean	5.98	0.41	19.46	5.78	45.89	54.11

Table 5. –Continued

Panel B: Time-Lengths of Quotes Remaining Competitive

Panel B reports summary statistics for time-lengths of competitive quotes (CQ). CQ is defined as $CQ_{js} = (BT_{js} + AT_{js}) / T_{js}$ where BT_{js} and AT_{js} denote the times of market maker j 's quotes staying at the inside bid price and the inside ask price over sample period, respectively, and T_{js} denotes market maker j 's total quoting time over study period. Top 3 is the average CQ for three market makers with the largest market shares and Rest is the average CQ for the remaining market makers.

Unit: %

Company	Mean	Min	Max	Std Dev	Top 3	Rest
ARG	56.64	48.18	70.00	6.86	67.46	53.39
BA	40.39	16.64	63.89	13.81	58.88	36.43
BARC	59.95	42.75	73.67	9.10	66.58	58.53
BATS	31.13	10.71	51.25	11.52	41.02	29.01
BAY	50.02	28.10	72.94	10.86	65.05	47.37
BP	32.56	6.76	62.01	14.70	52.43	29.05
BS	28.37	12.07	67.82	15.13	47.91	24.46
BTA	70.09	62.96	83.23	5.16	76.14	68.96
BTR	33.80	11.69	56.89	15.19	56.04	29.36
CBRY	45.21	27.03	71.28	13.15	59.57	42.34
CW	26.42	7.61	60.97	11.87	40.63	23.91
GAA	34.72	11.88	61.51	13.83	46.24	32.25
GAS	71.97	62.78	82.91	5.31	76.42	71.13
GLXO	22.96	0.31	45.52	14.21	36.62	20.55
HNSN	29.53	10.69	60.31	13.82	51.17	25.47
HSBA	20.81	1.66	72.90	18.83	29.90	19.21
NPR	39.15	2.55	70.54	25.60	66.36	34.35
NWB	55.69	37.83	71.12	8.89	66.21	53.43
PSON	25.61	2.11	65.15	18.73	49.11	19.73
RR	76.68	72.69	81.59	2.87	78.71	76.21
RTZ	40.71	16.37	68.92	13.24	55.92	37.46
UU	35.00	15.01	53.16	10.94	47.12	31.69
WLY	77.92	69.90	84.80	4.76	79.95	76.70
WTB	45.02	22.88	65.19	10.57	60.01	41.81
ZEN	35.42	15.15	51.01	10.59	48.36	33.13
Mean	43.43	24.65	66.74	11.98	56.95	43.05

Table 5. –Continued

Panel C: Quote Depths

Panel C reports summary statistics for Quote Depth (QD). QD_{js} is defined as the time weighted average quote depth for market maker j in stock s over the study period. Top 3 is the average QD for three market makers with the largest market shares and Rest is the average QD for the remaining market makers.

Unit: Shares

Company	Mean	Min	Max	Std Dev	Top 3	Rest
ARG	27790	5294	51577	14686	50558	20959
BA	46069	24511	51331	7834	49435	45348
BARC	66772	25137	102213	19348	84025	63075
BATS	47300	23600	51678	7922	51016	46504
BAY	91715	26640	109528	22449	99627	90319
BP	181768	49829	207952	48976	204567	177745
BS	174873	50556	203332	49552	198942	170059
BTA	93761	47543	100656	14551	98812	92814
BTR	85754	25056	103865	23216	99630	82979
CBRY	49675	25051	97819	14133	51341	49342
CW	93422	25488	103382	22107	102303	91855
GAA	47248	25056	52985	7594	49654	46733
GAS	171830	47178	204567	52693	201372	166290
GLXO	48998	24702	78419	9921	50082	48807
HNSN	171881	48710	203482	52124	199119	166774
HSBA	48502	25113	53456	7454	51852	47911
NPR	92868	25415	105320	22560	100818	91465
NWB	65038	24981	75975	17233	74957	62913
PSON	23161	10188	25573	4823	25178	22657
RR	93574	50785	103010	15796	101510	91743
RTZ	35407	9977	52145	15238	42100	33972
UU	41161	9640	52325	15525	49598	38860
WLY	26456	12046	48382	9988	33138	22446
WTB	40149	9681	51001	14942	39984	40184
ZEN	38291	10122	52202	15475	51350	35986
Mean	76139	26492	93687	20246	86439	73910

Table 5. –Continued

Panel D: Preferred Trading

Table 5. –Continued

Panel D: Preferred Trading: Summary Statistics of Preferred Trades

This table reports summary statistics for the preferred trades. Preferred trades are the trades that satisfy two criteria: (i) the price quote is not located on the inside; and (ii) the trade size is not greater than quote size. The reported percentage of preferred trades is defined as $PT_{js} = PV_{js}/TV_{js}$ where PV_{js} and TV_{js} denote preferred trading volume and total trading volume of market maker j in stock s over the study period, respectively. Top 3 is the average PT for three market makers with the largest market shares, while Rest is the average PT for the remaining market makers. At the bottom of this table, summary statistics for preferred trades based on the traditional definition are presented for comparison.

Unit: %

Company	Mean	Min	Max	Std Dev	Top 3	Rest
ARG	16.51	6.28	42.93	12.06	9.66	18.79
BA	37.60	9.02	95.52	23.14	16.71	42.08
BARC	32.12	10.74	70.76	18.29	27.31	33.15
BATS	32.73	12.34	80.37	21.26	19.81	35.50
BAY	40.50	16.43	82.29	19.55	25.61	43.13
BP	47.46	16.45	89.46	20.41	27.68	50.95
BS	28.35	4.67	75.39	20.54	11.47	31.73
BTA	29.09	12.40	61.67	14.41	24.55	29.95
BTR	32.77	7.18	74.13	16.85	25.37	34.25
CBRY	33.30	12.05	68.61	18.70	17.29	36.51
CW	44.60	20.77	90.75	18.22	32.53	46.73
GAA	40.02	16.71	76.31	23.18	21.32	44.02
GAS	31.64	6.45	60.07	14.27	27.42	32.43
GLXO	34.83	14.27	95.01	21.40	19.75	37.50
HNSN	33.99	11.54	83.37	20.24	22.09	36.22
HSBA	37.09	11.79	97.45	24.30	18.37	40.60
NPR	40.86	7.49	94.66	28.94	17.97	45.15
NWB	33.02	10.90	78.69	19.08	26.69	34.37
PSON	30.61	6.05	98.03	37.25	10.86	35.54
RR	23.47	6.79	67.62	18.45	9.86	26.61
RTZ	33.73	4.47	82.50	21.52	21.00	36.46
UU	38.11	2.31	77.98	23.42	17.92	43.61
WLY	7.44	2.33	14.00	3.53	4.63	9.13
WTB	33.56	5.25	78.51	21.34	14.80	37.58
ZEN	34.35	14.12	87.83	19.23	24.22	36.25
Mean	33.11	9.95	76.96	11.98	19.80	35.93
Traditional Definition	55.78	20.77	94.49	26.01	59.71	65.15

Table 5. –Continued

Panel E: Trading Profitability

Panel E reports summary statistics for overall profit margin (OM), spread margin (SM) and position margin (PM) in three sections. Total profit margin, spread margin, and position margin are calculated as suggested by Neuberger (1992), Sofianos (1995), and HNV (1999).

Section 1: Profit Margin (OM)

Unit: Basis Point

Company	Mean	Min	Max	Std Dev	Top 3	Rest
ARG	-57	-130	36	106	-37	-63
BA	-7	-83	100	43	-32	-2
BARC	-47	-96	106	158	12	-60
BATS	-40	-90	99	153	-18	-44
BAY	-3	-84	96	140	-5	1
BP	-36	-130	60	80	-7	-41
BS	-25	-142	149	88	21	-34
BTA	-16	-94	9	26	6	-20
BTR	-32	-183	139	374	47	-68
CBRY	-19	-153	120	102	21	-27
CW	21	-28	260	62	13	23
GAA	9	-169	240	84	1	11
GAS	-30	-91	112	234	41	-37
GLXO	-6	-115	90	43	0	-16
HNSN	2	-23	27	13	3	2
HSBA	4	-85	97	85	-17	15
NPR	61	-51	144	116	63	61
NWB	-50	-191	7	142	-10	-59
PERSON	-1	-171	100	79	17	-5
RR	-55	-190	70	108	-39	-59
RTZ	-9	-65	17	24	-13	-8
UU	2	-83	121	84	30	-6
WLY	6	-21	50	22	0	9
WTB	15	-91	75	41	-28	24
ZEN	-12	-135	113	52	-37	-7
Mean	-13	-108	97	98	1	-16

Table 5. --Continued

Panel E: -- Continued**Section 2: Spread Margin (SM)**

Unit: Basis Point

Company	Mean	Min	Max	Std Dev	Top 3	Rest
ARG	10	-8	21	8	6	11
BA	7	-18	27	10	-1	9
BARC	-22	-40	164	164	15	-30
BATS	8	-100	78	35	22	4
BAY	7	-5	39	10	7	7
BP	-11	-144	63	80	7	-15
BS	5	-28	24	13	6	4
BTA	-10	-76	12	29	6	-13
BTR	-22	-158	168	397	64	-59
CBRY	0	-62	54	42	10	-2
CW	11	-2	32	8	17	10
GAA	5	-3	14	5	7	5
GAS	16	-116	142	264	66	18
GLXO	18	-10	150	37	21	12
HNSN	6	-7	16	6	8	6
HSBA	55	-131	161	346	61	50
NPR	73	-96	117	269	87	66
NWB	9	-31	44	15	10	9
PSON	11	-12	33	10	12	11
RR	12	-4	40	10	17	11
RTZ	7	-10	39	10	2	8
UU	18	-4	77	20	28	15
WLY	12	5	18	4	15	10
WTB	6	-13	20	7	9	5
ZEN	-3	-67	10	17	-4	-2
Mean	9	-46	63	73	20	6

Panel E: -- Continued

Section 3: Position Margin (PM)

Unit: Basis Point

Company	Mean	Min	Max	Std Dev	Top 3	Rest
ARG	-67	-332	19	103	-43	-74
BA	-14	-81	93	39	-30	-10
BARC	-25	-184	88	66	-3	-30
BATS	-47	-118	88	156	-41	-48
BAY	-12	-47	81	32	-13	-11
BP	-25	-118	56	37	-15	-26
BS	-29	-139	143	83	15	-38
BTA	-5	-30	62	19	-1	-6
BTR	-10	-166	98	52	-16	-9
CBRY	-19	-152	115	86	11	-25
CW	11	-33	244	60	-4	13
GAA	4	-166	236	83	-6	6
GAS	-46	-30	125	38	-24	-55
GLXO	-24	-143	8	41	-21	-27
HNSN	-4	-24	21	13	-5	-4
HSBA	-51	-410	289	686	-77	-35
NPR	-12	-81	234	90	-24	-5
NWB	-59	-591	34	142	-21	-67
PERSON	-12	-276	66	76	6	-16
RR	-68	-399	58	108	-55	-70
RTZ	-16	-77	9	24	-16	-16
UU	-16	-187	144	68	1	-21
WLY	-7	-33	33	20	-15	-2
WTB	9	-105	79	45	-37	19
ZEN	-9	-124	113	48	-34	-5
Mean	-22	-162	101	89	-19	-23

Table 6. Differential Behavior of the Market Makers

This table reports regression results based on the following model:

$$V_{js} = \alpha_0 + \alpha_1 D_1 + \alpha_2 D_2 + \alpha_3 D_3 + \alpha_4 D_4 + e_{js}, \quad j = 1, \dots, N_s, s=1, \dots, 25. \quad (1)$$

where $D_1..D_4$ are dummy variables that are defined in the following manner. All market makers are sorted into 10 groups based on their relative market shares of trading. The market makers in Group 1 have the largest relative market shares, and the market makers in Group 10 have the smallest market shares. $D_1 = 1$ if the market maker belongs to Group 1 or 0 otherwise; $D_2 = 1$ if the market maker belongs to Group 2 or 0 otherwise; $D_3 = 1$ if the market maker belongs to Group 9 or 0 otherwise; $D_4 = 1$ if the market maker belongs to Group 10 or 0 otherwise; e_{js} denotes a random disturbance term; and j and s denote market maker and stock, respectively. Four key variables are used as the dependent variable. They are: (i) time-length of competitive quotes; (ii) quote depth; (iii) preferenced trading; and (iv) trading profitability. These variables are standardized to control for the cross-sectional heterogeneity across stocks. For each dummy variable, the estimated coefficients and corresponding t values are reported in the parentheses. F -value and number of observations (Obs) are also reported.

	D_1	D_2	D_3	D_4	R^2	F-value	No. of Obs
<u>Panel A: Time-Length of Competitive Quotes</u>							
	1.43** (11.92)	0.94** (7.80)	-0.69** (-5.79)	-0.70** (-5.76)	0.42	77.03	431
<u>Panel B: Quote Depth</u>							
	0.34* (2.45)	0.17* (2.27)	-1.01** (-7.49)	-1.31** (-9.47)	0.27	39.64	431
<u>Panel C: Preferenced Trading</u>							
Regression I	-0.52** (-4.11)	-0.45** (-3.52)	1.12** (8.82)	1.35** (10.47)	0.36	59.37	431
Regression II	0.11 (1.50)	-0.02 (-0.14)	0.05 (0.66)	0.07 (0.97)	0.06	0.87	431
<u>Panel D: Trading Profitability</u>							
<i>Profit Margin</i>							
	0.17* (1.98)	0.16 (1.78)	0.02 (0.10)	-0.13 (-0.82)	0.07	1.26	431
<i>Spread Margin</i>							
	0.40* (2.54)	0.14 (1.89)	-0.14 (-0.92)	-0.13 (-0.84)	0.16	2.05	431
<i>Position Margin</i>							
	-0.06 (-0.36)	0.02 (1.00)	-0.01 (-0.07)	0.04 (0.28)	0.03	0.33	431

Note: ** and * indicate statistical significance at 1%- and 5%-level, respectively.

Table 7. Trade Size Distributions of Non-preferenced and Preferred Trades

This table reports statistics for preferenced and non-preferenced trades in each stock over the study period. The distribution of the non-preferenced trades is reported in Panel A, while that of preferenced trades is reported in Panel B.

Company	<u>Panel A: Non-preferenced Trades</u>					<u>Panel B: Preferred Trades</u>				
	0~ 500	01~ 1,000	1,001~ 5,000	5,001~ 10,000	Over 10,000	0~ 500	501~ 1,000	1,001~ 5,000	5,001~ 10,000	Over 10,000
ARG	29.70	13.20	16.30	7.00	33.90	43.00	21.40	22.20	5.20	8.30
BA	22.40	8.50	15.70	5.90	47.50	38.20	12.60	18.70	8.80	21.70
BARC	33.80	25.90	18.60	3.20	18.40	42.10	26.30	20.30	3.70	7.50
BATS	15.00	19.80	27.00	5.50	32.60	20.00	24.20	36.60	7.90	11.30
BAY	47.10	10.10	11.80	4.20	26.70	36.20	17.20	21.10	5.70	19.70
BP	21.60	14.80	23.70	6.80	33.00	28.80	19.40	28.60	6.10	17.10
BS	13.40	14.20	23.20	6.10	43.00	24.00	22.20	29.00	6.60	18.20
BTA	38.60	26.20	23.80	2.30	9.00	40.70	28.20	24.70	2.30	4.10
BTR	11.30	23.00	33.70	6.00	26.00	14.60	25.40	38.70	7.20	14.20
CBRY	19.10	25.10	22.60	4.90	28.20	24.90	28.10	29.00	6.00	12.00
CW	14.80	22.00	27.40	6.60	29.20	18.40	22.60	35.60	7.70	15.60
GAA	16.80	13.00	18.00	6.20	46.00	29.70	19.20	25.50	8.20	17.30
GAS	39.30	23.90	21.90	2.90	12.00	41.80	25.20	23.40	2.60	7.00
GLXO	24.90	19.70	14.70	4.90	35.70	35.70	26.00	21.80	5.90	10.60
HNSN	10.20	14.40	41.40	6.30	27.80	10.60	16.30	48.90	7.90	16.40
HSBA	19.80	13.00	14.00	4.90	48.30	41.20	20.10	18.40	6.60	13.80
NPR	60.80	11.00	8.70	2.00	17.60	62.70	13.00	12.10	3.10	9.10
NWB	23.70	22.90	23.60	5.20	24.60	33.50	24.30	25.20	5.60	11.30
PERSON	14.00	13.90	18.50	6.60	47.00	23.30	23.80	32.10	9.40	11.40
RR	41.20	7.20	12.60	4.70	34.30	52.10	9.40	15.70	6.00	16.80
RTZ	33.00	18.70	17.40	4.10	26.70	37.00	25.70	23.30	5.10	9.00
UU	27.40	23.30	19.10	4.20	26.00	37.10	26.50	23.80	4.40	8.20
WLY	6.00	16.50	23.20	7.30	47.10	11.70	23.20	40.90	11.00	13.30
WTB	24.80	22.50	16.00	4.90	31.90	35.70	26.50	21.60	5.20	11.00
ZEN	36.50	17.30	14.30	4.10	27.90	51.70	20.00	14.50	4.70	9.10
Mean	25.81	17.60	20.29	5.07	31.22	33.39	21.87	26.07	6.12	12.56

Table 8. Difference in Spread Margins Across Market Makers

This table reports the spread margins for Top 3 market makers and the remaining market makers. For each size category, we separately calculate the mean spread margins for Top 3 market makers and the remaining market makers in each stock.

	Trade Size				
	Below 500	501~1,000	1,001~5,000	5,001~10,000	Over 10,000
Top 3 Market Makers [1]	27.37	22.50	23.60	11.71	11.97
The Remaining Market Makers [2]	26.81	11.96	15.92	-0.18	-11.52
Difference = [(1) - (2)]	0.56 (0.50)	10.54 (1.43)	7.68 (1.42)	11.89* (2.46)	23.49* (2.19)

Note: t-values are reported in the parentheses and * indicates statistical significance at the 5%-level.

Table 9. Determinants of Market Share

The relations between market shares of trading and the four key variables (measuring time-lengths of quotes remaining competitive, quote depths, preferred trades, and profitability) are evaluated using the following cross-sectional regressions:

$$MS_{js} = \alpha_0 + \alpha_1 CQ_{js} + \alpha_2 QD_{js} + \alpha_3 PT_{js} + \alpha_4 TP_{js} + \varepsilon_{js}; \quad (2)$$

$$MS_{js} = \beta_0 + \beta_1 CQ_{js} + \beta_2 QD_{js} + \beta_3 PT_{js} + \beta_4 SM_{js} + \beta_5 PM_{js} + \mu_{js} \quad (3)$$

where,

MS_{js} = market share of market maker j in stock s ;
 CQ_{js} = length of time that quotes remain competitive;
 QD_{js} = quote depth;
 PT_{js} = preferred trading;
 TP_{js} , SM_{js} , and PM_{js} denote total profit margins, spread margins, and position margins;
 and ε_{js} and μ_{js} are random disturbance terms.

All variables are standardized to purge cross-sectional heterogeneity across stocks. For each of the two model, t-values are reported in parentheses and F-value and the number of observations (Obs) are also reported. Regression I uses our definition of preferred trades, whereas Regression II uses HNV's definition of preferred trades.

Panel A: Equation (2)

	<u>CQ</u>	<u>QD</u>	<u>PT</u>	<u>TP</u>	<u>R²</u>	<u>F-value</u>	<u>Obs</u>
Regression I	0.62** (17.72)	0.11* (2.92)	-0.20** (-4.83)	0.07* (2.28)	0.60	162.49	431
Regression II	0.81** (14.93)	0.66* (5.94)	0.11 (0.48)	0.04* (2.08)	0.43	78.68	431

Panel B: Equation (3)

	<u>CQ</u>	<u>QD</u>	<u>PT</u>	<u>SM</u>	<u>PM</u>	<u>R²</u>	<u>F-value</u>	<u>Obs</u>
Regression I	0.61** (17.27)	0.11* (2.92)	-0.19** (-4.78)	0.06* (2.04)	0.01 (0.30)	0.60	129.17	431
Regression II	0.82** (14.91)	0.66* (5.38)	0.09 (0.23)	0.07* (2.01)	-0.01 (-0.30)	0.43	63.14	431

Note: t-values are reported in the parentheses; and ** and * indicate statistical significance at 1%- and 5%-level, respectively.