Principal Trading, Price Improvement and Liquidity Provision in a Non-Anonymous Market

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We model principal trading by upstairs market makers and find that it supplies significant liquidity and price improvement to the market. First, clients more frequently submit orders to firms that do upstairs principal trading. Second, these firms provide liquidity to clients that is unavailable in the consolidated limit order book. Principal trades are, on average, ten times larger than the depth available on the book. Third, when brokerage firms participate as principals, they give price improvement to more than 60% of client orders. The principal trading decision is affected by fixed trading costs and the liquidity of the security.

INTRODUCTION

Ready (1999) investigates how price improvement and liquidity provision occur in a specialist-centred market. A key conclusion is that, by sampling future order flow, the specialist can infer which current orders are likely to be informed and, based on this, offer uninformed orders prices that are better than prices currently available in the limit order book. Smith, Turnbull and White (2001) study the upstairs market[1] and find that the upstairs market maker facilitates or supplies liquidity by arranging trades on an agency basis or trading as a principal. They note that the upstairs market is non-anonymous, allowing upstairs market makers to filter informed and uninformed orders, sending the former to the downstairs market, while frequently trading the latter as a principal. As in Ready, these principal trades may be offered price improvement, as they are not information-laden. The focus of this paper is on principal trading, price improvement, and liquidity provision by the upstairs market maker, using data from the Toronto Stock Exchange.

Grossman (1992) discusses the role of the upstairs market maker in arranging trades between large investors who prefer not to fully disclose their trading interest to the market. When a large order arrives, the upstairs market maker, acting as an agent, can match some or all of the order with this undisclosed volume. Bessembinder and Venkataraman (2004) investigate the role of upstairs markets focussing on agency trades and conclude that agency trades are an important source of liquidity. In our sample, 46.2% of all upstairs trades were principal trades by the upstairs market maker, suggesting that principal trading is also an important source of liquidity and price improvement. Keim and Madhavan (1996) provide evidence of the importance of the upstairs market to liquidity provision on the NYSE. We develop and test a theory of principal trading, based on the non-anonymous order flow handled in upstairs markets, contributing to the understanding of the process of price improvement and liquidity provision.[2]

We contend that upstairs market makers will not engage in principal trading if it harms their clients. Order flow and trade prices are completely transparent on an ex-post basis. If principal trading is done to

the detriment of brokerage firm clients, the practice will be easily identified and will lead to a loss of reputation capital.[3] To the extent that principal trading is perceived to be costly to the client, the market maker runs the risk of alienating current or potential clients who could otherwise submit their order to another broker. Furthermore, many firms are multi-functional, engaging in underwriting, retail and institutional trading, among other activities. In such cases, trading may not be the primary business line; however, trading reputation could potentially impact all activities.

Using detailed order flow data from the Toronto Stock Exchange (TSX), this paper finds no evidence that upstairs principal trading is contrary to the interests of brokerage clients but rather finds evidence that it benefits them. In particular, we examine a market in which clients have an opportunity to submit orders to firms that do not engage in any principal trading. While less than 43% of the brokerage firms are active in upstairs principal trading[4], we find that the majority of client orders are submitted to brokerage firms that engage in principal trading. Given that investors are free to choose their brokers, this finding provides evidence that upstairs principal trading benefits clients. We analyze how characteristics of the order as well as the conditions in the consolidated limit order book (CLOB) affect the likelihood of principal trades. Brokerage firms fill orders as a principal that are, on average, ten times larger than the depth available to fill the order on the CLOB. We find that more than 60% of the orders that are handled on a principal basis are given prices better than those available in the CLOB. Brokerage firms engage in principal trading when market conditions suggest it is least costly to do so. In particular, principal trading is more likely to occur when bid-ask spreads are narrower. Furthermore, market makers are more likely to handle larger orders on a principal basis because of the fixed costs and the associated economies of scale in doing so. If principal trading occurs, it will be done to provide liquidity to incoming orders when there is insufficient volume available from other counterparties at the price offered by the market maker. This means that the market maker either offers more volume than available at the market or offers a better price than the client would have achieved if the order had been exposed to the market.

Despite its importance to investors, market makers, and regulators, to our knowledge no studies have been published which directly study upstairs principal trading. In this paper, we use very detailed intraday order flow data to gather evidence on principal trading. With data from the TSX, we are able to identify which orders are entered by the public (as opposed to the brokerage firms themselves) and which of these public orders are handled by the upstairs market makers of the firm on a principal basis. We are also able to distinguish between orders sent to firms that have upstairs market makers acting as principals and those sent to firms that never principal trade. While comparable data is not available from the NYSE, the many similarities between the two exchanges mean that results from the TSX should shed light on the process of price improvement and the provision of market liquidity on the NYSE.

Prior to the end of 2006, both market makers in the upstairs market and the specialist in the downstairs market could principal trade with public order flow before it was exposed to the rest of the market. In contrast, on the TSX, only market makers in the upstairs market can principal trade with public orders before they are exposed. The specialist in the downstairs market of the TSX, referred to as the Designated Market Maker (DMM), does not have an opportunity to transact with incoming orders ahead of public investors.[5] Thus, the focus of principal trading on the TSX is on the upstairs market makers who as discussed in Smith, Turnbull and White (2001) provide considerable liquidity to investors on the exchange. Rule 4-402 of the TSX Rule Book stipulates that orders of 1,200 or fewer shares must be automatically submitted to the downstairs market.[6] Upstairs market makers on the TSX are only allowed to principal trade ahead of client orders at prices quoted and immediately available in the downstairs market and only where the orders are in excess of 1,200 shares.

The rest of the paper is organized as follows. The second section of the paper describes a model of principal trading. The third section of the paper describes the data and order flow on the TSX. The fourth section discusses the research methods in greater detail and reports results on tests of participation by upstairs market makers as principal. The final section draws conclusions from this analysis.

THEORY OF UPSTAIRS MARKET MAKING

The question of interest is under what conditions will an upstairs market maker fill an incoming order by principal trading. To address this question, we consider how upstairs market makers serve a dual role in most brokerage firms. First, they make profits for their firms through trading. Second, they provide liquidity and perform other services for clients, services which may be particularly important to multi-functional firms. Based on the liquidity provision motive, we assume that the brokerage firm attempts to maintain, on average, a zero inventory.

We model the trading profit motive directly but, for the multi-functional firm, there is also a profit opportunity from underwriting. The ability to compete in this arena is a function of a firm's reputation for ongoing liquidity provision. Thus, there may be a significant liquidity provision motive in upstairs trading.[7] We control for this liquidity motive by analyzing the ability of the book to fill orders at the market. In particular, an order is more likely to be handled by the upstairs market maker on a principal basis when it is large relative to the depth available on the CLOB.

As found in Smith, Turnbull and White (2001) and Booth, Lin, Martikainen and Tse (2002), upstairs market makers screen out information-laden orders and only participate in liquidity-motivated orders.[8] Consequently, we model the profit from liquidity trading only. Based on the premise that informed traders will seek immediacy, we control for information-laden orders in our empirical analysis by including an order aggressiveness variable based on whether orders are immediately executable. Those orders which are immediately executable are not expected to be handled on a principal basis by the upstairs market maker.

To model trading profit, we assume there are a non-trivial number, *N*, of potential traders of a security. All of these traders are liquidity providers who are risk-neutral profit maximizers. We assume the trader faces both fixed and variable costs in handling a trade as a principal. The fixed costs reflect the time involved in analyzing and executing a trade of any size. Variable costs are consistent with paying a round-trip spread, greater inventory holding costs, and greater liquidity costs associated with reversing a larger position in a security.

Upon acquiring a position (long or short), we assume that the upstairs market maker will hold the position for a short time and then reverse it at time *t*. The upstairs market maker has the following profit function from trading:

$$\pi(t)|\psi_0 = Q[m(p(t) - p_0) - C_v] - C_f \tag{1}$$

$$p(t) = p_0 + \mu(\psi_0)t + B(t) \tag{2}$$

$$\mu(\psi_0) = \mu_0 + \lambda \ln\left(\frac{V_B}{V_A}\right) \tag{3}$$

$$C_v = \alpha_0 + \alpha_1 RSpread \tag{4}$$

where: $\pi(t)$ = profit realized from trading at 0 and subsequent reversal at time *t*
ψ_0 = market information set about the composition of the CLOB as of time 0
Q = quantity of shares traded at time 0 and subsequently unwound at time *t*
m = position taken by market maker at time 0: +1 if long, -1 if short
$p(t)$ = market price process which is assumed to follow a stochastic process where $B(t)$ is standard Brownian motion
p_0 = trade price at time 0
C_v = round-trip variable cost of trading one share
C_f = round-trip fixed costs of trading
$\mu(\psi_0)$ = instantaneous price process drift at time 0 given market information, ψ_0
μ_0 = drift in market price per unit of time given no market information, i.e. $\psi_0 = \{\varnothing\}$

λ = market drift acceleration per unit of imbalance in the CLOB
V_B = volume at the bid (buy side) in the CLOB
V_A = volume at the ask (sell side) in the CLOB
RSpread = relative spread: 2*(Ask - Bid)/(Ask + Bid)*

Upstairs market makers have a competitive advantage because they can choose to interact with an order before the rest of the market has that opportunity. Since the upstairs market maker is a profit maximizer, he will principal trade whenever the expected profit from trading is greater than zero; this is the profit motive. The expected profit from trading is:

$$E(\pi|\psi_0) = Q\left\{m\left[\mu_0 + \lambda \ln\left(\frac{V_B}{V_A}\right)\right]t - C_v\right\} - C_f \quad (6)$$

On a per share basis, the expected profit from trading is greater than zero when

$$m\left[\mu_0 + \lambda \ln\left(\frac{V_B}{V_A}\right)\right]t > C_v + \frac{C_f}{Q} \quad (7)$$

All else equal, Equation 6 says that expected trading profit increases with:

i) Greater order imbalance in the book, $m\ln(V_B/V_A)$. Buying/selling pressure results in a trending market and will be evidenced by an imbalance in the CLOB. In equilibrium, V_B would be equal to V_A and there would be no buying/selling pressure. All market participants observe the imbalance; however, the upstairs market maker has the first opportunity to act. The greater the order imbalance, the higher the probability the upstairs market maker will principal trade.
ii) Lower variable trading costs, C_v. The relative spread is a measure of market liquidity: the narrower the spread the more liquid the market for the security. The greater the market liquidity (narrower the relative spread), the greater the probability the upstairs market maker will principal trade.
iii) Lower fixed cost per share, C_f/Q. As the fixed cost of trading per share declines with order size, Q, there are economies of scale in trading. The probability of a public order being taken on a principal basis is an increasing function of order size.

In summary, to serve the roles of profit-seeking trader and service-provider to brokerage clients, upstairs market makers are influenced by a number of factors for which we will empirically test. We expect that the probability of the upstairs market maker principal trading is an increasing function of the following variables: greater order imbalances in the CLOB in the opposite direction to the client order, narrower bid-ask spread, larger order size, orders that are not immediately executable, and larger order size relative to the depth available to fill the order on the CLOB. The first three of these factors are related to their trading profit motive and the last two factors are related to their role as liquidity providers.

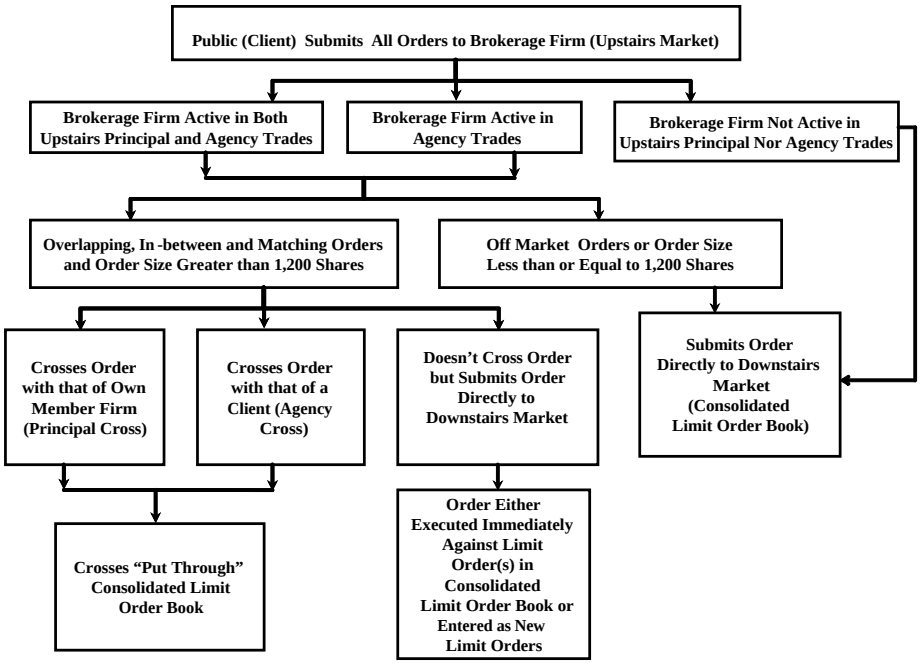
DATA

The TSX data we use contains all order flow so all orders and trades can be classified and the CLOB can be reconstructed with accuracy. The database provides a complete history of each order on the exchange from time of submission until disposition. Each order has a unique identifier which permits tracking its disposition across subsequent transactions. For each order submitted to the exchange, the data indicates the time of submission, broker numbers, the direction, price and size as well as details on related fills, changes (CFOs), cancellations and other characteristics of the orders. Ideally, it would be interesting to study the extent of principal trading on other markets in addition to the TSX. However, available data from these markets is not sufficiently detailed to allow us to identify characteristics of order flow.

The study covers the trading days from February 5 to 28, 2001.[9] We examine order data handled by the 78 TSX member brokerage firms that handled orders for sample stocks over this time period; of these, 33 firms had at least one upstairs principal trade in one or more of the stocks in the sample. We limit our analysis to the 431 common shares which traded every day during this period and had a constant tick size of one penny. The analysis includes all public orders with a valid prior quote through firms that handle orders for sample stocks in either the upstairs or downstairs market. Pre-opening, opening and crossing session (after the close) orders are excluded.

FIGURE 1
FLOW OF PUBLIC ORDERS ON THE TORONTO STOCK EXCHANGE

Figure 1 shows how public orders are handled by upstairs market makers on the Toronto Stock Exchange (TSX) during the period, February 5 to February 28, 2001. Upstairs principal trades are those in which brokerage firms employ upstairs market makers (called liability or NX traders) who act as principals with incoming public orders for common shares listed on the TSX. Upstairs agency trades involve upstairs market makers matching two incoming public orders. Orders generated by the market makers within the brokerage firm and in the downstairs market are excluded. Off market orders have an order price that is less than the market quote on the same side of the Consolidated Limit Order Book (CLOB). Matching orders have an order price that is equal to the market quote on the same side of the CLOB. In-between orders have an order price that is inside the market quotes of the CLOB. Overlapping orders have an order price that is better than or equal to the market quote on the opposite side of the CLOB.



Since we are only interested in examining how incoming public orders are handled, we exclude orders generated by market makers within the firm and in the downstairs market. Figure 1 shows how public orders are handled by brokerage firms on the TSX. The Figure illustrates that investors can limit the fashion in which their order is handled by selecting a brokerage firm that offers the following specific sets of upstairs market-making functions for the security in question: 1) active in upstairs principal and agency trading; 2) active in upstairs agency trading only; and 3) not active in upstairs trading. The focus of our research is on the orders handled by the first group of brokerage firms, since it is this group that does principal trading.

ANALYSIS

If principal trading is considered by investors to be contrary to their interests, then we suspect that investors will avoid submitting orders to brokerage firms who conduct upstairs principal trading. We address this issue by examining where orders are submitted. The first row of Panel A of Table 1 provides evidence that, on average, a majority of orders (50.86%) are sent to brokerage firms who do upstairs principal trading with incoming orders on that stock. Thus, investors appear to prefer to submit orders for a security to brokerage firms that do upstairs principal trading in that security.

TABLE 1
PARTICIPATION BY FIRMS IN UPSTAIRS PRINCIPAL TRADING

The table shows descriptive statistics on the participation by brokerage firms on the Toronto Stock Exchange (TSX) during the trading days from February 5 to February 28, 2001. The analysis includes all public orders sent to sample firms excluding orders generated by market makers within the firm and in the downstairs market as well as orders equal to or less than 1,200 shares.

Panel A:	Across Sample Stocks			
	Mean	Median	Minimum	Maximum
% of Orders for Stock that are sent to a firm that does Upstairs Principal Trading with Incoming Public Orders on that Stock	50.86%	52.06%	0.00%	96.88%

Panel B:	Across TSX Brokerage Firms with Upstairs Principal Market Makers			
	Mean	Median	Minimum	Maximum
Number (%) of Stocks in which a Firm Does Upstairs Principal Trading With Incoming Client Orders	21.3 (4.9%)	1 (0.2%)	0 (0.0%)	157 (36.4%)
Number (%) of Stocks in which a Firm Does Upstairs Agency Trading but No Upstairs Principal Trading	9.4 (2.2%)	4 (0.9%)	0 (0.0%)	52 (12.1%)
Number (%) of Stocks in which a Firm Does No Upstairs Trading With Incoming Client Orders	400.3 (92.9%)	423.5 (98.3%)	261 (60.6%)	431 (100.0%)

Panel B of Table 1 highlights that a majority of brokerage firms on the TSX do no principal trading. Furthermore, the average number of stocks that any brokerage firm principal traded in during the period of the study is 21.3 or 4.9% of the 431 stocks studied. The most active upstairs principal participation by any single brokerage firm is 157 stocks (36.4% of sample of stocks). There are stocks for which firms do upstairs agency trades but do not do upstairs principal trading. The average number of such stocks across brokerage firms is 9.4 or 2.2% of all 431 stocks examined. Thus, firms tend to specialize in upstairs trading of a subset of securities.

In summary, our findings suggest that, on average, investors send a majority of orders to firms that engage in upstairs principal trading on that stock. Investors appear to benefit from principal trading. Second, we find that such firms tend to concentrate their principal trading on a subset of securities in the market. This finding is consistent with the notion that a firm's reputation for after-market support in the trading of shares issued by current and prospective clients is a critical factor when competing for

underwriting business. The ability to provide liquidity enhances the reputation of the brokerage firm which in turn attracts more underwriting business.

TABLE 2
FLOW OF PUBLIC ORDERS ON TORONTO STOCK EXCHANGE

Table 2 summarizes how public orders are handled by upstairs market makers on the Toronto Stock Exchange during the trading days from February 5 to February 28, 2001. The analysis includes all public orders with a valid prior quote through firms that handle orders for sample stocks in either the upstairs or downstairs market. Pre-opening, opening and crossing session (after the close) orders as well as orders generated by market makers within the firm and in the downstairs market are excluded. Off-market orders have prices above or below the market quotes on the same side. Orders that match have prices that are equal to the market quote on the same side. In-between orders have prices that are in-between the market quotes. Overlapping orders have prices that are better than or equal to the market quote on the opposite side of the CLOB.

				Number of Orders	Millions of Shares	Average Order Size
All Incoming Public Orders				1,619,798	2,870.2	1,772
Orders Sent Directly to Downstairs Market: Off-market orders and/or orders with ≤1,200 shares				1,351,787	791.8	586
Order at or Better than Market Quote on the Same Side and Order Size > 1,200 Shares	Sent to Firms With No Principal Trading in Stock	Total		63,349	352.9	5,571
		Sent to Downstairs Market		61,724	277.8	4,501
		Agency Crosses		1,625	75.1	46,190
	Sent to Firm With Principal Trading in Stock	Total		204,662	1,725.6	8,431
		Sent to the Downstairs Market	Match Quote	51,168	214.8	4,197
			Between	43,280	174	4,019
			Overlap	92,935	442.4	4,760
			Total	187,383	831.1	4,435
		Agency Crosses	Match Quote	2,952	152.7	51,733
			Between	3,307	137.3	41,529
			Overlap	3,013	156.1	51,816
			Total	9,272	446.2	48,121
		Principal Crosses	Match Quote	2,585	163	63,074
			Between	2,322	107.3	46,230
			Overlap	3,100	177.9	57,382
			Total	8,007	448.3	55,986

Table 2 provides further evidence that investors choose to submit orders to firms with upstairs principal trading. On the TSX, from February 5 to 28, 2001, there are 1,619,978 orders that involved 2,870.2 million shares. Of these orders, 1,351,787 (791.8 million shares) are off-market orders and/or orders equal to or less than 1,200 shares. Off-market orders are buy (sell) orders priced below the bid (above the ask). Because principal crosses are only allowed for orders in excess of 1,200 shares at prices at or within the market quotes, off-market orders are submitted directly downstairs regardless of the brokerage firm to which they are sent.

Of the orders that could be filled as a principal cross, 63,349 are sent to firms with no principal trading in the stock versus 204,662 sent to firms with principal trading. Thus, there is more evidence of an

investor preference for submitting orders to brokerage firms with principal participation. This preference appears to hold true for larger orders. The average size of the orders sent to firms with no principal trading in the stock is 5,571 versus 8,431 for firms with principal trading. Of the orders sent to firms with principal trading, only 9,272 and 8,007 are handled as agency and principal crosses, respectively. However, these crosses represent over half of the volume of trading. The average order size of the agency and principal crosses is 48,121 and 55,986, respectively. These figures are more than ten times the size of orders sent directly to the downstairs market.

While there is considerable evidence that principal trading offers benefits to clients of brokerage firms, an additional concern is that principal trading may unduly violate the price priority of limit orders on the CLOB. To address this issue, we examine the extent of price improvement achieved in crosses relative to the price available in the CLOB as well as the relative size of crossed orders in comparison to depth available to fill the order at market prices on the CLOB.

FIGURE 2
PRICE IMPROVEMENT FOR UPSTAIRS PRINCIPAL TRADES

Figure 2 shows the price improvement given to public orders taken by upstairs market makers on a principal basis on the Toronto Stock Exchange (TSX) during the period, February 5 to February 28, 2001. Price improvement of zero cents means the client order was executed at the market price: *Ask* for client buy orders and *Bid* for client sell orders. Price improvement of *X* cents means the client order received a price of the *Ask* less *X* for client buy orders and the *Bid* plus *X* for client sell orders. If an order received price improvement of more than ten cents, it is included in the ">10" category. The vertical axis is the percentage of all upstairs principal trades in sample stocks, by number and by volume.

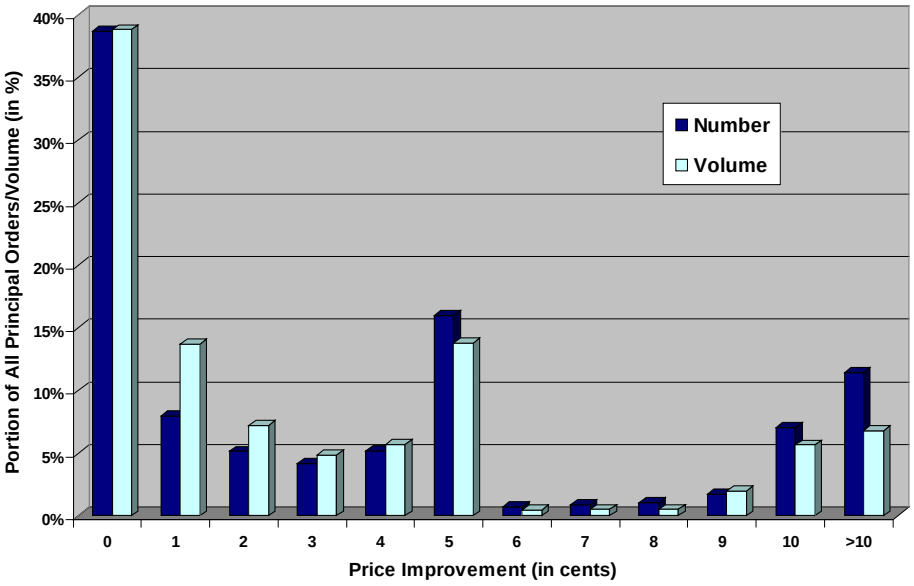


Figure 2 shows that over 60% of the public orders, by number and volume, taken by upstairs market makers on a principal basis receive price improvement. Less than 8% by number and 14% by volume receive price improvement of only one penny. The clients of brokerage firms for whom principal crosses are done do not appear to be price-takers. The nearly equal volume of crosses that match and overlap the market, shown in Table 2, suggests that prices are negotiated between parties of equal strength. The symmetric distribution of prices of crosses between the market quotes also suggests that upstairs market makers who buy (sell) are not actively disadvantaging traders placing limit orders in the same direction.

The last column of Table 2 shows that crosses are substantially larger than orders submitted to the downstairs market. The average size of principal crosses is 55,986 shares versus only 4,435 for orders sent directly to the CLOB. As reported in Table 3, the size of principal crosses is approximately ten times

the depth at the market quote in the CLOB at the time of the cross. For crosses whose price overlaps the market, the depth at the market quote relative to the size of the cross is, on average, only 11.3%. This means that only a small fraction of the order could have been immediately executed at the same price if it had been directly sent to the CLOB. If complete and immediate execution was demanded, the price would have been less favorable to the brokerage firm client, assuming sufficient volume was available in aggregate. Principal crosses benefit brokerage firm clients by providing liquidity that is not immediately available in the CLOB.

TABLE 3
SIZE OF PRINCIPAL CROSSES RELATIVE TO AVAILABLE LIQUIDITY ON CONSOLIDATED LIMIT ORDER BOOK

This table reports the average portion of the client-side order in a principal cross that the consolidated limit order book could have absorbed. The data includes all upstairs principal crosses on the Toronto Stock Exchange during the trading days from February 5 to February 28, 2001. The volume available to fill the client order is the volume at the quote on the opposite side of the consolidated limit order book. Orders that match the quote have prices that are equal to the market quote on the same side. In-between orders have prices that are in-between the market quotes. Overlapping orders have prices that are better than or equal to the market quote on the opposite side of the CLOB.

Price of Client Order Relative to the Market	Number of Crosses	Volume at Market Quote as a % of Client Order
Match Quote	2,585	10.11%
Between	2,322	9.51%
Overlap	3,100	11.30%
Total	8,007	10.44%

While the evidence so far in this study indicates that upstairs principal trading benefits clients through price improvement and liquidity provision, we are also interested in what motivates the upstairs market maker to engage in principal trading. The factors developed in Section 2 of the paper are expected to affect the likelihood of an order being handled as a principal cross. As such, we conduct the following logit regression model:

$$Upstairs\ Principal_{i,j} = f(Imbalance_{i,j}, LVolRel_{i,j}, Immed_{i,j}, RSpread_{i,j}, LVol_{i,j}) \quad (7)$$

where: $Upstairs\ Principal_{i,j}$ = Dummy variable with value 1 if an incoming public order is handled by an upstairs market maker; 0 otherwise

$Imbalance_{i,j}$ = (Volume at Bid)/(Volume at Ask) for upstairs market maker buy; (Volume at Ask)/(Volume at Bid) for upstairs market maker sell

$LVolRel_{i,j}$ = Ln of ratio of Size of order to Volume at Bid (Ask) for upstairs market maker buy (sell)

$Immed_{i,j}$ = Dummy variable with value 1 if order is immediately executable, that is, it is a buy (sell) order priced at, or above (below), the ask (bid) quote; 0 otherwise

$RSpread_{i,j}$ = Bid-ask spread divided by spread mid-quote at time of order

$LVol_{i,j}$ = Ln of size of order

Upstairs market makers will participate in principal crosses when market conditions and order characteristics suggest expected profit from a trade is greater than zero. Equation 6 shows the factors affecting the upstairs market maker's choice. If there is an order imbalance with depth at the bid

exceeding depth at the ask, then it is likely to be a more profitable time to principal trade as a buyer than as a seller. Thus, the coefficient of $Imbalance_{i,j}$ should be positive.

Earlier evidence indicates that liquidity provision is a likely motive for principal crosses. We expect that an order too large to be filled from the book is more likely to be filled as a principal cross than an order that can be filled at the market from the book. The variable, $LVolRel_{i,j}$ is greater than one when the book contains insufficient volume to satisfy the incoming immediately executable order. In this case, principal trading provides liquidity, as some portion of the incoming order would not execute if it was sent to the book. Consequently, we expect the coefficient of the variable, $LVolRel_{i,j}$, to be positive.

As discussed in Section 2, a primary role of upstairs market makers is to provide liquidity. As such, they will choose not to trade with information-laden orders which will, instead, be routed downstairs. Assuming informed traders will seek immediacy, the variable $Immed_{i,j}$ is a screening variable for informed versus liquidity-motivated orders. We expect the coefficient of $Immed_{i,j}$ to be negative, as aggressively priced (information-laden) orders are less likely to be handled as crosses.

TABLE 4
LOGIT MODEL OF PRINCIPAL TRADING BY UPSTAIRS MARKET MAKER ACROSS TIME

This table shows coefficients and significance levels (in brackets) of a logit model for the likelihood of an upstairs market maker acting as a principal with incoming clients orders on The Toronto Stock Exchange (TSX) during the trading days from February 5 to February 28, 2001. The analysis includes all public orders, with a valid prior quote for each sample stock, submitted through firms with upstairs market makers that act as a principal in that stock in either the upstairs or downstairs market. The analysis excludes pre-opening, opening and crossing-session (after the close) orders and orders generated by market makers within the firm or in the downstairs market as well as orders equal to or less than 1,200 shares. A '#' means that the posterior odds ratio indicates that the odds against the null hypothesis of the coefficient equaling zero are greater than 20:1.

$$Upstairs\ Principal_{i,j} = f(Imbalance_{i,j}, LVolRel_{i,j}, Immed_{i,j}, RSpread_{i,j}, LVol_{i,j})$$

where:

$Upstairs\ Principal_{i,j}$	=	Dummy variable with value 1 if an incoming public order is handled by an upstairs market maker on a principal basis; 0 otherwise
$Imbalance_{i,j}$	=	(Volume at Bid)/(Volume at Ask) for upstairs market maker buy (Volume at Ask)/(Volume at Bid) for upstairs market maker sell
$LVolRel_{i,j}$	=	Ln of ratio of Size of order to Volume at Bid (Ask) for upstairs market maker buy (sell)
$Immed_{i,j}$	=	Dummy variable with value 1 if order is immediately executable, that is, it is a buy (sell) order priced at or above the ask (at or below the bid) quote; 0 otherwise
$RSpread_{i,j}$	=	Bid-ask spread divided by spread mid-quote at time of order
$LVol_{i,j}$	=	Ln of size of order

Variable	Coefficient (significance level)		
	February 5 to 28, 2001	February 5 to 16, 2001	February 19 to 28, 2001
Constant	-14.556 (0.00#)	-14.722 (0.00#)	-14.404 (0.00#)
$Imbalance_{i,j}$	0.001 (0.48)	0.000 (0.82)	0.002 (0.15)
$LVolRel_{i,j}$	0.085 (0.00#)	0.060 (0.00#)	0.117 (0.00#)
$Immed_{i,j}$	-0.433 (0.00#)	-0.412 (0.00#)	-0.461 (0.00#)
$RSpread_{i,j}$	-65.524 (0.00#)	-79.497 (0.00#)	-53.680 (0.00#)
$LVol_{i,j}$	1.317 (0.00#)	1.341 (0.00#)	1.295 (0.00#)
Nagelkerke R^2	0.381	0.407	0.348
# of Orders	204,662	108,597	96,065

The variable, $RSpread_{i,j}$, is included in the logit regression as a measure of the variable costs of trading. The wider the spread, the more expensive a round-trip trade will be for the upstairs market maker. Consequently, we expect the coefficient of the variable, $RSpread_{i,jj}$, to be negative.

Finally, we expect that there are economies of scale in upstairs trading. The coefficient of the variable, $LVol_{i,j}$, should be positive.

Table 4 shows the results of the logit regression. The coefficient of the variable, $Imbalance_{i,j,}$ is not significantly different from zero. Thus, there is no evidence order imbalances affect the likelihood that an upstairs market maker will principal trade. This is consistent with the market maker not speculating on market trends, as evidenced by imbalances in the CLOB or, alternatively, firms limiting exposure to adverse price movements by restricting capital for speculation. This second explanation suggests that profit-taking positions are non-linear with respect to order size; market makers may speculate in smaller orders only.

TABLE 5
LOGIT MODEL OF PRINCIPAL TRADING BY UPSTAIRS MARKET MAKER ACROSS ORDER SIZE

This table shows coefficients and significance levels (in brackets) of a logit model for the likelihood of an upstairs market maker acting as a principal with incoming clients orders on The Toronto Stock Exchange (TSX) during the trading days from February 5 to February 28, 2001. The analysis includes all public orders, with a valid prior quote for each sample stock, submitted through firms with upstairs market makers that act as a principal in that stock in either the upstairs or downstairs market. The analysis excludes pre-opening, opening and crossing-session (after the close) orders and orders generated by market makers within the firm or in the downstairs market as well as orders equal to or less than 1,200 shares. A '#' means that the posterior odds ratio indicates that the odds against the null hypothesis of the coefficient equaling zero are greater than 20:1.

$$Upstairs\ Principal_{i,j} = f(Imbalance_{i,j}, LVolRel_{i,j}, Immed_{i,j}, RSpread_{i,j}, LVol_{i,j})$$

where:

$Upstairs\ Principal_{i,j}$	=	Dummy variable with value 1 if an incoming public order is handled by an upstairs market maker on a principal basis; 0 otherwise
$Imbalance_{i,j}$	=	(Volume at Bid)/(Volume at Ask) for upstairs market maker buy (Volume at Ask)/(Volume at Bid) for upstairs market maker sell
$LVolRel_{i,j}$	=	Ln of ratio of Size of order to Volume at Bid (Ask) for upstairs market maker buy (sell)
$Immed_{i,j}$	=	Dummy variable with value 1 if order is immediately executable, that is, it is a buy (sell) order priced at or above the ask (at or below the bid) quote; 0 otherwise
$RSpread_{i,j}$	=	Bid-ask spread divided by spread mid-quote at time of order
$LVol_{i,j}$	=	Ln of size of order

Variable	Coefficient (significance level)		
	February 5 to 28, 2001 All Orders	February 5 to 28, 2001 Orders Less Than or Equal to 5,000 Shares	February 5 to 28, 2001 Orders Greater than 5,000 Shares
Constant	-14.556 (0.00#)	-13.039 (0.00#)	-11.184 (0.00#)
$Imbalance_{i,j}$	0.001 (0.48)	0.005 (0.00#)	0.000 (0.81)
$LVolRel_{i,j}$	0.085 (0.00#)	0.203 (0.00#)	0.083 (0.00#)
$Immed_{i,j}$	-0.433 (0.00#)	-0.630 (0.00#)	-0.448 (0.00#)
$RSpread_{i,j}$	-65.524 (0.00#)	-31.068 (0.00#)	-70.675 (0.00#)
$LVol_{i,j}$	1.317 (0.00#)	1.044 (0.00#)	1.005 (0.00#)
Nagelkerke R^2	0.381	0.043	0.28
# of Orders	204,662	159,156	45,506

The coefficients of the variables, $LVolRel_{i,j}$, $Immed_{i,j}$, $RSpread_{i,j}$, and $LVol_{i,j}$ are highly statistically significant and of the expected sign. The coefficient of $LVolRel_{i,j}$ is positive, which indicates that crosses

provide liquidity for orders that are large relative to volume available on the CLOB. As expected, aggressively priced orders are less likely to be filled as principal trades; the coefficient of $Immed_{i,j}$ is negative. The findings of liquidity provision and order screening are consistent with our earlier analysis. The coefficient of the variable, $RSpread_{i,j,}$ is consistent with the argument that upstairs market makers are reluctant to conduct principal trades when variable costs are high. The coefficient of the variable, $LVol_{i,j}$, is significantly positive. This is consistent with the argument that larger orders are more profitable for upstairs market makers to handle given the fixed cost structure of their trading activity.

We also conduct some sensitivity analysis on the logit regression. We subdivide the orders into those occurring from February 5 to 16, 2001 and those from February 19 to 28, 2001. As shown on the last two columns of Table 4, the results for each of these periods is similar to those over the full time period. We test for non-linearities in the profit motive by splitting the sample into orders between those less than or equal to 5,000 shares and those larger. There is some non-linearity in the results as shown in Table 5. The coefficient of $Imbalance_{i,j,}$ is statistically significantly greater than zero for the smaller size orders but not significantly different from zero for the 5,000+ share orders. This means that, for upstairs market makers, the profit motive is stronger when handling small orders than large orders; this is consistent with a capital constraint and exposure management argument. Thus, the results do not appear to be data specific.

CONCLUSIONS

The paper addresses questions as to what extent market makers trade as principals in the upstairs market and the factors that explain the market maker's decisions. We study order flow for 431 firms in February 2001 on the TSX, a hybrid market with an active upstairs market and a CLOB. We conclude that upstairs principal trading benefits the investing public. First, while investors are free to submit orders to brokerage firms who do not do principal trading, on average, just over one-half of orders are sent to brokerage firms that do principal crosses on that stock. Furthermore, brokerage firms tend to concentrate in doing crosses on a small number of securities. On average, firms do principal crosses for only 21 stocks. Thus, order flow for a stock tends to gravitate to firms which specialize in market making for that security.

Second, we find that upstairs principal crosses provide both price improvement and liquidity to clients. In fact, one-third of crosses match the quote on the same side as the incoming order. Only 30% of the number and 40% of the volume of crosses overlap the market. Furthermore, for those crosses that do overlap the market, the volume of these crosses is nearly ten times that of the depth in the CLOB. A logit regression reinforced this finding. In particular, immediately executable orders are more likely to be sent directly downstairs than handled by the upstairs market maker. The greater the size of the order relative to the depth on the CLOB, the more likely the order would be handled as an upstairs principal trade. This suggests upstairs markets can fill an important role in enhancing electronic markets.[10]

For orders in excess of 5,000 shares, a market imbalance does not significantly affect the likelihood that an order will be handled as a principal cross. For orders of 5,000 or fewer shares, the profit motive is significant.

Upstairs market makers also tend to handle orders larger in absolute size as principals. This is consistent with the argument that there are economies of scale in upstairs trading. In addition, a higher relative spread lessens the probability that an order will be handled as a cross. This is likely because higher spreads make it more expensive to trade.

Overall, the paper finds that principal trading by upstairs market makers benefits the investing public. Investors' orders gravitate to firms that do principal crosses. Principal trading provides substantial price improvement and liquidity over that available in the consolidated limit order book. This finding is consistent with the argument that active liquidity provision enhances the reputation of those brokerage firms which are engaged in underwriting and other services.

ENDNOTES

1. In a hybrid market like the New York Stock Exchange (NYSE) or the Toronto Stock Exchange (TSX), a public order for securities is submitted to a brokerage firm who in turn can handle the order in one of three ways. First, in the upstairs market, the brokerage firm may fill the order directly as a principal. Second, in the upstairs market, the firm may act in an agency capacity and match the order with that of another of its clients. Third, the firm may submit the order to the downstairs market whereby the order would gain wider exposure through the floor of the exchange (NYSE) and/or by means of the limit order book.
2. While the focus of this paper is principal trading in a hybrid market, Hansch, Naik and Viswanathan (1999) analyse a related practice, internalization, on the London Stock Exchange, a dealer market. Internalization occurs when a broker routes order flow to a dealer belonging to the same firm. Internalized orders receive better execution.
3. Reiss and Werner (2005) study the LSE, a broker-dealer market, and report that informed orders tend to be routed to the non-anonymous inter-dealer market while liquidity-motivated orders tend to be routed to the apparently anonymous broker market. However, brokers match two clients (dealers), thus, to the broker, this market is non-anonymous. This is what we would expect if brokers were trying to maintain their reputation capital to preserve an ongoing business relationship. Brokers will not match liquidity orders with informed orders so all informed orders are forced to the inter-dealer market. Our conjecture is supported by the findings in Bernhardt, Dvoracek, Hughson and Werner (2005) and Battalio, Ellul and Jennings (2007). Both papers find support for reputation capital in market making.
4. Capital requirements are one possible reason for certain firms not engaging in upstairs principal trading. We do not have the data to investigate this explanation.
5. While the Designated Market Maker (DMM) cannot offer price improvement to an order before it is exposed to the market, under one set of conditions time priority of existing limit orders is not maintained. This can occur when the DMM elects to participate in up to half of the volume of each small order of a stock where a “small” trade is defined by the TSX as one whose size is below the Minimum Guaranteed Fill (MGF). The MGF is prescribed for each stock by the TSX according to factors such as the volume of stock traded. The option to “auto-participate” in small orders is meant to offset the DMM’s requirement to fill market or immediately executable limit orders whose size is below the MGF.
6. Rule 4-502 of the TSX Rule Book requires that upstairs market makers must price improve orders between 1,201 and 5,000 shares in order to take them on a principal basis. The Rule doesn’t apply if the spread of the market quotes is equal to the minimum tick size for the security. Rule 4-104 allows brokerage firms to match certain orders in-house by using their own electronic order matching systems. On September 22, 2000, prior to the period in this study, Rule 4-104 was amended (see TSX Regulatory Notice 2000-028) to allow the use of these systems to match all orders for more than 1,200 units of any non-debt security without requiring price improvement. Rule 4-502 was repealed on April 1, 2002, subsequent to the period of the study.
7. Harris and Panchapagesan (2005) investigate liquidity provision by the specialist on the NYSE. The NYSE measures specialist performance based on liquidity provision, thus motivating specialists to provide liquidity or price improvement. There is no such measurement or requirement for the upstairs market maker on the TSX.
8. See Griffiths, Smith, Turnbull and White (2000) for a discussion of order aggressiveness.
9. The majority of securities listed on the TSX changed to penny ticks on January 31, 2001. As a change in tick size may affect market maker behaviour, February 5, 2001 was selected as a start date to allow for learning. During the period of our study, the tick size for all shares priced at 50 cents or higher was one penny.
10. Several papers have examined the impact of Rule NMS (Chung and Chuwonganant (2012)) and/or the introduction of the NYSE’s Hybrid (Gutierrez and Tse (2009), Hendershott and Moulton (2011)) on market quality. Although speed of execution (a measure of market quality) has increased following both, there has also been a decline in price improvement (see Gutierrez and Tse (2009)).

REFERENCES

Battalio, R., Ellul, A. & Jennings, R. (2007). Reputation effects in trading on the New York Stock Exchange. *Journal of Finance*, 62, 1243-1271.

Bernhardt, D., Dvoracek, V., Hughson, E. & Werner, I.M. (2005). Why do larger orders receive discounts on the London Stock Exchange? *Review of Financial Studies*, 18, 1343-1368.

Bessembinder, H. & Venkataraman, K. (2004). Does an electronic stock exchange need an upstairs market? *Journal of Financial Economics*, 73, 3-36.

Booth, G., Lin, J., Martikainen, T. & Tse, Y. (2002). Trading and pricing in upstairs and downstairs markets. *Review of Financial Studies*, 15, 1111-1115.

Chung, K.H., & Chuwonganant, C. (2012). Regulation NMS and market quality. *Financial Management*, 41, 285-317.

Griffiths, M.D., Smith, D.F., Turnbull, D.A.S. & White, R.W. (2000). The costs and determinants of order aggressiveness. *Journal of Financial Economics*, 56, 65-88.

Grossman, S. (1992). The information role of upstairs and downstairs markets. *Journal of Business*, 65, 509-529.

Gutierrez, J.A. & Tse, Y. (2009). NYSE execution quality subsequent to migration to hybrid. *Review of Quantitative Finance and Accounting*, 33, 59-81.

Hansch, O., Naik, N. & Viswanathan, S. (1999). Preferencing, internalization, best execution, and dealer profits. *Journal of Finance*, 54, 1799-1828.

Harris, L.E. & Panchapagesan, V. (2005). The information content of the limit order book: evidence from NYSE specialist trading decisions. *Journal of Financial Markets*, 8, 25-67.

Hendershott, T., & Moulton, P.C. (2011). Automation, speed, and stock market quality: the NYSE's Hybrid. *Journal of Financial Markets*, 14, 568-604.

Keim, D.B. & Madhavan, A. (1996). The upstairs market for large-block transactions: analysis and measurement of price effects. *Review of Financial Studies*, 9, 1-36.

Reiss, P.C. & Werner, I.M. (2005). Anonymity, adverse selection, and the sorting of interdealer trades. *Review of Financial Studies*, 18, 599-636.

Ready, M.J. (1999). The specialist's discretion: stopped orders and price improvement. *Review of Financial Studies*, 12, 1075-1112.

Smith, B.F., Turnbull, D.A. & White, R.W. (2001). Upstairs market for principal and agency trades: analysis of adverse information and price effects. *Journal of Finance*, 56, 1723-1746.