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Upstairs Market for Principal and Agency Trades: Analysis of Adverse Information and Price Effects

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ABSTRACT

This paper directly tests the hypothesis that upstairs intermediation lowers adverse selection cost. We find upstairs market makers effectively screen out information-motivated orders and execute large liquidity-motivated orders at a lower cost than the downstairs market. Upstairs markets do not cannibalize or free ride off the downstairs market. In one-quarter of the trades, the upstairs market offers price improvement over the limit orders available in the consolidated limit order book. Trades are more likely to be executed upstairs at times when liquidity is lower in the downstairs market.

THIS PAPER EXAMINES THE EXTENT to which upstairs market makers, who know the identity of parties submitting orders, route orders based on perceived information content. The paper also investigates whether the upstairs market cannibalizes or free rides off the downstairs market.

The recent explosive growth of Electronic Communications Networks (ECNs) and other anonymous order entry systems, such as Island and Instinet, raises the question of the role and importance of an upstairs market. As discussed in Harris (1993), off-market activities potentially impose a number of externalities on public exchanges. These can make it difficult to enforce secondary precedence rules. For example, in the downstairs market, orders are generally matched first on the basis of price and second on the basis of time of arrival. However, as orders received in the upstairs market do not have to be submitted immediately to the downstairs market, they may be matched in the upstairs market ahead of any equally priced orders in the downstairs market.

On the other hand, Burdett and O'Hara (1987) and Seppi (1990) suggest that the upstairs markets are a response to the needs of clients who wish to transact a large block of shares but do not want their full orders revealed to

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the downstairs market. This is because the traders in the downstairs market cannot know the motives of the block buyer or seller without a costly time-consuming search. Upstairs traders conduct these audits of clients and screen out orders containing adverse information. As discussed in Grossman (1992), another role of upstairs trading is to collect information on unexpressed supply of and demand for securities and to utilize that information to facilitate block trades.

In summary, the public policy debate over upstairs trading revolves around trade-offs of potential costs and benefits. The benefits accrue to those submitting large block orders from screening for adverse information and from facilitating trades based on knowledge of unexpressed supply and demand. The costs are the network externalities imposed on the rest of the market. This paper contributes to the debate in five ways. First, the paper provides detailed information on the extent of upstairs agency and principal trading on The Toronto Stock Exchange (TSE), whose electronic trading system has been adopted by a number of other agency auction exchanges such as the Paris Bourse. Over half of the volume on the TSE, in our sample, is facilitated by the upstairs market and approximately 40 percent of that is done on a principal basis. Upstairs trades involve securities of firms that are less liquid, slightly smaller, and less volatile than those of downstairs trades.

Second, the paper directly tests whether upstairs intermediation solves the adverse selection problem. It shows that the upstairs market almost entirely screens out any trades motivated by adverse information. The fact that market participants who know the identity of potential counterparties' screen orders is documented in previous studies such as Scholes (1972). We add to this literature by directly measuring the extent of this screening.

Third, by the use of a unique database, the paper demonstrates that there is no difference between principal and agency adverse selection costs in the upstairs market.[1] When upstairs market makers take positions as a principal and hold an inventory of securities, their capital is at risk. Consequently, we hypothesize that the upstairs market makers will not take a principal position in an information-motivated trade. Our findings suggest that the clients of upstairs brokers also rely on them as agents to screen out information-based orders. This is consistent with the notion that upstairs market makers value their reputation capital and that clients can easily monitor whether a particular broker is acting in their interests. As transactions are immediately and widely disclosed, the extent of screening by upstairs traders is highly visible.

Fourth, we compare temporary and total price impacts between the types of trades in a multivariate analysis. As in Madhavan and Cheng (1997), we find order execution costs, as measured by total price impacts, have a higher fixed component but lower variable component in the upstairs market than

[1] A few other papers, including Panchapagesan (1998) and Sofianos (1995), examine market makers' endogenous order execution decisions in the context of the downstairs market.

in the downstairs market.[2] In particular, trades greater than 24 percent of the median daily trading volume are less expensive to execute in the upstairs than the downstairs market. We find that total and temporary price impacts are lower for upstairs principal trades than for upstairs agency trades. This result is consistent with the argument that brokerage firms are interested in maintaining their reputation capital. The visibility of the price impacts and the ongoing broker–client relationships would dissuade upstairs market makers from actions such as cream-skimming their clients. See Roell (1990).[3]

The concern over access to order flow by upstairs market makers is connected with the issue of whether upstairs crosses should have time priority over preexisting downstairs limit orders at the same price. Subsequent to the period of our study, on August 31, 1998, the TSE established Rules 4-402 and 4-502 that require that small orders of 1,200 or fewer shares be immediately sent to the consolidated limit order book and that upstairs principal trades of 5,000 or fewer shares improve upon the price available in the limit order book. We find that approximately one-quarter of the upstairs trades result in price improvement over the limit orders available at the time of the trade in the downstairs market. While 75 percent of the upstairs trades occur at the best available limit order prices, the generally large size of the upstairs trades relative to depth available in the limit book and the lower order execution costs documented in this paper indicate that the upstairs market is providing liquidity over and above that available in the downstairs market.

Fifth, the paper measures one of the potential negative externalities associated with the upstairs market. Harris (1993) notes that the upstairs and downstairs markets may unduly fragment the market if orders received upstairs are not disclosed in a timely manner to the total market. Conversations with TSE officials indicate that orders submitted to the upstairs market are dealt with quickly due to the exposure of upstairs market makers to adverse price movement from holding orders. In addition, the literature indicates that the wider the bid-ask spread, the lower the liquidity of the market. We find the wider the spread, the more likely the trade is executed upstairs. Furthermore, the lower the depth on the opposite side of the limit order book, the more likely the trade will be executed upstairs, given the greater need to supply liquidity to the market. Overall, the upstairs market makers provide liquidity when liquidity is low in the downstairs market, and thus we conclude the two markets are complementary.

Section I of the paper describes the rules governing the upstairs market of the TSE. Sections II and III discuss the analysis and conclusions, respectively.

[2] Additional explanations for lower costs are the sharing of the double commissions and the bundling (several small orders comprise one or both sides of the trade) of upstairs orders.

[3] Another concern raised by Fishman and Longstaff (1992) regarding traders acting as both brokers and dealers is front-running of client orders. Front-running is illegal on The Toronto Stock Exchange as well as other exchanges such as the NYSE. As we do not have the time when various orders are received in the upstairs market, we cannot measure this activity.

I. Order Execution on The Toronto Stock Exchange

The TSE is a continuous auction market with a fully open consolidated limit order book. All orders submitted to the exchange must be recorded on the consolidated limit order book. Thus, the TSE is totally transparent. As described in greater detail below, even if a trade is consummated in the upstairs market, it can be identified by two matching orders in the limit order book. All retail and institutional orders must be submitted to the exchange through a member firm. The member firms submit all orders to the TSE electronically.[4]

The member firms of the TSE operate the upstairs market of the exchange. Member firms receive all orders and are allowed to fill these orders in the upstairs market. However, the TSE requires member firms to execute these orders in the upstairs market on terms at least as favorable as those available through the downstairs market at the time the order is received.[5] This obligation leads upstairs market makers to submit most orders immediately to the downstairs market. In the upstairs market, the order may be filled by the member firm acting as principal or as agent. Orders filled in the upstairs market are sent as "put-throughs" to the consolidated electronic order book that comprises the downstairs market. This means that the orders are recorded in the order book as two orders submitted at the same time that are matched with each other. The client order flow is shown in Figure 1. Those orders that are not filled in the upstairs market are entered in the consolidated electronic order book as limit orders (market orders are entered as limits at the price on the opposite side of the book) and follow strict price priority rules.[6]

Because of the complete transparency of the consolidated order book, the public can tell when a trade is executed upstairs. If the trade did not change any outstanding limit orders, the trade was executed upstairs. However, whether it was a principal or agency trade is not revealed on a real-time basis. Only the member firm executing the trade knows this information.

We use a TSE database comprising all transactions for securities priced more than or equal to $5.00 during June 1997.[7] For each order sent to the downstairs market, the data indicate its direction, price, size, and time of submission to the nearest second, as well as details on related fills, changes, and cancellations. For transactions in the upstairs market, we have information on all put-throughs, including their size, time, and whether upstairs market makers acted as principal or agent. While a longer period of data

[4] Retail and institutional clients can submit orders to the member firms by a variety of means, such as telephone, the Internet, or in person, before they are passed along to the TSE electronically. Nonmember institutional clients submit orders directly to upstairs traders of the member firms, whereas retail orders generally pass through retail brokers to upstairs traders of the member firms.

[5] See Sections 3.10 and 3.11 of the May 1997 Toronto Stock Exchange Equities Trading Manual.

[6] For a detailed discussion of these price priority rules, see Griffiths et al. (2000).

[7] This avoids measurement error due to changing tick sizes. As of April 1996, securities trading at $5.00 or more on the TSE have a tick size of $0.05. See Griffiths et al. (1998).

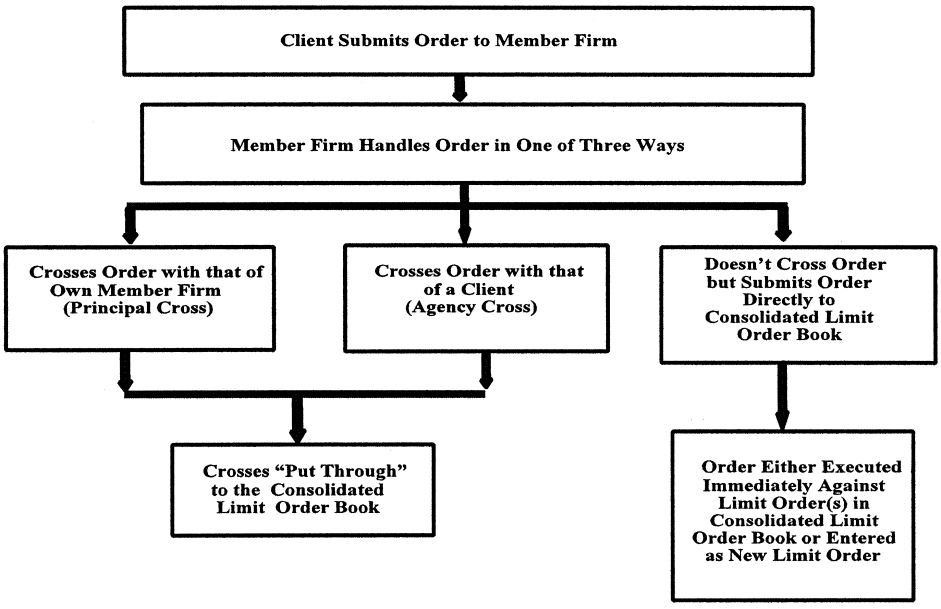

Figure 1. Client order-flow on The Toronto Stock Exchange. This figure illustrates the routing of client orders on The Toronto Stock Exchange. The upstairs market consists of the handling of orders by member firms prior to their submission to the consolidated limit order book. Upon submission to the consolidated limit order book, the handling of orders is referred to as the "downstairs market." In addition to trades resulting from client order flow, there are nonclient/nonclient trades. These account for less than 0.1 percent of trades.

would have been preferred, the month of June 1997 is not unusual in terms of daily volume of shares traded, returns, or volatility from the rest of the months of 1997. We examine the data for keying errors and exclude certain trades. For example, we eliminate trades accompanied by negative bid and ask spreads. Further, since the TSE opens as a call auction market, which differs from the continuous order entry and matching market in operation during the rest of the day, all transactions at the open are eliminated. In addition, all trades entered outside of trading hours are excluded, as it is impossible to ascertain the price impact of these transactions.

We categorize the trades in three ways: by whether the trade occurred upstairs or downstairs; by type of counterparties; and by whether the trade was buyer or seller initiated. Upstairs principal trades involve the brokerage firm and a client (principal/client trade), while upstairs agency trades involve two clients of the brokerage firm (client/client trade).[8] For downstairs trades, whether the trade is buyer initiated or seller initiated is de-

[8] There is also a small percentage (<0.1 percent) of trades involving buyers and sellers from different accounts of the same brokerage firm, that is, a principal/principal trade. These upstairs trades are excluded from the analysis as the number of such trades is too small to determine statistically significant results.

termined by the direction of the order that removes volume from the book. Functionally, this is the order with the later time stamp in the order flow data. That is, if two orders comprise a trade, the direction of the order that arrived second determines the direction of the trade. As we cannot determine the direction of downstairs trades involving orders that are entered concurrently, such downstairs trades are eliminated from our study. All downstairs trades involving registered traders are eliminated because registered traders (particularly the designated registered trader (DRT), his alternates and temporary replacements) do not always participate in the market on a discretionary basis, given their special mandate to supply liquidity to the exchange.[9] In particular, when a client submits a market order or immediately executable limit order at or below a security's minimum guaranteed fill, and there is insufficient volume on the book to fill the order, the DRT must automatically fill it with any additional volume required. This trade is recorded by the TSE as a client order matched against a subsequent order of the DRT. As the order of the DRT is recorded after that of the client, our algorithm for determining trade direction would erroneously classify the trade as DRT initiated.

Upstairs trades consist of matched orders with the same time stamp that are put through the book simultaneously. These put-throughs are categorized as buyer initiated (seller initiated) if the transaction price is higher (lower) than the midpoint of the bid and ask quotes immediately prior to the trade.[10] Upstairs trades with a trade price equal to the prior mid-quote are excluded from the regression analyses. Of the original sample of 6,470 upstairs trades, 666 (10.29 percent) are excluded on this basis. Furthermore, 12.94 percent of put-throughs are priced between the bid and ask quotes, but not at the mid-quotes. Thus, in aggregate, about one-quarter of the upstairs trades provide price improvement over the limit orders available at the time of the trade in the consolidated limit order book, while 41.10 percent and 35.67 percent of the upstairs trades are priced at the bid and ask prices, respectively.

For upstairs trades, price priority is preserved, but time priority is not. Consequently, if the transaction price of the upstairs trades is better than the market quote on the opposite side the book, the opposite side must be cleared off up to the upstairs trade price. Using a backward search algo-

[9] A DRT is charged with making an orderly market for a certain number of securities. In this regard, the DRT's main focus is in providing liquidity for small orders and he rarely participates in large orders. Thus, the DRTs are predominately passive traders. Another reason that the trades of registered traders are excluded is that there is no clear record of who is filling in for the DRT and when. The traders who fill in for the DRT may at other times be trading on behalf of their own accounts.

[10] We apply this tick test to the upstairs market as we do not know the time when orders that are matched as "put-throughs" in the upstairs market were originally entered. To examine the accuracy of this approach, we apply the tick test to all downstairs trades for which trade direction is known. For approximately 99 percent of downstairs trades, the tick test indicates the correct trade direction. This result supports the application of the tick test to the upstairs market.

rithm (as described in the legend of Table V), we find that "book clearing" is infrequent. Of the 5,804 upstairs trades examined, only 13 (or 0.2 percent) require trades to "clear" the consolidated limit order book. Each of these 13 trades requires only 1 downstairs clearing trade. The lack of upstairs trades involving book clearing suggests that the upstairs trades are generally liquidity motivated.

As described in Hasbrouck, Sofianos, and Sosebee (1993), the rules on the NYSE for crossing orders are generally more restrictive than those on the TSE. For example, NYSE Rule 76 requires that brokers, before proceeding with a cross, must make a public bid on behalf of both sides of the cross, offering at a price one tick higher than their bid. Because the NYSE rules impose greater costs and lead to more broken-up orders, it is not surprising that crosses are much less frequent on the NYSE than the put-throughs on the TSE. According to Hasbrouck, Sofianos, and Sosebee (1993), only 14 percent of total volume was upstairs-facilitated block trades on January 12, 1993, whereas we find that the figure for the TSE for the month of June 1997 is 56 percent of total volume.

II. Analysis of Upstairs Trading

Table I presents descriptive statistics of the sample of trades in the upstairs and downstairs markets of the TSE in June 1997. In addition to the cases excluded because of an inability to identify the trade initiator, trades in which securities do not trade on every trading day in the three-month period ended May 31, 1997, are excluded. Infrequent trading leads to some block trades having an extremely high value of trade size relative to median daily volume. This produces extreme outliers in this measure of trade size, which is used as an explanatory variable in our study. The table shows that the upstairs market is the preferred trading venue for the largest orders. While only 3.22 percent of trades occur in the upstairs market, these trades represent 55.53 percent of the total trading volume. Furthermore, 908 of the 5,804 trades in the upstairs market are larger than 100,000 shares. These represent only 0.51 percent of all the trades but comprise 37.87 percent of the total volume. In contrast, in the downstairs market, only 10 of 173,553 trades are larger than 100,000 shares. Furthermore, for trades in each category above 20,000 shares, there are more trades handled in the upstairs than downstairs market.

Approximately 40 percent of the total number of trades and total number of shares traded in the upstairs market are handled on a principal basis. The widespread handling of large trades through an upstairs market maker's own inventory is similar to that of the London Stock Exchange, as described by Gemmill (1996). Furthermore, the distribution of upstairs trades across trade-size categories is similar for the principal and agency trades.

Table II provides summary descriptive statistics on the principal trading activities of the most active, by security, upstairs market makers. In addition to trading with clients, upstairs market makers place orders on or take

Table I

Distribution of Trades in Upstairs and Downstairs Markets by Trade Size

Table I provides statistics on the relative number and volume of upstairs and downstairs trades on The Toronto Stock Exchange during June 1997. The upstairs trades consist of all orders crossed by member firms of The Toronto Stock Exchange and "put through" to the consolidated limit order book. Downstairs trades consist of all other orders matched and executed on the consolidated limit order book. Upstairs principal trades are put-throughs where the member firm is a buyer or seller of the security. Upstairs agency trades are put-throughs where the member firm acts as an agent for both buyer and seller. The table excludes cases where the same member firm is a buyer and seller (principal/principal trade), trades involving the registered trader, and trades where the stock does not trade every trading day in the period March 1 through May 31, 1997. Also excluded are trades where the trade direction cannot be established: upstairs trades priced at the mean of the bid and ask; downstairs trades with orders entered concurrently; trades at the open; and trades entered after the close.

	Upstairs Trades						Downstairs Trades			
Trade Size in Thousands	Number	Percentage of All Trades	Volume in Millions	Percentage of All Volume	Number of Upstairs Principal Trades	Upstairs Principal Trades as a Percentage of Upstairs Volume	Number of Trades	Percentage of All Trades	Volume in Millions	Percentage of All Volume
>100	908	0.51%	172.4	37.87%	375	41.02%	10	0.01%	2	0.43%
50 to 100	595	0.33%	35.2	7.73%	249	41.96%	26	0.02%	1.7	0.36%
40 to 50	159	0.09%	6.9	1.51%	57	35.87%	32	0.02%	1.4	0.31%
30 to 40	242	0.13%	8	1.76%	109	45.38%	32	0.02%	1.1	0.23%
20 to 30	546	0.30%	12.9	2.84%	236	43.38%	271	0.15%	6.1	1.34%
10 to 20	816	0.45%	10.4	2.28%	346	42.40%	1,818	1.01%	21.4	4.70%
5 to 10	654	0.36%	4.1	0.91%	257	40.13%	7,217	4.02%	45.4	9.97%
<5	1,884	1.05%	2.9	0.63%	674	38.86%	164,147	91.52%	123.4	27.11%
Total	5,804	3.22%	252.8	55.53%	2,303	41.29%	173,553	96.76%	202.4	44.45%

Table II

Descriptive Statistics of the Average Time to Trade Reversal for the Most Active Upstairs Market Maker in Each Stock

This table provides descriptive statistics on the most active upstairs market maker's (in each stock) principal trading activity on The Toronto Stock Exchange during June 1997, averaged across all stocks in the sample. All stocks with at least one active upstairs market maker and at least one trade reversal (a buy followed by sell or a sell followed by a buy) are included, for a total of 230 securities. The second column records data on the number of active upstairs market makers per security, that is, on average, a security has 10.45 market markers taking principal positions in its shares in the upstairs market. The third column is the total number of trades made, both with clients and the limit order book. The fourth column is the number of trades that reversed the previous trade direction: trades can occur either with clients or the limit order book. The fifth column is the time, in hours, between reversing trades by the most active upstairs market maker in a given security. The time between reversing trades is measured from the time of the first trade in one direction to the time of the first trade in the opposite direction.

	Number of Active Market Makers	Number of Trades by Most Active Market Maker	Number of Trade Reversals by Most Active Market Maker	Average Time Between Reversals in Hours
Mean	10.45	165.14	32.43	12.22
Median	9	73	13.5	7.52
Standard deviation	5.67	230.5	48.95	15.85
Minimum	2	3	1	0.37
Maximum	29	1616	361	113.47

orders off the limit order book. The minimum average time to a trade reversal (through the limit order book or with a client through a principal cross) for the most active market maker with principal trades, across all securities, is 0.37 hours. The median, across securities, of the average time to a trade reversal for the most active market maker is 7.52 hours. This is consistent with the hypothesis that upstairs market makers are liquidity providers.

Table III provides further evidence that trades in the upstairs market are significantly larger than trades in the downstairs market, but there is no significant difference in size between trades handled upstairs on a principal-versus-agency basis. The mean (median) size of a downstairs trade is 1,166 (400) shares versus 43,550 (11,050) in the upstairs market. Descriptive statistics on the firm characteristics and market conditions of the upstairs and downstairs trades are also provided in Table III. There are 243 separate stocks in the sample. The table shows that the stocks traded in the upstairs market are smaller in terms of market capitalization, and have lower price volatility and median daily trading volume in the prior three months. Thus, the upstairs market facilitates trades of less liquid and less volatile stocks than those that trade in the downstairs market. In addition, at the time immediately prior to the trade, the relative spreads in the limit order book

Table III

Descriptive Statistics of Trade Size, Firm Characteristics, and Market Conditions of Upstairs and Downstairs Trades

This table provides descriptive statistics on trade size, firm characteristics, and market conditions of upstairs and downstairs trades on The Toronto Stock Exchange during June 1997. Market capitalization of the firm is measured at the close of trading on May 30, 1997. Price volatility is the standard deviation of daily return of the stock in the three-month period ending May 31, 1997. Relative spread is the bid-ask spread divided by the bid-ask mid-quote immediately prior to the trade. Depth on opposite side of the limit order book is the number of shares at the best quote available on the side of the limit order book opposite to that of the initiator of the trade immediately prior to the trade. The unbracketed figure in each cell is the mean. The figure in the parentheses is the median and the figure in the square brackets is the standard deviation.

	Downstairs Trades	Upstairs Trades	*t*-test of Mean of Downstairs vs. Upstairs Trades	Upstairs Trades		*t*-test of Mean of Upstairs Agency vs. Principal Trades
		All Types		Agency	Principal	
Number of trades	173,553	5,804		3,501	2,303	
Number of shares in trade	1,166	43,550	−29.18**	42,386	45,318	−0.92
	(400)	(11,050)		(10,000)	(13,675)	
	[2,892]	[110,672]		[100,439]	[124,632]	
Firm characteristics						
Median daily number of shares traded	342,987	300,333	9.87**	261,855	358,827	−10.95**
	(219,183)	(189,305)		(137,293)	(224,406)	
	[349,849]	[323,065]		[298,638]	[349,043]	
Market capitalization of firm in $billions	5.52	5.21	3.85**	4.82	5.80	−6.08**
	(2.75)	(2.71)		(2.42)	(3.10)	
	[5.97]	[6.03]		[6.02]	[6.00]	
Price volatility	2.07%	1.89%	13.37**	1.84%	1.97%	−4.55**
	(1.73%)	(1.71%)		(1.73%)	(1.69%)	
	[1.46%]	[1.00%]		[0.84%]	[1.19%]	
Market conditions immediately prior to trade						
Relative spread	0.76%	0.95%	−21.77**	0.96%	0.93%	1.79
	(0.65%)	(0.77%)		(0.77%)	(0.77%)	
	[0.44%]	[0.66%]		[0.71%]	[0.56%]	
Depth on opposite side of limit order book	6,345	6,363	−0.13	5,858	7,214	−4.77**
	(3,700)	(3,400)		(3,000)	(3,900)	
	[8,568]	[10,390]		[9,943]	[10,994]	

** indicates significance at the 1 percent level.

are wider for the sample of upstairs trades. While the mean depth of the opposite side of the limit order book is nearly identical between the markets, the median depth prior to an upstairs trade is 3,400 shares versus 3,700 shares prior to a downstairs trade. Based on these market conditions, the upstairs market provides liquidity to complement that available in the downstairs market.

There are some significant differences in the characteristics of trades of upstairs traders serving as principals rather than as agents. Upstairs principal trades involve larger firms with greater historic trading volumes and more price volatility. Thus, the provision of liquidity to trades in smaller, less liquid firms in the upstairs market is attributable to the agency rather than principal trades. In addition, while there is no statistically significant difference in the bid-ask spread prior to the upstairs principal trades versus agency trades, the depth on the opposite side of the limit order book is higher in the case of upstairs principal trades. Again, the upstairs agency trades appear to provide a more complementary role to the downstairs market, in terms of liquidity provision, than upstairs principal trades.

Table IV provides details on trade direction and the total, permanent, and temporary price impacts in the various trading venues. Apart from the previously noted differences in trade size, 54.6 percent of downstairs trades are buyer initiated while only 46.6 percent of upstairs trades are buyer initiated. The z-statistic of the difference in percentages is significant at the one percent level. The average permanent price impact of the downstairs trades is 0.113 percent versus 0.006 percent for upstairs trades.[11] On a trade valued at $1.065 million—the average size of upstairs trades—the dollar costs of the permanent price impacts would be $1,204 in the downstairs market versus $64 in the upstairs market. The permanent price impact of a trade is measured by the change in the market quotes from immediately before to 15 seconds after the trade. The difference is consistent with the hypothesis that the upstairs market sends information-motivated trades to the downstairs market. There is no difference in the proportion of buyer-initiated trades between the samples of upstairs principal-versus-agency trades, and no difference in the permanent price impact of these types of trades, that is, both impacts are 0.006 percent. Thus, in the upstairs market, trades on average, whether they are done on an agency or principal basis, carry virtually no adverse information.

[11] The permanent price impacts of the downstairs market of the TSE are lower than those of another exchange when examining the same securities across markets. As shown in Smith, Turnbull, and White (2000), the lower price impacts are attributable to differences in market quality and clientele effects.

Since the only information that the consolidated order book reveals is the broker number attached to the order, there can be no direct signaling of reputation in the downstairs market that would lead to lower price impacts. However, a strategic trader could indirectly signal reputation through an identifiable trading pattern. Analysis of this potential signaling is beyond the scope of this paper.

Table IV

Descriptive Statistics of Trade Direction and Price Impacts of Upstairs and Downstairs Trades

The third through fifth rows of this table provide descriptive statistics on the total, permanent, and temporary price impacts of upstairs and downstairs trades on The Toronto Stock Exchange during June 1997. Total price impact of trade j for stock i equals $\ln(P_{i,j}/E_{i,j})$ for seller-initiated trades where $E_{i,j}$ equals the mean of the best bid-ask prices immediately before trade j for stock i; for upstairs trades, the bid-ask prices are determined before any limit order clearing (needed to accommodate an aggressive upstairs trade) occurs and $P_{i,j}$ equals the price of the trade. The permanent price impact of trade j for stock i equals $\ln(A_{i,j}/E_{i,j})$ for buyer-initiated trades and $\ln(E_{i,j}/A_{i,j})$ for seller-initiated trades where $A_{i,j}$ equals the mean of the best bid-ask prices 15 seconds after trade j for stock i. The temporary price impact equals $\ln(P_{i,j}/A_{i,j})$ for buyer-initiated trades and $\ln(A_{i,j}/P_{i,j})$ for seller-initiated trades. Market capitalization of the firm is measured at the close of trading on May 30, 1997. The unbracketed figure in each cell is the mean. The figure in parentheses is the median and the figure in the square brackets is the standard deviation.

	Downstairs Trades	Upstairs Trades	*t*-test of Mean of Downstairs vs. Upstairs Trades	Upstairs Trades		*t*-test of Mean of Upstairs Agency vs. Principal Trades
		All Types		Agency	Principal	
Number	173,553	5,804		3,501	2,303	
% Buyer initiated	54.6%	46.6%	12.04** (*z*-statistic)	47.1%	45.9%	0.90 (*z*-statistic)
Total price impact	0.216% (0.152%) [0.232%]	0.251% (0.169%) [0.264%]	−9.97**	0.269% (0.180%) [0.291%]	0.223% (0.159%) [0.213%]	7.76**
Permanent price impact	0.113% (0.000%) [0.310%]	0.006% (0.000%) [0.114%]	64.03**	0.006% (0.000%) [0.130%]	0.006% (0.000%) [0.086%]	0
Temporary price impact	0.103% (0.093%) [0.308%]	0.245% (0.169%) [0.285%]	−37.24**	0.263% (0.179%) [0.316%]	0.217% (0.156%) [0.226%]	6.46**

** indicates significance at the 1 percent level.

The univariate analysis indicates downstairs trades have lower total price impact that we attribute to lower temporary price impact. The average temporary price impact of the upstairs trades is 0.142 percent higher than that of the downstairs trades. This suggests higher costs for liquidity provision in the upstairs market, which is consistent with larger trade size, the less-liquid securities handled, and the less-liquid market conditions at the time of the trade. Conversely, within the upstairs market, the agency trades entail 0.046 percent higher temporary price impacts than the principal trades. This finding is consistent with higher costs for facilitating trades of less liquid securities and upstairs market makers providing liquidity when there is less liquidity in the downstairs market. However, as discussed below, we conduct regressions to isolate the marginal impact of the trading venue from firm characteristics and market conditions.

In order to more accurately measure whether upstairs market makers screen out adverse information, we conduct a regression. Given the findings of Holthausen, Leftwich and Mayers (1987) and Keim and Madhavan (1996) that price responses to block buys are different from those of block sells, we run the following and the other regressions separately for buyer- and seller-initiated trades. The results indicate symmetry in the relationship of the variables to price impacts, so for the sake of brevity, we report results for the combined sample. For the combined sample of buyer- and seller-initiated trades, we conduct the following regression:[12]

$$\begin{aligned} I_{i,j} = {} & C_0 + C_1\, TradeSize_{i,j} + C_2\, PriceVol_{i,j} + C_3\, FirmSize_{i,j} + C_4\, Upstairs_{i,j} \\ & + C_5\, Upstairs_{i,j} * TradeSize_{i,j} + C_6\, Upstairs_{i,j} * PriceVol_{i,j} \\ & + C_7\, Upstairs_{i,j} * FirmSize_{i,j} + e_{i,j} \end{aligned} \tag{1}$$

where

$I_{i,j}$ = $\ln(A_{i,j}/E_{i,j})$ for buyer-initiated trades and $\ln(E_{i,j}/A_{i,j})$ for seller-initiated trades: price impact of trade j for stock i;

$E_{i,j}$ = the mean of the best bid-ask prices immediately before trade j for stock i; for upstairs trades, the bid-ask prices are determined before any limit order clearing (needed to accommodate an aggressive upstairs trade) occurs;

$A_{i,j}$ = the mean of the best bid-ask prices 15 seconds after trade j for stock i;

[12] The structure of the TSE market does not allow an outside trader to select the upstairs or downstairs market for execution; instead, all trades go to an upstairs market maker first, and the market maker decides whether to try to fill the order upstairs as either a principal or agent, or send the order downstairs (there is one exception: the trader can elect to prohibit the market maker from participating as a principal). Thus, we are modeling the decision of the upstairs market maker, unlike Madhavan and Cheng (1997) who model the decision of the trade initiator.

$TradeSize_{i,j}$ = the trade size divided by the median daily number of shares traded over all trading days during the three-month period ended May 31, 1997;
$Upstairs_{i,j}$ = dummy variable with value of one if the trade is handled in the upstairs market and zero otherwise;
$PriceVol_{i,j}$ = the standard deviation of the daily return on the stock during the period of March 1 through May 31, 1997, inclusive;
$FirmSize_{i,j}$ = log of the market capitalization of the firm as at the close of trading on May 30, 1997.

Easley and O'Hara (1987) argue that since informed traders prefer to trade in larger amounts, there will likely be a larger permanent price effect for larger orders. Consequently, C_1, the coefficient for *TradeSize* is expected to be positive. We also expect C_2, the coefficient of *PriceVol*, to be positive. According to the efficient market hypothesis, prices change as a result of the arrival of new information. Using *PriceVol* as a proxy for information flow, higher *PriceVol* implies a greater flow of new information. To the extent that the company's information flow is constant, historical volatility should be positively related to greater price impact in current trades. Finally, as trades of smaller firms are expected to be more information driven than those of larger firms, we expect C_3, the coefficient for *FirmSize*, to be negative. The fact that smaller firms generally have less analyst-following implies greater information asymmetry among investors. Trades of more volatile and smaller firms are expected to contain greater information. If upstairs market makers are able to distinguish between liquidity and informed traders, C_4, C_5, and C_6, the coefficients for the *Upstairs*, *Upstairs* $*$ *TradeSize*, and *Upstairs* $*$ *PriceVol* variables, respectively, should be negative. Likewise, C_7, the coefficient for *Upstairs* $*$ *FirmSize*, is expected to be positive as the impact of adverse information related to *FirmSize* is expected to be reduced in the upstairs market.

Table V shows the results of the regression analysis of the change in the mid-quotes surrounding trades. The coefficients are all in the expected direction. The coefficients of *Upstairs* and *Upstairs* $*$ *TradeSize* are negative and significant at the one percent level. Thus, as hypothesized, information-laden trades are handled in the downstairs market and those that are more liquidity-motivated are processed in the upstairs market. The coefficient of *TradeSize* is significantly positive as expected. This indicates that larger trades carry more information. The coefficient value of 0.38 for *TradeSize* means that for a trade whose size is equal to that of the median daily volume of trading for a stock, the contribution to the permanent price impact is 0.38 percent. However, for an average-size trade of 3.45 percent of median daily volume, the contribution is 0.013 percent, which is not economically significant.

The coefficient of *PriceVol* is significantly positive. The coefficient of *FirmSize* is significantly negative. These findings support the argument that trades of more volatile and smaller firms carry more information.

Table V

Regression Analysis of Price Impact of Trades in Upstairs and Downstairs Markets

This table shows the coefficients (multiplied by 100), *t*-statistics (in parentheses) and adjusted $R^2$of regression (1) for trades on The Toronto Stock Exchange during June 1997. To determine the trade initiator for the downstairs trades, we use the direction of the order that took volume off the limit order book of the exchange. To determine the trade initiator for the upstairs trades, the tick test is used by comparing trade price to the mid-quote. For the purpose of establishing a benchmark mid-quote, we identify downstairs trades during the period 15 minutes prior to the put-through that involve the same broker number as the upstairs market maker and that move the quote on the opposite side of the limit order book to, or beyond, the trade price. Such trades are assumed to be executed in order to clear the limit order book in anticipation of the upstairs trade. The benchmark mid-quote is determined by the mid-quote that is just prior to the first of these "book clearing" trades.

$$PriceImpact_{i,j} = C_0 + C_1\, TradeSize_{i,j} + C_2\, PriceVol_{i,j} + C_3\, FirmSize_{i,j} + C_4\, Upstairs_{i,j} + C_5\, Upstairs_{i,j} * TradeSize_{i,j}$$
$$+ C_6\, Upstairs_{i,j} * PriceVol_{i,j} + C_7\, Upstairs_{i,j} * FirmSize_{i,j} + e_{i,j}$$

where $PriceImpact_{i,j}$ is defined in three ways. *Permanent Price Impact* equals $\ln(A_{i,j}/E_{i,j})$ for buyer-initiated trades and $\ln(E_{i,j}/A_{i,j})$ for seller-initiated trades, where $A_{i,j}$ is the mean of the best bid-ask prices 15 seconds after trade j for stock i and $E_{i,j}$ is the mean of the best bid-ask prices immediately before trade j for stock i; for upstairs trades, the bid-ask prices are determined before any limit order clearing (needed to accommodate an aggressive upstairs trade) occurs. *Temporary Price Impact* equals $\ln(P_{i,j}/A_{i,j})$ for buyer-initiated trades and $\ln(A_{i,j}/P_{i,j})$ for seller-initiated trades where $P_{i,j}$ is the price of trade j for stock i. *Total Price Impact* equals $\ln(P_{i,j}/E_{i,j})$ for buyer-initiated trades and $\ln(E_{i,j}/P_{i,j})$ for seller-initiated trades. $Upstairs_{i,j}$ is a dummy variable with value of one if the trade is handled in the upstairs market and zero otherwise. $TradeSize_{i,j}$ is the trade size divided by the median daily number of shares traded over all trading days during the three-month period ended May 31, 1997. $PriceVol_{i,j}$ is the standard deviation of the daily return on the stock during the period of March 1 through May 31, 1997, inclusive. $FirmSize_{i,j}$ is the logarithm of the market capitalization of the firm as at the close of trading on May 30, 1997.

Dependent Variable	*Intercept*	*TradeSize*	*PriceVol*	*FirmSize*	*Upstairs*	*Upstairs* * *TradeSize*	*Upstairs* * *PriceVol*	*Upstairs* * *FirmSize*	Adjusted *R*-squared	Number of Trades
Permanent price impact	1.27	0.38	1.18	−0.05	−1.28	−0.38	−0.69	0.05	0.07	179,357
	(104.07)**#	(42.40)**#	(24.32)**#	(−97.35)**#	(−18.02)**#	(−41.62)**#	(−1.76)	(17.01)**#		
Temporary price impact	1.03	−0.27	0.41	−0.04	1.51	0.27	1.25	−0.06	0.04	179,357
	(82.42)**#	(−29.82)**#	(8.27)**#	(−74.59)**#	(20.88)**#	(30.00)**#	(3.13)**	(−19.69)**#		
Total price impact	2.30	0.11	1.60	−0.10	0.23	−0.10	0.56	−0.01	0.30	179,357
	(285.21)**#	(18.13)**#	(49.65)**#	(−262.91)**#	(5.00)**#	(−16.65)**#	(2.17)*	(−4.69)**#		

* and ** indicate significance at the 5 and 1 percent levels, respectively.
# means that the posterior odds ratio indicates that the odds against the null hypothesis of the coefficient equaling zero are greater than 20:1.

In addition to permanent price impacts, we also analyze temporary and total price impacts by replacing the dependent variable of equation (1) with the following measures of these impacts. The temporary price impact is measured by $\ln(P_{i,j/\mathrm{A_{i,j}}})$ for buyer-initiated trades and $\ln(A_{i,j}/P_{i,j})$ for seller-initiated trades where $P_{i,j}$ is the price of trade j for stock i. We measure the total price impact in the same way as Chan and Lakonishok (1995) and use $\ln(P_{i,j}/E_{i,j})$ for buyer-initiated trades and $\ln(E_{i,j}/P_{i,j})$ for seller-initiated trades.

Given that larger trades should entail greater efforts on the part of the liquidity provider, we expect a positive relationship between *TradeSize* and temporary price impact. We expect C_1 to be positive. The coefficient for *PriceVol*, C_2, is expected to be positive as greater volatility means that a stock is riskier to hold in a market maker's inventory because of potential holding losses. Higher order execution costs compensate liquidity providers for this risk. As stocks of smaller firms are expected to be more thinly traded than those of larger firms, it is expected that those providing liquidity for these shares will require higher compensation. Thus, the coefficient for *FirmSize*, C_3, is expected to be positive. The lack of small trades in the upstairs market suggests that there is higher fixed cost for providing liquidity in this market over the downstairs market. In addition, Madhavan and Cheng (1997) report that the fixed costs of the upstairs market are greater than those of the downstairs market. Thus, it is expected that C_4 will be positive. However, the direction of C_5, C_6, and C_7 cannot be predicted a priori. If the upstairs market has lower (higher) liquidity provision costs than the downstairs market based on trade size, price volatility, and firm size, then these coefficients should have the same (opposite) sign as per the permanent price impact regression.

Given that the signs of the expected relationship between *TradeSize*, *PriceVol,* and *FirmSize*, and permanent price impacts are the same as those for the temporary price impact, it is expected that C_1, C_2, and C_3 will be positive for the total price impact. Based on the findings of Madhavan and Cheng (1997), C_5 is expected to be negative while C_4 is expected to be positive. Following our discussion above, the direction of C_5, C_6, and C_7 cannot be predicted a priori.

For temporary price impacts, we find that the signs of the coefficients are in the expected direction except for the coefficient of *TradeSize*. The coefficient of *TradeSize* is significantly negative, suggesting that larger trades entail smaller liquidity costs. While the negative slope for the temporary effect is unexpected, it does not appear to be economically significant. For the whole sample, the 95th highest percentile value of *TradeSize* is 0.0792. The product of this value with the estimated coefficient of -0.27 for the whole sample is -0.021 percent. Thus, even for larger trades, the estimated contribution of the variable component of the effect of trade size on the temporary price impact is minuscule. We also note that Keim and Madhavan (1996) find the unexpected result of a significantly negative relationship of *TradeSize* with temporary price impact for a sample of buyer-initiated block trades.

As shown on Table V, consistent with previous research such as Keim and Madhavan (1996), we find that the total price impact is positively related to trade size and stock price volatility, and negatively related to firm size. All these relationships are significant at the one percent level. The coefficient of the dummy variable *Upstairs* is significantly positive and the coefficient of the variable *Upstairs* ∗ *TradeSize* is significantly negative. This indicates that the fixed cost component of the upstairs market price impact is higher than that of a downstairs market trade but the variable cost is lower. In particular, given firms of average market capitalization and price volatility, the coefficients of the last four variables shown in the bottom row of Table V indicate that trades in excess of (below) 24 percent of the median daily trading volume are found to be less (more) expensive in the upstairs market. This cost structure is consistent with concentrations of small and very large trades in the downstairs and upstairs markets, respectively. It is also consistent with the finding of lower adverse information for larger trades in the upstairs markets.

Changes in the mean of the market quoted prices are used to capture changes in equilibrium prices. In the downstairs market, a trade removes volume from the book. Consequently, new market quotes are posted. This is not the case for an upstairs trade that is put through the book. The mean (median) length of time from a trade in the upstairs market to the next market quote change is 305 (68) seconds, whereas the mean and median for the downstairs market is 0 seconds. We assume that 15 seconds is long enough for the market to react and consequently we use the market quote that is valid 15 seconds after the trade. The announcements of both put-throughs and downstairs trades are immediately and fully reported in the consolidated limit book. Given the identical treatment of this news, we attribute the relative lack of quote changes following upstairs versus downstairs trades to the differing motivations of the two types of trades. Upstairs trades are more liquidity motivated than information motivated.

As a further test of whether the permanent price impact is captured in the first 15 seconds following a trade, we rerun regression (1) by analyzing mid-quote changes first for periods of 60 seconds and then for periods of 15 minutes following the trade. We do this sensitivity analysis at the risk of contaminating the measure of the permanent price impact with the effect of subsequent news. The results from this analysis are not different from those reported in the paper.

We next investigate whether there is a statistically significant difference in the information impact of upstairs trades that are handled on an agency basis versus a principal basis. Using only upstairs trades, we conduct the following regression:

$$I_{i,j} = C_0 + C_1\, TradeSize_{i,j} + C_2\, Principal_{i,j} + C_3\, Principal_{i,j} * TradeSize_{i,j} + C_4\, PriceVol_{i,j} + C_5\, FirmSize_{i,j} + e_{i,j} \tag{2}$$

where

$Principal_{i,j}$ = dummy variable with value of one if at least one of the trade counterparties is acting as a principal and zero otherwise.

The other variables are defined as in equation (1).

As discussed earlier in the paper, it is unclear from past research whether upstairs market makers will engage in trades with less adverse information when they act as principals or as agents. The regulations of the TSE and the evidence of a fairly large number of near-term reversals of their inventory positions suggest that the upstairs market makers provide liquidity and have short-term investment horizons. Thus, in order not to risk their capital unduly on a short-term basis, market makers are expected to avoid acting as counterparties to orders that they suspect are motivated by adverse information. Clients may also look to the upstairs market to avoid information-motivated trades. Consequently, market makers who are concerned about their reputation among clients may be reluctant to match orders where there are suspected asymmetries of information possessed by different clients. Thus, we expect the sign of coefficients C_2 and C_3 in equation (2) to be zero. On the other hand, if as discussed in Grossman (1992), the role of the upstairs trader is to monitor unexpressed demand and supply of securities and broker trades on this basis, then clients may not necessarily rely on the upstairs trader to screen out counterparties with adverse information. Coefficients C_2 and C_3 in equation (2) could be negative on this basis.

Table VI reports that for the permanent price impacts, neither the coefficient of *Principal* nor of *Principal* $*$ *TradeSize* is significant. Thus, the method of handling trades in the upstairs market has no relationship to the degree of adverse information. For the temporary and total price impacts, the coefficients of the variables *Principal* and *Principal* $*$ *TradeSize* are negative. Order execution costs are lower when the upstairs trader acts as principal rather than as agent. Thus, there is no evidence that the upstairs trader's activity in supplying liquidity to the market is more expensive as a principal than as an agent. The coefficients for the control variables, *TradeSize*, *PriceVol*, and *FirmSize*, are in the expected direction.

The next analysis uses a logit model to examine which factors, including adverse information, are related to the likelihood of a trade being executed in the upstairs market.[13] The logit model is expressed as follows:

$$Upstairs_{i,j} = f(FirmSize_{i,j}, TradeSize_{i,j}, I_{i,j}, PriceVol_{i,j}, RelSpread_{i,j}, DepthOpp_{i,j}), \quad (3)$$

[13] An interesting extension of this model would incorporate the principal-versus-agency decision in the upstairs market in a nested logit model. However, a critical input to this analysis would include the upstairs market maker's inventory and the expected order arrival rate at each point in time. This information is not available to us.

Table VI

Regression Analysis of Price Impact of Upstairs Trades

This table shows the coefficients (multiplied by 100), *t*-statistics (in parentheses) and adjusted R^2 of regression (2) for trades on The Toronto Stock Exchange during June 1997. To determine the trade initiator for the upstairs trades, the tick test is used by comparing trade price to the mid-quote. For the purpose of establishing a benchmark mid-quote, we identify downstairs trades during the period 15 minutes prior to the put-through that involve the same broker number as the upstairs market maker and that move the quote on the opposite side of the limit order book to, or beyond, the trade price. Such trades are assumed to be executed in order to clear the limit order book in anticipation of the upstairs trade. The benchmark mid-quote is determined by the mid-quote that is just prior to the first of these "book clearing" trades.

$$PriceImpact_{i,j} = C_0 + C_1\, TradeSize_{i,j} + C_2\, Principal_{i,j} + C_3\, Principal_{i,} * TradeSize_{i,j} + C_4\, PriceVol_{i,j} + C_5\, FirmSize_{i,j} + e_{i,j}$$

where $PriceImpact_{i,j}$ is defined three ways. *Permanent Price Impact* equals $\ln(A_{i,j}/E_{i,j})$ for buyer-initiated trades and $\ln(E_{i,j}/A_{i,j})$ for seller-initiated trades, where $A_{i,j}$ is the mean of the best bid-ask prices 15 seconds after trade j for stock i and $E_{i,j}$ is the mean of the best bid-ask prices immediately before trade j for stock i; for upstairs trades, the bid-ask prices are determined before any limit order clearing (needed to accommodate an aggressive upstairs trade) occurs. *Temporary Price Impact* equals $\ln(P_{i,j}/A_{i,j})$ for buyer-initiated trades and $\ln(A_{i,j}/P_{i,j})$ for seller-initiated trades where $P_{i,j}$ is the price of trade j for stock i. *Total Price Impact* equals $\ln(P_{i,j}/E_{i,j})$ for buyer-initiated trades and $\ln(E_{i,j}/P_{i,j})$ for seller-initiated trades. $Principal_{i,j}$ is a dummy variable with value of one if at least one of the trade counterparties is acting as a principal and zero otherwise. $TradeSize_{i,j}$ is the trade size divided by the median daily number of shares traded over all trading days during the three-month period ended May 31, 1997. $PriceVol_{i,j}$ is the standard deviation of the daily return on the stock during the period of March 1 through May 31, 1997, inclusive. $FirmSize_{i,j}$ is the logarithm of the market capitalization of the firm as at the close of trading on May 30, 1997.

Dependent Variable	*Intercept*	*TradeSize*	*Principal*	*Principal* * *TradeSize*	*PriceVol*	*FirmSize*	Adjusted R-squared	Number of Trades
Permanent price impact	−0.01	0.00	−0.00	0.00	0.49	0.00	0.003	5,804
	(−0.25)	(3.05)**	(−0.07)	(0.10)	(3.25)**	(0.07)		
Temporary price impact	2.54	0.01	−0.01	−0.01	1.71	−0.11	0.25	5,804
	(43.19)**#	(5.70)**#	(−40.06)**#	(−3.88)**	(5.23)**#	(−40.06)**#		
Total price impact	2.53	0.01	−0.01	−0.01	2.21	−0.11	0.30	5,804
	(48.19)**#	(7.95)**#	(−2.39)*	(−4.29)**#	(7.53)**#	(−44.77)**#		

* and ** indicate significance at the 5 and 1 percent levels, respectively.
# means that the posterior odds ratio indicates that the odds against the null hypothesis of the coefficient equaling zero are greater than 20:1.

where

$Upstairs_{i,j}$ = dummy variable with value of one if trade executed in the upstairs market and 0 if trade executed in the downstairs market;
$RelSpread_{i,j}$ = (ask − bid)/[(bid + ask)/2.0] immediately before the trade;
$DepthOpp_{i,j}$ = for buyer- (seller-) initiated trades, the depth at the ask (bid) immediately before the trade divided by the median daily number of shares traded over all trading days during the three-month period ended May 31, 1997.

The explanatory variables are firm size, trade size, adverse information, stock price volatility, relative spread, and depth on the opposite side of the limit order book. It is expected that trades of larger sizes are handled in the upstairs market, given the lower order execution costs for the larger trades found in Madhavan and Cheng (1997). Furthermore, trades of more volatile stocks and smaller firms are expected to be sent to the downstairs market, as we expect such trades to be more information motivated. The adverse information variable, as measured by the change in the mid-quote from immediately before to 15 seconds after the trade, should be negatively related to the likelihood of a trade being executed upstairs.

The final two variables are used to examine whether the upstairs market is complementary to the downstairs market or whether there is undue fragmentation as discussed as a concern in Harris (1993). In particular, does the upstairs market provide liquidity when there is low liquidity in the downstairs limit order book? It is expected that a larger spread in the consolidated limit order book will precipitate relatively more upstairs than downstairs trades. In addition, the lower the depth on the opposite side of the limit order book, the more likely the trade will be executed upstairs, given the greater need to supply liquidity to the market. Thus, the coefficients of the *RelSpread* and *DepthOpp* variables should have a positive and negative sign, respectively.

The logit model, the results of which are shown in Table VII, identifies a number of differences between trades executed upstairs and downstairs. First, larger trades are more likely to be executed upstairs as the coefficient of *TradeSize* is significantly positive. Second, trades that carry information, as evidenced by the change in mid-quote, are more likely to be sent downstairs. That is, the coefficient of the variable *I* is significantly negative. Third, trades of highly volatile stocks are less likely to be executed upstairs as the coefficient of *PriceVol* is significantly negative. Fourth, the greater the depth on the opposite side of the limit order book, the less likely the order will be handled in the upstairs market. Finally, there is no significant relationship between firm size and the likelihood of a trade being executed in the upstairs market. This implies that upstairs market makers are not simply using firm size to discriminate between information-laden and liquidity-motivated orders. This represents further evidence that the upstairs market makers

Table VII

Logit Model of Likelihood of Trade Being Executed in Upstairs Market

This table shows coefficients and z-statistics (in parentheses) of a logit model (3) for trades on The Toronto Stock Exchange during June 1997. To determine the trade initiator for the downstairs trades, we use the direction of the order that took volume off the limit order book of the exchange. To determine the trade initiator for the upstairs trades, the tick test is used by comparing trade price to the mid-quote. For the purpose of establishing a benchmark mid-quote, we identify downstairs trades during the period 15 minutes prior to the put-through that involve the same broker number as the upstairs market maker and that move the quote on the opposite side of the limit order book to, or beyond, the trade price. Such trades are assumed to be executed in order to clear the limit order book in anticipation of the upstairs trade. The benchmark mid-quote is determined by the mid-quote that is just prior to the first of these "book clearing" trades.

$$Upstairs_{i,j} = f(FirmSize_{i,j}, TradeSize_{i,j}, I_{i,j}, PriceVol_{i,j}, RelSpread_{i,j}, DepthOpp_{i,j}),$$

where

$Upstairs_{i,j}$ = dummy variable with value 1 if trade executed in the upstairs market and 0 if trade executed in the downstairs market;
$FirmSize_{i,j}$ = log of the market capitalization of the firm as at the close of trading on May 30, 1997;
$TradeSize_{i,j}$ = the trade size divided by the median daily number of shares traded over all trading days during the three-month period ended May 31, 1997;
$I_{i,j}$ = $\ln(A_{i,j}/E_{i,j})$ for buyer-initiated trades and $\ln(E_{i,j}/A_{i,j})$ for seller-initiated trades: permanent price impact of trade j for stock i;
$PriceVol_{i,j}$ = the standard deviation of the daily return on the stock during the period of March 1 through May 31, 1997, inclusive;
$RelSpread_{i,j}$ = (bid − ask)/((bid + ask)/2.0) immediately before the trade;
$DepthOpp_{i,j}$ = for buyer- (seller-) initiated trades, the depth at the ask (bid) immediately before the trade divided by the median daily number of shares traded over all trading days during the three-month period ended May 31, 1997.

	Intercept	*FirmSize*	*TradeSize*	Change in Mid-quote, $I_{i,j}$	*PriceVol*	*RelSpread*	*DepthOpp*	Number of Cases
Coefficient	−4.44	0.00	3.32	−223.58	−11.52	0.83	−1.89	179,357
(z-statistic)	(−16.34)**#	(0.36)	(59.38)**#	(−28.49)**#	(−8.52)**#	(44.19)**#	(−28.68)**#	

** indicates significance at the 1 percent level.
# means that the posterior odds ratio indicates that the odds against the null hypothesis of the coefficient equaling zero are greater than 20:1.

are screening primarily on the basis of orders they suspect, with some accuracy, of having adverse information.

To help interpret the logit regression coefficients, we use the logistic function to determine the probability of a typical trade being handled upstairs. Based on the mean values of all the explanatory variables, the estimated probability of being handled upstairs is 1.48 percent. The marginal impact of doubling trade size from a mean of 3.45 percent of median daily volume increases the likelihood of being handled upstairs to 1.71 percent. If the trade size equals 100 percent of median daily volume, the estimated probability of a trade being handled upstairs rises to 59.14 percent.

We conduct sensitivity analysis of these results. First, we use an alternative measure of trade size where scaling is done on the basis of shares outstanding. The results are similar to those shown in the paper. Second, Madhavan and Smidt (1991) and Hasbrouck (1991) report that the per-share impact of trades is concave in trade size. We test for nonlinearity with an approach similar to Keim and Madhavan (1996) and another along the lines of Madhavan and Smidt (1991). While we find some concavity in the trade size/price impact relationship, we do not report these regressions as the results for the other variables are similar to those reported in the paper. We also repeat the regressions above using a subsample of trades of at least 10,000 shares. The analyses of the subsample of block trades are done to ensure the study's results can be replicated with a data set comparable to those of other studies of the upstairs market, such as those of Keim and Madhavan (1995, 1996). We do not show the results for this sensitivity analysis as the findings are generally not markedly different in terms of sign or significance from those reported herein.

III. Conclusions

The upstairs market, as organized and regulated on the TSE, provides substantial liquidity to the exchange by handling large liquidity-motivated orders. The sample of upstairs trades in our study represents 3.22 percent of the total number of trades, and 55.53 percent of the total volume of trading on the TSE. The securities handled in the upstairs market trade less frequently, exhibit less price volatility, and represent slightly smaller firms than those sent to the downstairs market. Approximately 40 percent of the volume of upstairs trading is done on a principal basis. In addition to trading with clients, upstairs market makers place orders on or take orders off the limit order book. The median, across securities, of the average time to a trade reversal for the most active market maker was 7.52 hours. This is consistent with the hypothesis that upstairs market makers are liquidity providers.

This paper provides extensive evidence on the adverse information and price effects of an upstairs market in which traders see all order flow on a nonanonymous basis and can selectively participate in handling these orders. Specifically, we examine how market makers in the upstairs market of the

TSE decide between handling the order on a principal basis, on an agency basis, or by sending the order to the downstairs market. We find that orders with almost entirely no information content are handled upstairs, whereas information-motivated orders are sent downstairs. On average, the adverse information impact of upstairs trades is only 0.006 percent versus 0.113 percent for downstairs trades. The lack of adverse information is independent of whether the order is handled upstairs on a principal or agency basis. Furthermore, the relationship of trade size to the adverse information impact is negligible in the upstairs market.

Consistent with this finding, the variable component of order execution cost is higher for downstairs trades than for upstairs trades. However, the fixed component of order execution is higher in the upstairs market. For trades greater than approximately 24 percent of the median daily volume of trades, the total order execution cost is lower in the upstairs market. This evidence is consistent with the concentration of very large orders in the upstairs market. In one-quarter of the trades, the upstairs market offers price improvement over the limit orders available in the consolidated limit order book. Furthermore, order execution costs are marginally lower when the upstairs trader acts as principal rather than as agent. These findings demonstrate that upstairs traders value their reputation capital and allay concerns about their dealing role.

Finally, the evidence in the paper supports the argument that the upstairs market has a complementary role to the downstairs market in supplying liquidity. We find that a trade is more likely to be executed upstairs when there is a wider bid-ask spread and when there is less depth on the opposite side of the limit order book. Furthermore, since the likelihood of trades being handled upstairs is not related to firm size, traders are not simply relying on the readily observable measure of market capitalization to screen information-laden trades.

In summary, the findings of our paper suggest that the upstairs market enhances the liquidity offered by the downstairs market without imposing excessive network externalities on the rest of the market. By allowing market makers to identify counterparties, the upstairs market facilitates the execution of very large liquidity-motivated trades and increases operational efficiency. In particular, the largest liquidity-motivated traders can realize lower order execution costs in a nonanonymous market. The downstairs market will continue to play an important role given its processing of information-laden orders and its lower execution costs for the vast majority of orders. In addition, upstairs market makers are reluctant to hold orders due to the exposure to price risk as a consequence of regulation. Thus, we expect both markets to survive well into the future.

REFERENCES

Burdett, Kenneth, and Maureen O'Hara, 1987, Building blocks: An introduction to block trading, *Journal of Banking and Finance* 11, 193–212.

Chan, Louis, and Josef Lakonishok, 1995, The behavior of stock prices around institutional trades, *Journal of Finance* 50, 1147–1174.

Easley, David, and Maureen O'Hara, 1987, Price, trade size, and information in securities markets, *Journal of Financial Economics* 19, 69–90.

Fishman, Michael, and Francis Longstaff, 1992, Dual trading in futures markets, *Journal of Finance* 47, 643–672.

Gemmill, Gordon, 1996, Transparency and liquidity: A study of block trades on the London Stock Exchange under different publication rules, *Journal of Finance* 51, 1765–1790.

Griffiths, Mark, Brian F. Smith, D. Alasdair Turnbull, and Robert White, 1998, The role of tick size in upstairs trading and downstairs trading, *Journal of Financial Intermediation* 7, 393–417.

Griffiths, Mark, Brian F. Smith, D. Alasdair Turnbull, and Robert White, 2000, The costs and determinants of order aggressiveness, *Journal of Financial Economics* 56, 65–68.

Grossman, Sanford J., 1992, The informational role of upstairs and downstairs trading, *Journal of Business* 65, 509–528.

Harris, Lawrence, 1993, Consolidation, fragmentation, segmentation and regulation, *Financial Markets, Institutions, Instruments* 2, 1–23.

Hasbrouck, Joel, 1991, Measuring the information content of stock trades, *Journal of Finance* 46, 179–207.

Hasbrouck, Joel, George Sofianos, and Deborah Sosebee, 1993, New York Stock Exchange systems and trading procedures, Working paper #93-01, NYSE.

Holthausen, Robert, Richard Leftwich, and David Mayers, 1987, The effect of large block transactions on security prices: A cross-sectional analysis, *Journal of Financial Economics* 19, 237–267.

Keim, Donald B., and Ananth Madhavan, 1995, Anatomy of the trading process: Empirical evidence on the behavior of institutional traders, *Journal of Financial Economics* 37, 371–398.

Keim, Donald B., and Ananth Madhavan, 1996, The upstairs market for large-block transactions: Analysis and measurement of price effects, *Review of Financial Studies* 9, 1–36.

Madhavan, Ananth, and Minder Cheng, 1997, In search of liquidity: Block trades in the upstairs and downstairs market, *Review of Financial Studies* 10, 175–203.

Madhavan, Ananth, and Seymour Smidt, 1991, A Bayesian model of intraday specialist pricing, *Journal of Financial Economics* 30, 99–134.

Panchapagesan, Venkatesh, 1998, What if time priority is not enforced among traders? Ph.D. Dissertation, University of Southern California.

Roell, Aisla, 1990, Dual capacity trading and the quality of the market, *Journal of Financial Intermediation* 1, 105–124.

Scholes, Myron, 1972, The market for securities: Substitution versus price pressure and the effects of information on share prices, *Journal of Business* 45, 179–211.

Seppi, Duane, 1990, Equilibrium block trading and asymmetric information, *Journal of Finance* 45, 73–94.

Smith, Brian F., D. Alasdair Turnbull, and Robert W. White, 2000, Network externalities, market quality and trading activities, Working paper, University of Western Ontario.

Sofianos, George, 1995, Specialist gross trading revenues at the New York Stock Exchange, Working paper #95-01, NYSE.