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Is There a Link Between Quote Competition and Order Flows?

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ABSTRACT

This paper investigates the link between the quotes made by market makers and the order flows they receive. Using data from the London Stock Exchange, it is shown that quotes and trades are closely related despite the heavy presence of preferenced orders. Specifically, market makers receive relatively more buy (sell) orders when they change the quotes by posting only the best ask (bid) price or when they stop posting the best bid (ask), and they receive balanced orders when they post the best quotes or neither. Moreover, the fewer market makers there are that post the best quotes, the more unbalanced the orders will be that each one receives. The link between quote and trades is most pronounced in trades of medium or large sizes.

JEL classification: *G10, G13, G18*

Keywords: *Dealers; Quotes; London Stock Exchange*

I. INTRODUCTION

The aim of this paper is to investigate if quote competition is related to order flows in a dealership market. The regulator of such a market expects market makers to compete with one another to offer the best services to the investors. The quality of the services can be evaluated from different dimensions, such as the speed of the trades or the volumes of the trades, but undoubtedly it is the costs of the trades that attract much of the attention. In theory, broker-dealers route orders to those market makers who quote the lowest ask or the highest bid price. Thus, investors enjoy the lowest execution costs and market makers have to compete in quotes to attract business. In practice, broker-dealers often route preferenced orders to those market makers who execute the order at prevailing best quotes but who do not post those quote themselves. If preferenced orders are substantial, then it is interesting to see whether posting the best quotes has anything to do with attracting order flows.

This paper provides detailed analysis of quotes and trades on the London Stock Exchange (LSE), which used to be a typical multiple dealership market. Even after the introduction of electronic limit order books for liquid stocks, the majority of the stocks are still trading in a dealer system, the Stock Exchange Automated Quotation System (SEAQ), where registered market makers are obliged to maintain two-way quotes on every trading day.[2] The SEAQ screen provides relevant information of quotes, including the names of the market makers, their bid and ask prices, and the current best quotes. Nevertheless, the market participants are free to choose any market maker to trade with, even though the market maker may not post the best quotes. As a result, preferenced orders are pervasive. Board et al. (1996) and Hansch et al. (1999) respectively find that nearly 80% and 71% of the orders are preferenced. However, defining preferenced orders by volume and excluding trades with big sizes, Chang et al. (2000) find that only 36% of the orders of liquid stocks are preferenced.

Is there a link between order flows and quote competition in the London market? The evidence is mixed. Board et al. (1996) state that posting the best quotes does not make a significant difference on the terms of trades. Board et al. (2000) further provide evidence that there are some "fair weather market makers" who apparently do not commit to market making. Reiss and Werner (1998) believe that moving the quotes to attract customer order flow is costly and suggest market makers use inter-dealer trading to reduce inventory positions. Hansch et al. (1998) find that the market makers together on the best ask and the bid respectively increase market shares by 6.6% and 5.3%, such that market makers may have some incentives to compete for the order flows. Finally, Chang et al. (2000) suggest that market makers may compete in depths instead of prices.

This paper examines to what extent quotes on the LSE are related to the order flows. The investigations in this paper focus on the effects of quote competition on the order imbalance. The reason to examine order imbalance is simple. Previous work such as Reiss and Werner (1996) and Hansch et al. (1998) report that market makers usually position their quotes without changing the spread.[3] As a result, most of the time some market makers post only the best ask, others post only the best bid, while still others post neither. If market makers compete in quotes, then they appear to compete for unbalanced orders. On the other hand, it is often argued in the literature that market makers set the quotes for inventory or information reasons. It implies that market

makers have incentives to attract orders from one side of the yellow strip. Therefore, it is interesting to examine to what extent the quotes of market makers are related to the directions of the orders they receive.

One may intuitively expect the market makers who post only one side of the best quotes receive unbalanced order flows, whereas the orders of those who post both or neither side of the best quotes would be balanced. To examine the order imbalance, simple measures are created by subtracting the number or volumes of seller-initiated trades from buyer-initiated ones, expressed in percentage points. It is an approach similar to that taken by Hansch et al. (1998). They compare standardized relative inventory positions between market makers who change the quote and who have the longest or shortest inventory positions, and they conclude that changes in quotes are related to changes in inventory.

The approach used by this paper is direct and simple, without comparing inventory positions among market makers. Moreover, early studies on the LSE focus on liquid stocks, almost all of which are FTSE-100 constituents, but this paper includes less-liquid stocks in the sample. The shift of the attention is particularly interesting because only less-liquid stocks are traded in SEAQ nowadays. Moreover, there are less preferenced orders of less-liquid stocks, so that it is useful to contrast their results from those of liquid stocks.

Another reason to include less-liquid stocks is that few market makers provide quotes for them, and it turns out that the number of market makers posting the best quotes affects the link between order flows and quote status. As the number of market makers on the best quotes decreases, the orders of those who post the best quotes become even more unbalanced. The results may partly explain why the increase in market share as a result of posting the best quotes in Hansch et al. (1998) is not very impressive: They pool all the data together, including the case in which everybody posts the best quotes and the increase in market share is always zero, and the increase does not appear to be substantial.

This paper further investigates what kinds of size of trades are attracted by quotes. Market makers only honor their quotes up to a certain trade size. Prices of trades with sizes bigger than the quote size have to be negotiated between clients and the market makers, and the latter may not post the best quotes. However, it is shown that posting the best quote on one side attracts that side of the trades for different sizes. By posting the best quotes, market makers not only commit themselves to executing trades smaller than the quote size, but they also signal their willingness to execute larger trades with lower costs. The signaling effect further strengthens the link between quotes and order flows.

The remainder of the paper is organized as follows. Section II provides a descriptive and preliminary analysis of the question. Section III considers the change of order imbalance with respect to the change in quote status of market makers. Section IV provides more analysis on the quote status, trade imbalance, and trade sizes. Section V concludes the paper.

II. DATA

A. Descriptions

Data are retrieved from the CD-ROM *Transaction Data Service* provided by the London Stock Exchange. The format of the dataset is similar to the one used by Hansch et al. (1999) in that both the transaction and quote records contain the identifications of market makers. The sample includes all SEAQ trades on stocks for which more than one market maker posts quotes during all the trading days between February and March 1996. Trades in Inter-Dealer-Broker markets are excluded as they are arranged by the brokers instead of going through SEAQ.

Summary statistics of the data are shown in Table 1. There are 1,831 stocks in the sample. Twenty-eight firms act as market makers, and as many as nineteen market makers are found to quote one stock. The spreads are quite large for the less-liquid stocks. However, as the number of market makers increase, the spreads fall and the ratio of inside spread to the quote spread decreases. The quote and the inside spreads of the stocks with many market makers are similar to those in Hansch et al. (1999) and Huang and Stoll (2001), both of which study liquid stocks.

Table 1
Summary statistics

# of MM	# of stocks	% Quote Spread	% Inside Spread	Daily Number of Market Makers				Number of trades	Volume in £ millions	Preferenced trades %
				On-Ask	On-Bid	On-Both	Straddle			
2	606	8.25	7.04	0.46	0.45	1.07	0.01	70,442	904	19
3	429	7.03	5.52	0.89	0.92	0.63	0.05	67,916	1,129	29
4	250	5.23	3.64	1.28	1.33	0.31	0.16	47,497	1,274	36
5	161	4.55	2.85	1.57	1.66	0.15	0.50	37,765	1,576	40
6	112	3.17	1.92	1.92	1.99	0.03	1.02	32,808	1,320	47
7	73	3.21	1.81	1.92	2.09	0.00	1.70	29,254	1,374	51
8	74	3.21	1.85	2.16	2.54	0.00	2.14	37,753	1,665	52
9	77	2.39	1.33	2.44	2.55	0.00	2.84	66,835	2,652	56
10	32	2.30	1.32	2.63	2.51	0.00	3.38	34,973	1,815	59
11	20	2.26	1.31	2.44	2.64	0.05	3.96	22,533	1,716	56
12	23	2.42	1.30	2.47	2.36	0.09	5.54	29,480	1,644	62
13	23	2.43	1.31	2.59	2.89	0.00	5.43	36,361	2,082	59
14	21	1.72	0.95	2.90	3.27	0.00	5.70	30,031	2,452	58
15	36	1.57	0.87	2.96	3.15	0.01	7.03	59,321	3,849	63
16	46	1.38	0.74	2.45	3.13	0.00	8.47	118,717	9,059	66
17	47	1.15	0.63	3.29	3.31	0.00	8.21	99,445	6,826	68
18	32	1.09	0.56	3.11	3.25	0.00	9.03	182,322	13,095	67
19	14	1.14	0.56	2.55	3.25	0.00	10.95	143,012	10,655	71
Buy								468,940	32,327	54
Sell								677,525	32,758	58
Total								1,146,465	65,086	57

The next four columns of the table indicate the means of the number of market makers in one of the four quote status during the day: At best ask only ("on-ask"), at best bid only ("on-bid"), at both best bid and ask ("on-both"), and at neither of the best quotes ("straddling" the yellow strip).[4] The number of market makers who straddle the yellow strip is bigger than in previous studies. Reiss and Werner (1996) find the median

of market makers on the best bid, ask, and straddle are 4, 4 and 1 respectively. Hansch et al. (1998) report that 70% of market makers quote one side, and there are typically two to four market makers at either side at any time. Board et al. (1996) also state that more than half of the market makers are on either side of the best quote. In the current sample, however, straddling the yellow strip is much more common.

Despite the apparent differences, this sample exhibits some other features similar to those in previous studies. For example, same as documented in Board et al. (2000), market makers use a few common spreads, among which three, five, seven, and ten pence are the most popular ones. Second, although there is no formal tick rule, market makers appear to post the quotes in pence. Regarding the change in quotes, it is very rare for market makers to change the spreads or the quote size. More than 99% of the quote changes are to move the bid and ask upwards or downwards together by one or two pence.

The next columns report statistics from trade records. There are more than 1.1 million trades and the volumes of the trades are more than 65 billion pounds sterling. A lot of trades concentrate on a few stocks with many market makers. In contrast, those stocks with only two or three market makers do not trade very frequently. The bottom of the table reports the trades classified as buyer- and seller-initiated trades, which are defined according to the opposite direction of the market makers. Seller-initiated trades are much more than buyers' trades, but the difference between trading volumes is rather small. It implies that the sample consists of relatively big buyer-initiated trades and many small seller-initiated ones.

The last column of the table reports the percentage of preferenced trades, which, following Hansch et al. (1999), Board et al. (2000), and Chung et al. (2004), are defined as the buyer- (seller-) initiated trades executed by those market makers who were not posting the best ask (bid) prices. Fifty-seven percent of trades are preferenced in the sample. Seller-initiated trades are more likely to be preferenced than buyer-initiated ones. Furthermore, the proportion of preferenced trades is positively related to the number of market makers, along with the number of trades and the turnovers.[5]

The positive relationship between the number of market makers and the proportion of preference trades seems counterintuitive, for the number of market makers is often regarded as a proxy for competitiveness. However, in an investigation on the behavior of London's market makers of liquid stocks, Board et al. (2000) find that some of them do not act in a competitive way, including keeping away from the best quotes and trading mainly with the other market makers. On the other hand, preferenced trades may be a result of competition: If it is too costly to obtain orders by competitive quotes, market makers may seek other means for orders. Indeed, the evidence from Section 3 reveals that posting the best quotes along with a lot of market makers may not obtain many orders.

B. Order Flows and Quote Status: Preliminaries

Hansch et al. (1998) show that the quotes of market makers have small, albeit statistically significant, effects on the trades received; Reiss and Werner (1998) suggest that it is difficult for the market makers to attract orders by moving the quotes; Table 2 examine their claims by grouping the trades by the quote status: "On-ask", "on-bid", "on-both", and "straddle". Panel A reports the number of trades and trading volumes of

the full sample. It shows that market makers execute both buy and sell trades regardless of their quote status, which is a direct consequence of preferenced orders. However, the quote status does make a difference in order imbalance after a close look.

Table 2
Trades in the four-way classification

Panel A. The Full Sample

	Quote	Number of Trades					Volume in £1,000				
	status	Buy	%	Sell	%	Δ^N	Buy	%	Sell	%	Δ^V
	On-ask	160,198	46	187,352	54	-8	11,376,731	57	8,612,404	43	14
	On-both	53,384	49	55,687	51	-2	1,459,523	49	1,507,682	51	-2
	Straddle	126,913	38	207,676	62	-24	9,637,799	49	10,001,909	51	-2
	On-bid	128,445	36	226,810	64	-28	9,853,088	44	12,636,450	56	-12

Panel B. Groups by Different Number of Market Makers (MM)

Number	Quote	Number of Trades					Volume in £1,000				
of MM	status	Buy	%	Sell	%	Δ^N	Buy	%	Sell	%	Δ^V
2-4	**On-ask**	32,645	61	21,004	39	22	487,309	51	459,556	49	1
	On-both	38,896	54	33,640	46	8	602,480	50	610,216	50	0
	Straddle	1,918	46	2,220	54	-8	46,828	50	46,511	50	0
	On-bid	24,920	45	30,612	55	-10	508,892	48	544,987	52	-4
5-15	**On-ask**	66,804	49	70,070	51	-2	4,068,183	54	3,467,166	46	8
	On-both	11,832	42	16,410	58	-16	701,571	49	721,250	51	-2
	Straddle	44,406	41	62,954	59	-18	2,300,238	49	2,373,299	51	-2
	On-bid	53,010	37	91,628	63	-26	3,943,059	46	4,569,050	54	-8
16-19	**On-ask**	60,749	39	96,278	61	-22	6,821,239	59	4,685,683	41	18
	On-both	2,656	32	5,637	68	-36	155,472	47	176,216	53	-6
	Straddle	80,589	36	142,502	64	-38	7,290,733	49	7,582,099	51	-2
	On-bid	50,515	33	104,570	67	-34	5,401,137	42	7,522,412	58	-16

Trades are classified according to the quote status of the market makers when they are executed. The four quote status are: Posting the best ask only ("on-ask"), the best bid only ("on-bid"), both the best bid and ask ("on-both"), and neither ("straddling" the best quotes.) Δ^N is defined as the percentage of the number of buy trades minus sell, and Δ^V is the percentage of the buy volumes minus sell.

Define Δ^N as the percentage of the number of buys minus the percentage of the number of sells, and define Δ^V as the percentage of buy volumes minus the percentage of sell volumes. Thus, Δ^N and Δ^V respectively measure the trade and volume imbalance of the market makers under different quote status. Had there been no preferenced orders, then those market makers who post only the best ask would receive only buy orders, and $\Delta^N = \Delta^V = 100\%$. By contrast, $\Delta^N = \Delta^V = -100\%$ for those who post the best bid only. However, there are more sell orders than buy orders and many of the orders are preferenced, and Δ^N is all negative for all the quote status in Panel A. On the other hand, the volumes are more balanced than the number of trades. They are positive in "on-ask" and negative in the other three categories, and the smallest Δ^V occurs in the "on-bid". In other words, market makers who post the best ask (bid) only receive relatively more

buy (sell) volumes despite the presence of preferenced orders.[6]

Panel B further divides the sample into three groups according to the number of market makers of the stocks. The grouping of the stocks reflects not only the competition among market makers, but also the liquidity of the stocks and the level of order preferencing. The first group includes the majority of the stocks. They are thinly-traded stocks with no more than four market makers. The third group consists of over one hundred stocks with no less than sixteen market makers. These stocks account for more than half of the trading volumes on the Exchange.

In each group, Δ^N is biggest in the "on-ask" category and smallest in the "on-bid" category, indicating that posting the best ask (bid) only attracts relatively more buy (sell) orders in a market with a heavy presence of preferenced sell orders. The picture is even clearer with Δ^V, which is positive in the "on-ask" category and negative in the "on-bid" in all of the sub-samples. The result suggests that large-size orders go to market makers who post the best quotes, which is an interesting phenomenon that will be explored later.

III. THE DYNAMICS OF ORDER IMBALANCE

A. Changes in Quote Status

Table 2 shows that quoting on one side of the yellow strip attracts relatively unbalanced orders. However, it is a static analysis. The quote status of market makers may change during a day when one or more market makers move their quotes. It is interesting to see whether the change in the quote status affects the balance of orders.

Table 3 presents the means of the changes of Δ^V as the quote status of market makers change. Similar to the previous section, Δ^V of a particular quote status x is defined as the percentage of buy volumes minus that of sell volumes during the time of which the quote status of the market maker is x. The change of Δ^V presented in the table is defined as Δ^V after the change of the quote status minus Δ^V before the change. An increase in Δ^V means the orders received by the market makers are more unbalanced toward the buy side after the change in quote status, and a fall in Δ^V means the orders are more unbalanced toward the sell side.

The quote status is classified into the four categories in Table 3 as in the previous section. The sample only includes the change in Δ^V of the consecutive periods when trades are executed in the market.[7] The mean changes of Δ^V in Panel A reveal that order flows change according to the changes in quote status. For example, Δ^V increases when market makers change from any other categories to "on-ask" or when they change from "on-bid" to any other categories. On the other hand, Δ^V falls when market makers change from "on-ask" to any other categories or when they move from any others to "on-bid". The mean change could be as large as seventeen percentage points.

The number of events is large in a few status-change categories. Therefore, the t-values are subject to Lindley's (1957) paradox that they are increasing in the sample size. The solution in classical statistics is to raise the significant level. Alternatively, Connolly (1989) adapted Leamer's (1978) approach to use the Bayesian critical values

$$t^* = [(n-1)*(n^{1/n}-1)]^{0.5} \quad (1)$$

where n is the sample size. The t-values are significant in the Bayesian sense if they are greater than t^*.

The results from both approaches are reported in Table 3. The t-values which are significant at 0.001 and 0.0001 levels in the classical sense are indicated by one and two asterisks, respectively. The t-values which are significant in the Bayesian sense are typeset in boldface. The different significant criteria yield similar results. The changes are significant whenever market makers move from or into "on-bid" or "on-ask" categories; whereas the changes between "on-both" and "straddle" rarely occur and their Δ^V are not statistically significant.[8]

Table 3
Percentage change of volume imbalance with respect to change in quote status

Panel A. The full sample								
	To: On-ask		**To: On-both**		**To: Straddle**		**To: On-bid**	
From:	Mean	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
On-ask			-8.75	**-14.21****	-5.69	**-29.17****	-14.74	**-37.79****
On-both	14.25	**24.58****			11.46	1.34	-17.47	**-30.07****
Straddle	5.73	**28.60****	1.02	0.11			-6.31	**-30.60****
On-bid	11.91	**29.12****	6.13	**10.86****	3.23	**16.80****		
Panel B. 2-to-4 market maker group								
	To: On-ask		**To: On-both**		**To: Straddle**		**To: On-bid**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
On-ask			-16.20	**-12.71****	-12.92	**-4.45****	-39.26	**-20.19****
On-both	29.29	**24.67****					-36.10	**-29.33****
Straddle	21.28	**7.78****					-16.11	**-5.48****
On-bid	40.04	**19.92****	13.73	**11.29****	4.47	1.71*		
Panel C. 5-to-15 market maker group								
	To: On-ask		**To: On-both**		**To: Straddle**		**To: On-bid**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
On-ask			-6.99	**-7.87****	-6.71	**-17.91****	-15.87	**-25.46****
On-both	9.14	**10.73****			-7.69	-0.37	-10.15	**-12.03****
Straddle	6.09	**15.69****	2.91	0.19			-7.98	**-19.71****
On-bid	11.35	**17.59****	2.84	**3.49****	4.07	**11.11****		
Panel D. 16-to-19 market maker group								
	To: On-ask		**To: On-both**		**To: Straddle**		**To: On-bid**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
On-ask			-1.64	-1.68	-5.16	**-22.67****	-10.60	**-21.32****
On-both	3.80	**4.18****			16.05	1.85	-7.36	**-8.32****
Straddle	5.39	**23.09****	-0.28	-0.03			-5.50	**-23.00****
On-bid	8.69	**16.43****	2.60	**2.95***	2.84	**12.59****		

The volume imbalance (Δ^V) is the percentage of the buy volumes minus sell. The table reports the mean change Δ^V in volume imbalance when the quotes the market makers change from one of the four status to another. The four quote status are: Posting the best ask only ("on-ask"), the best bid only ("on-bid"), both the best bid and ask ("on-both"), and neither ("straddle".) One and two asterisks (*) respectively indicate the t-values are significant at the 0.001 and 0.0001 level in classical statistics. Boldface t-values indicate that they are significant in Bayesian statistics.

The next three panels report the change in Δ^V in the three sub-samples grouped by the number of market makers. The pattern prevails that a move to the "on-ask" ("on-bid") category increases (reduces) Δ^V, and a move out of the "on-ask" ("on-bid") category reduces (increases) Δ^V. In each group, the biggest changes in Δ^V take places when the quote status changes between "on-ask" and "on-bid", that is, when market makers change their quotes from one extreme to another. Furthermore, the magnitude of the change is much bigger in Panel B than in Panel C, which is slightly bigger than in Panel D.

Although the grouping reflects the competition, the liquidity, and the level of order preferencing of the stocks, one may be eager to conclude that only the last characteristic is capable of explaining the difference among the three groups. After all, the last group contains large number of preferenced orders, so is it not obvious that the small change of order imbalance in the last group is due to the presence of substantial preferenced orders?

B. Competitions on the Yellow Strip

The number of market makers plays a substantial role, because non-preferenced orders may go to any market makers on the yellow strip.[9] Therefore, the more market makers there are on the yellow strip, the smaller the order flows will be that each market maker receives. To illustrate whether the number of market makers on the yellow strip indeed affects the order imbalance of those market makers, trades are classified by whether the market maker is on the best quote, and by how many market makers there are on the best quote.

Three categories are identified if the market maker is on the best ask (bid): A_1 (B_1) includes the trades of those market makers who stand alone on the best ask (bid), A_2 (B_2) includes the trades of those market makers who post the best ask (bid) when the number of market makers on the best ask (bid) is less than half of the total number of market makers, and A_3 (B_3) include the trades of those market makers who post the best ask (bid) when the number of market makers on the best ask (bid) is equal to or more than half of the total number of market makers. Categories A_4 and B_4 include trades by the market makers who are not on the best ask (bid).

Table 4 reports the mean change of Δ^V as the quote status changes, where the quote status is classified according to the status of the best ask. Panel A shows that if a market maker moves from A_4 to any other categories, then Δ^V increases. On the other hand, if a market maker moves from any other categories to A_4, then Δ^V falls. The change in Δ^V ranges from −24% to 23% and all of the t-statistics are significant. If a market maker has been on the best ask, then a move to a category with more (less) market makers on the best ask increases (reduces) Δ^V. Regarding the results from the sub-samples grouped by the number of market makers of the stocks, the patterns are still the same, and the quote changes between two extreme quote status (A_1 and A_4) yield the biggest changes in order imbalance.

Table 4
Change of volume imbalance with different number of market makers on the best ask

Panel A. The full sample								
	To: A_1		**To: A_2**		**To: A_3**		**To: A_4**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
A_1			-7.03	**-8.72****	-19.47	**-20.69****	-24.36	**-27.77****
A_2	16.64	**22.96****			-2.40	**-4.31****	-8.70	**-33.59****
A_3	26.35	**26.65****	4.62	**13.11****			-9.49	**-40.59****
A_4	23.48	**26.11****	6.56	**20.24****	4.63	**21.99****		
Panel B. 2-to-4 market maker group								
	To: A_1		**To: A_2**		**To: A_3**		**To: A_4**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
A_1					-18.96	**-13.83****	-43.21	**-14.10****
A_2								
A_3	32.83	**24.56****					-32.17	**-33.22****
A_4	39.86	**12.12****			17.49	**17.83****		
Panel C. 5-to-15 market maker group								
	To: A_1		**To: A_2**		**To: A_3**		**To: A_4**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
A_1			-5.78	**-4.41****	-23.11	**-12.66****	-25.13	**-16.12****
A_2	17.12	**14.50****			-3.53	**-4.20****	-11.86	**-23.29****
A_3	18.85	**9.59****	6.42	**10.18****			-8.37	**-22.16****
A_4	22.51	**13.93****	8.51	**13.57****	3.67	**10.32****		
Panel D. 16-to-19 market maker group								
	To: A_1		**To: A_2**		**To: A_3**		**To: A_4**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
A_1			-7.83	**-7.67****	-16.54	**-9.36****	-20.71	**-18.49****
A_2	16.31	**17.82****			-1.24	-1.70	-7.40	**-24.74****
A_3	14.57	**6.99****	3.53	**8.47****			-5.85	**-19.85****
A_4	21.67	**18.98****	5.72	**15.18****	3.22	**12.55****		

The volume imbalance (Δ^V) is the percentage of the buy volumes minus sell. The table reports the mean change in volume imbalance when the ask price quoted by the market maker change from one of the four status to another. The status A_1, A_2 and A_3 indicates that the market maker posts the best ask alone, with less than half of the market makers, with half or more of the market makers, respectively. A_4 indicates that the market maker does not post the best ask. One and two asterisks (*) respectively indicate the t-values are significant at the 0.001 and 0.0001 level in classical statistics. Boldface t-values indicate that they are significant in Bayesian statistics. There are no more than four market makers of the stocks in Panel B so that there is no trade in A_2.

Table 5 further reports the change of Δ^V as the quote status change, where the quote status is classified according to the number of market makers on the best bid. It shows that if a market maker moves from B_4 to any other categories, then Δ^V falls. If a market maker moves from any other categories to B_4, then Δ^V increases. If a market maker has already been on the best bid, then Δ^V falls (increases) when he moves to a category with more (less) market makers on the best bid. The sub-samples repeat the same pattern as Panel A.

Table 5
Change of volume imbalance with different number of market makers on the best bid

Panel A. The full sample								
	To: B_1		**To: B_2**		**To: B_3**		**To: B_4**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
B_1			2.69	**3.33****	13.79	**14.21****	21.71	**22.30****
B_2	-10.42	**-13.80****			-0.03	-0.06	5.38	**20.53****
B_3	-29.03	**-29.25****	-6.35	**-18.57****			5.78	**25.05****
B_4	-24.40	**-24.35****	-7.19	**-21.91****	-5.33	**-25.01****		
Panel B. 2-to-4 market maker group								
	To: B_1		**To: B_2**		**To: B_3**		**To: B_4**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
B_1					15.81	**11.56****	37.78	**11.06****
B_2								
B_3	-37.84	**-28.28****					26.83	**28.60****
B_4	-48.90	**-14.31****			-19.34	**-19.68****		
Panel C. 5-to-15 market maker group								
	To: B_1		**To: B_2**		**To: B_3**		**To: B_4**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
B_1			2.15	1.71	14.22	**7.16****	23.98	**13.76****
B_2	-10.98	**-8.91****			-0.19	-0.25	6.88	**13.24****
B_3	-18.35	**-9.59****	-7.35	**-11.56****			5.24	**14.11****
B_4	-22.77	**-12.79****	-10.04	**-16.15****	-6.65	**-18.39****		
Panel D. 16-to-19 market maker group								
	To: B_1		**To: B_2**		**To: B_3**		**To: B_4**	
From:	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
B_1			3.11	**2.96***	7.94	**4.37****	17.51	**14.20****
B_2	-10.02	**-10.56****			0.11	0.17	4.77	**15.81****
B_3	-14.98	**-6.85****	-5.83	**-14.54****			1.98	**6.71****
B_4	-21.11	**-16.48****	-5.89	**-15.32****	-2.17	**-8.36****		

The volume imbalance (Δ^V) is the percentage of the buy volumes minus sell. The table reports the mean change in volume imbalance when the bid price quoted by the market maker change from one of the four status to another. The status B_1, B_2 and B_3 indicates that the market maker posts the best bid alone, with less than half of the market makers, with half or more of the market makers, respectively. B_4 indicates that the market maker does not post the best bid. One and two asterisks (*) respectively indicate the t-values are significant at the 0.001 and 0.0001 level in classical statistics. Boldface t-values indicate that they are significant in Bayesian statistics. There are no more than four market makers of the stocks in Panel B, so that there is no trade in B_2 group.

There are interesting similarities among the patterns exhibited in the last three panels of Table 4 and Table 5. For example, the changes of Δ^V between adjacent quote categories are often modest, whereas that between A_1 (B_1) and A_4 (B_4) are quite substantial. Furthermore, the magnitude of change in volume imbalance in the first sub-group is still the biggest, but the change in the other two groups can be as big as 25%, i.e., the difference among the three groups is not as big as those found in Table 3. The classification in Table 3 does not consider the number of market makers posting the best ask or the best bid, and the "on-bid" and "on-ask" categories of the third group consist of trades with the presence of many "on-bid" or "on-ask" market makers. As

non-preferenced orders are divided by them, any individual market maker only receives a small proportion of orders and the change in order imbalance is small. Competition in liquid stocks paradoxically undermines the link between quote status and order flows.

C. Order Imbalance, Number of Market Makers, and Preferenced Trades

In Table 1, it has been shown that the proportion of preferenced trades increases with the number of market makers of the stocks. In Table 3, it has been shown that the magnitude of the change of volume imbalance decreases with the number of market makers. Although the evidence from the last section indicates that order imbalance depends on the competition on the yellow strip, the readers may still wonder whether the number of market makers only serves as a proxy for preferenced orders and has no marginal explanatory power for the imbalance.

To explore the role of preferenced orders on order imbalance, the stocks in each number-of-market-maker group are further classified into three categories by the proportion of preferenced orders. The three categories are (a) less than 40% of the orders are preferenced, (b) between 40% and 60% of the orders are preferenced, and (c) more than 60% of the orders are preferenced. Then a study similar to one in Section 3.2 is conducted to examine the change in volume imbalance when the market makers change their ask-quote status.[10]

Similar to the findings in the previous section, the results show that, with very rare exceptions, a move to a category with more (less) market makers on the best ask significantly increases (reduces) Δ^V. The less number of market makers, or the less preferenced orders, the bigger the magnitude of change in Δ^V. However, each variable has some explanatory power for the change in Δ^V after controlling the other one. For example, comparing the groups with the same number of market makers, the magnitude of the change in Δ^V is often smaller for the group with more preferenced orders. Comparing the groups with the same level of preferenced orders, the magnitude of the change is often smaller for the group with more market makers. The average difference of the magnitude of the change is 4.93% for the comparison with different level of order preferencing, and it is 5.80% with different number of market makers. It suggests that both the level of order preferencing and the number of market makers explain the volume imbalance; the latter cannot be regarded as only a proxy for the former.

IV. ORDER IMBALANCE AND TRADE SIZES

In SEAQ market makers indeed honor the quotes up to a certain size, which is one or half times the Normal Market Size (NMS),[11] but they may negotiate the terms of trades with customers. When a customer seeks to execute a large order, it is not necessary for her to trade with those market makers who are posting the best quotes. It is possible, however, that posting the best quotes signals the willingness of the market makers to execute the large trades at lower costs. The signaling effect will therefore strengthen the link between quote and order flow.

To investigate the relationship between the sizes of trades and quote competition, trades are classified into groups based on the NMS. The majority of the trades are of less than 0.05 NMS multiples, but they only contribute less than 4% of the volume to the market. The volume concentrates on trades with sizes between one and seventy-five

NMS multiples.

Define Δ^V similar to before as the percentage difference between buy and sell volumes in one of the four-way categories of a particular stock of a market maker within a particular size range. Table 6 presents the means and t-statistics of Δ^V in different size groups.[12] The familiar pattern emerges from most of the size groups, where Δ^V in the "on-ask" category is positive except for the group of trades smaller than 0.1 times NMS and trades bigger than 6 times NMS. The biggest Δ^V in the category is 39.69%, which occurs with trades between 1 and 2 times NMS.

On the other hand, Δ^V in the "on-bid" category is negative except for a big trade-size group. The smallest Δ^V in the "on-bid" category is −44.82%, which occurs with trades between 1 and 2 times NMS, too. Furthermore, Δ^V in the "on-ask" category is almost always bigger than that in the "on-both" or "straddle" category, which is bigger than that in "on-bid" category. The exceptions occur at the two biggest trade-size categories.

The most unbalanced order flows in both "on-bid" and "on-ask" categories overall occur around the size of one times NMS, as market makers are not obliged to trade above that size. Nevertheless, those who post one side of the best quote execute orders bigger than the quote size, implying that those who post the best quotes will trade with the public at *any* size. It is not surprising that the means of volume imbalance of the group with six times NMS or more show different signs in the "on-bid" or "on-ask" category, because the very large trades often experience lengthy negotiations. Some of them are pre-arranged (Franks and Schaefer, 1995); some of them are matched by market makers between two or more customers. The particularity of the very large trades implies that market makers are aware of the trades long before they are executed. Therefore, the quote status at the time of trade execution has little to do with the big trades.

Table 6
Volume imbalance by sizes of trades

NMS multiples	**On-ask**		**On-both**		**Straddle**		**On-bid**	
between	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**	**Mean**	***t*-value**
0 – 0.05	-6.43	**-5.86****	-13.66	**-9.08****	-20.55	**-18.53****	-27.20	**-26.24****
0.05 – 0.1	-2.90	-2.51	-8.78	**-5.10****	-14.04	**-11.61****	-22.05	**-19.98****
0.1 – 0.2	2.20	2.01	-7.46	**-4.83****	-11.72	**-9.65****	-23.28	**-22.44****
0.2 – 0.5	14.65	**15.19****	-4.73	**-3.61***	-9.66	**-8.33****	-28.24	**-31.12****
0.5 –1	29.11	**27.58****	-5.05	**-3.40***	-3.37	-2.41	-34.52	**-34.00****
1 – 2	39.69	**40.04****	-7.58	**-5.23****	-3.15	-2.22	-44.82	**-47.73****
2 – 3	33.76	**27.44****	-4.43	-2.57	-1.60	-0.90	-34.50	**-29.17****
3 – 6	16.25	**12.44****	-6.94	**-4.15****	-0.90	-0.50	-17.82	**-14.41****
6 – 75	-7.11	**-5.31****	-5.83	**-3.74***	-4.77	-2.40	4.56	**3.63***
> 75	-15.05	**-3.30**	-1.33	-0.30	28.26	**2.56**	-2.01	-0.48

This table reports average volume imbalance in four quote-status categories: Posting the best ask only ("on-ask"), the best bid only ("on-bid"), both the best bid and ask ("on-both"), and neither ("straddling" the best quotes.) The imbalance, Δ^V, is the percentage of the buy volumes minus sell. One and two asterisks (*) respectively indicate the t-values are significant at the 0.001 and 0.0001 level in classical statistics. Boldface t-values indicate that they are significant in Bayesian statistics.

What is really interesting is that the order imbalance concentrates on the very small trades. Order preferencing seems to be prevalent in small trades, and being on one side of the yellow strip does not attract many orders from that direction. In fact, the result is consistent with the early investigation of Board et al. (1996), in which they examine exclusively small trades and only detect a very weak link between quote status and order flows.

V. CONCLUSIONS

Applying a detailed analysis to a rich data set, it is found that the quoting behavior of market makers is closely related to the order flows they receive. Those market makers who move to the best ask or leave the best bid will receive more buy volumes and less sell volumes. Those who move to the best bid or leave the best ask will receive more sell volumes and less buy volumes. The more market makers there are posting the best quotes, the smaller the effects will be of changing quotes on order imbalance. The relationship between quote status and order imbalance holds if the latter is measured in the number of trades instead of volume. The strongest link between trades and quotes is among medium to large trades.

The link between order flows and quote status is not established by the rule of the exchange under which the market makers are obliged to offer competitive prices. Instead, the evidence suggests that the quotes are driven by the intentions of market makers to adjust their inventory levels or to derive any gain from information. Posting the best quote, especially posting the best quote alone on one side, essentially reveals the willingness of market makers not only to trade up to a certain quote size, but to trade with the public at any size. Although the vast amounts of preferenced orders are not related to quotes, they are mainly small trades. Big trades go to those market makers who post the best quotes, and they generally get the volumes they want in the end.

ENDNOTES

1. Part of this works was done when the author was at London School of Economics. I thank Market Quality Group, the London Stock Exchange for providing data, and John Board, Chuang-Chang Chang, Lucie Chaumeton, Andrew Ellul, Bruce Lehmann, Narayan Naik, Charles Sutcliffe, Stephen Wells, and an anonymous referee for helpful comments.
2. The most liquid stocks have been traded in an electronic system SETS since 1997. Recently, the Exchange has set up a new system, SETSmm, for moderately liquid stocks, where market makers are obliged to post limit orders in the electronic order book.
3. Chan et al. (1995) observe similar patterns in NASDAQ.
4. Because the best quotes are highlighted in yellow color on the SEAQ screen, they are also known as “the yellow strip.” Another jargon for the best quote is “touch” (Hansch et al., 1998).
5. The Pearson correlation coefficient of the number of a stock’s market makers and its proportion of preferenced orders is 0.7571.
6. In SEAQ, the only orders market makers receive are market orders, and the number

of trades and the number of orders are equivalent.

7. A trade occurs in a dealership market when a broker-dealer routes an order to a market maker. If no investor is willing to trade, then Δ^V is zero regardless of the quote status. Therefore, the periods during which no trades occur are excluded from the analysis. The sample selection increases the weights of the liquid stocks in the full sample, but it does not affect the sub-samples grouped by the number of market makers.
8. The quote status of a market maker may switch between "on-both" and "straddle", because (a) the market maker himself widens or shrinks the spread, which rarely happens; (b) two or more market makers move the quotes to opposite directions simultaneously, which is even less likely to happen.
9. Theoretical models of dealership markets often assume that non-preferenced orders are equally split among those market makers who post the best quotes (Bondarenko 2001; Kandel and Marx 1997; 1999; Vogler 1997).
10. To save the space, only the key results are summarized below. The detailed report is available from the author upon request.
11. The NMS is a measure computed by the LSE to capture the equivalence of 2.5% of daily trading volume.
12. Note that this is a static analysis extended from Table 2. A dynamic analysis of dividing trades according to quote status and trade size would not only be excessively complicated but the result would also be difficult to interpret, even if the number of trade-size categories were reduced to two.

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