Market vs. Limit Orders: The SuperDOT Evidence on Order Submission Strategy

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Abstract
This paper discusses performance measures for market and limit orders. We suggest two measures: one for precommitted traders (who must trade) and another for passive traders (who are indifferent to trading). We compute these measures for a sample of NYSE SuperDOT orders. The results suggest that the limit order placement strategies most commonly used by NYSE SuperDOT traders do in fact perform best. Limit orders placed at or better than the prevailing quote perform better than do market orders, even after imputing a penalty for unexecuted orders, and after taking into account market order price improvement. Unconditional order submission strategies that use SuperDOT to offer liquidity in competition with the specialist do not appear to be profitable.

I. Introduction
Order submission decisions are among the most important choices traders make. Traders typically must decide when to use market orders (which demand execution at the best available price) and when to use limited price orders (which execute only if a counterparty meets the limit price). Market orders pay an implicit price for immediacy. Limit orders bear the risks of nonexecution and adverse selection. This paper presents an empirical analysis of the tradeoffs involved based on the execution performance of an actual sample of New York Stock Exchange (NYSE) orders.

We employ two performance measures. The first measure compares the execution price of an order to the opposite quote prevailing when the order was received by the market (the average fill price of a sell order less the prevailing bid quote, or the ask less the average fill price of a buy order.) This ex ante measure
estimates the prospective benefits of using a limit order versus a market order that immediately executes against the prevailing opposing quote. Such a choice typically confronts an agent who is precommitted to trade, such as a trader who must sell the asset by the close of the day’s trading to fund a debt obligation. To avoid the selection bias that would result from dropping unexecuted limit orders from the sample, we assume that a failed or canceled limit order is replaced by a market order.

The second measure compares the execution price of an order to the same-side quote prevailing after the execution (the average fill price of a buy order less the subsequent bid, or the subsequent ask less the average fill price of a sell order.) This ex post measure estimates the trader's retrospective loss or gain associated with the newly established position. It is appropriate for a passive trader (such as a dealer) whose only reason to trade are expected trading profits.

Our analysis relates to several themes in microstructure research. Cohen, Maier, Schwartz, and Whitchcomb (1981) model the trader’s choice between market and limit orders in a market with homogeneous information. Harris (1995) characterizes the individual trader’s optimal strategy in a general multiperiod setting. Holden and Chakravarty (1995) model the single-period interactions of an informed trader who can submit market and limit orders, a dealer who posts quotes and exogenous liquidity traders. Kumar and Seppi (1992) analyze equilibrium in a setting that allows market and limit orders with discreteness. All of these models reflect the essential tradeoff between market and limit orders, that between execution uncertainty and transaction cost.

Empirical work on order strategies is still relatively nascent. Bronfman (1991) presents a characterization of one day’s order flow for the NYSE. Petersen and Fialkowski (1994) examine a sample of market orders for two days, and describe intermarket differences in execution performance. Biais, Hillion, and Spatt (1995) analyze order flows in the Paris Bourse, and characterize the determinants of order submission and price placement. Handa and Schwartz (1991) impose simulated limit order strategies on actual transaction price and quote realizations, thereby constructing a random sample of hypothetical limit orders. This approach assumes, however, that the stock price path is not affected by the submission or execution of the simulated order. Because the present sample consists of actual orders, it may be more realistic.

This paper is also related to the literature on transaction cost measurement, surveyed in Beebower (1989) and Harris (1990). Most of these studies focus on realized trades, however. Perold (1988) notes that this ignores the cost of foregone trades. By focusing on orders and imputing a cost of execution failure, the present analysis attempts to remedy this defect.

Blume and Goldstein (1993) and Lee (1993) present comparative market studies based on price improvement, defined as the difference between a transaction price and the prevailing quote. This quantity is similar to our ex ante performance measure. The price improvement calculation, however, assumes that the disadvantaged party in the transaction is a market order trader. Such an assumption is unnecessary in the present study because we observe the orders underlying the transaction. On the other hand, because our order sample comprises only NYSE submissions, it does not support intermarket comparisons.
Using a sample of actual NYSE orders, we compute averages of ex ante and ex post order performance measures. The results show that when limit orders are classified by their price relative to the quote prevailing at the time of order submission, the orders that display the best performance are also the orders that are most frequently submitted. The results further suggest that if a trader passively places limit orders, and then (upon execution) actively attempts to reverse the initial trade, losses are likely to result. That is, off-floor traders cannot profitably operate as quasi-dealers in competition with the specialist and other floor traders.

We condition our analysis only on spread, order size, and order direction (buy or sell), and within each classification cell, we rely on unconditional means of our performance measures. We do not know the ultimate objectives, the complete strategies, and the full information sets associated with the orders. This means that we may be assessing the outcomes of strategies that are, given actual objectives and information sets, suboptimal. Real world traders may surpass our performance estimates.

The rest of the paper is organized as follows. The next section describes our empirical approach. Section III discusses order handling at the NYSE and the characteristics of our data. Section IV describes the main results. A brief summary concludes the paper in Section V.

II. Empirical Methods

A. Description of Strategies

For present purposes, an order strategy is defined by the choice of market or limit order, and (if a limit order) the limit price position. Denote the bid and ask quotes prevailing at the time of order submission as $q^\text{bid}_{\text{sub}}$ and $q^\text{ask}_{\text{sub}}$. The limit price position is defined as the limit price relative to the prevailing quote on the same side of the order,

\[
L = \begin{cases} 
(limit \text{ price}) - q^\text{bid}_{\text{sub}}, & \text{for a buy order} \\
q^\text{ask}_{\text{sub}} - (limit \text{ price}), & \text{for a sell order}
\end{cases}
\]

$L$ measures the "aggressiveness" of the limit order, the extent to which it betters the existing quote. A limit buy order at the current bid price has $L = 0$. Such orders will be referred to as at-the-quote orders. Limit orders away from the market have $L < 0$. As defined, $L$ is a notational convenience that normalizes the limit price relative to the quotes and direction of the order. Marketable limit orders (those priced to meet or better the opposing quote) are essentially similar to a market order. We group these orders with market orders for reporting purposes, and comment on the differences in the discussion of the results.

B. Performance Measures

In the spirit of the transactions cost literature cited in the introduction, this paper measures order performance by comparing the actual or imputed fill price with a nearby market price that serves as a benchmark. The benchmark price need
not correspond to an actual transaction price because order strategies are compared to each other, not to the benchmark. In this paper, we compare the fill price to a nearby quote.

1. Ex Ante Performance Measure

Our ex ante measure takes as a reference price the opposite-side quote prevailing at the time the order was submitted. For an order that executes at the average fill price $p^\text{fill}$, our ex ante performance measure is

$$p^\text{ex ante} = \begin{cases} q^\text{ask}_{\text{sub}} - p^\text{fill}, & \text{for a buy order} \\ p^\text{fill} - q^\text{bid}_{\text{sub}}, & \text{for a sell order} \end{cases}$$

Use of the opposite-side quote establishes a comparison to a hypothetical market order that executes against the quote.

For orders not completely filled due to expiration or cancellation, a fill price does not actually exist. These orders cannot be dropped from the sample because they embody the very real costs of foregone trades. While these costs cannot be accurately measured without detailed knowledge of the individual trader’s situation, it is common to impute a cost. Handa and Schwartz impute a fill to these orders at a future price, and we follow this approach. Specifically, we impute to the canceled portion of an order a fill at the opposite-side quote prevailing at the time of cancellation. For example, a canceled buy order is assumed to have been filled at the seller’s quote (the prevailing ask).

This implicitly assumes a strategy in which a canceled order is immediately resubmitted as a market order that executes against the opposite-side quote. While possessing the virtue of simplicity, this practice almost certainly exaggerates the penalty associated with execution failures. The fact that only a fraction of all canceled orders are actually resubmitted indicates that many limit order traders are passive in the sense that they are only willing to trade at their price. Accordingly, this measure is most appropriate for precommitted traders who use limit orders to lower the cost of trades that they intend to complete under most circumstances. This computation also overstates the true economic loss because market orders often execute at prices more favorable than the opposite-side quote.

Expired orders are handled in a similar fashion. An expired buy order is assumed filled at the closing ask price; an expired sell order at the closing bid. This practice implicitly assumes that the limit order trader is willing to forego immediacy only up to the close of the day’s trading. As with canceled orders, this approach probably overstates the actual opportunity cost of the foregone trade.

The ex ante measure reflects the concerns of an agent who is precommitted to trade. For a market order, the fill price reflects an actual execution in virtually all instances, and $p^\text{ex ante}$ reflects the extent to which this price betters the opposite-side quote, a quantity often termed “price improvement.” For a limit order that is priced away from the market, the ex ante measure will be positive if the order executes, but will be generally negative otherwise (due to the imputed fill when the market has moved away from the limit price).
2. **Ex Post Performance Measure**

For orders that are completely filled, we compare the fill price to a market price prevailing after the execution. Our ex post performance measure is defined relative to $q_{fill+5}^\text{bid}$ and $q_{fill+5}^\text{ask}$, the bid and ask quotes prevailing five minutes after the order is filled,

$$ P_{\text{ex post}} = \begin{cases} q_{fill+5}^\text{bid} - p_{fill}, & \text{for a buy order} \\ p_{fill} - q_{fill+5}^\text{ask}, & \text{for a sell order} \end{cases} $$

For a buy order, for example, $P_{\text{ex post}}$ compares the price paid with the price that others are willing to pay five minutes after the fill. Alternatively, it may be viewed as the cost of reversing the trade using a market order that is executed against the quote. If the market closes within the five-minute period subsequent to the order fill, the closing quotes are used.

For a limit order, $P_{\text{ex post}}$ is determined in part by the information content of the counterpart order that was executed against it. In the standard adverse selection models, for example, a market sell order that executes against a limit buy order engenders a downward revision in the quotes. This is reflected as a negative value of $P_{\text{ex post}}$.\footnote{Note that $P_{\text{ex post}}$ is not a measure of ex post regret. In the zero transaction cost special case of Glosten and Milgrom (1985), for example, the subsequent quote can be interpreted as the best estimate of the security value conditional on another trade (one that hits the subsequent quote), not the previous trade.} In practice, however, $P_{\text{ex post}}$ will capture more than the information content of the counterparty trade. Rock (1995) notes that a limit order may execute as a portion of a much larger order. Furthermore, due to delays in monitoring and processing market information, a limit order cannot be instantaneously revised. In consequence, a limit order may be “blown through” by a wave of market orders that may carry the price to a level well away from the submitted limit price. As constructed, $P_{\text{ex post}}$ measures such events.

The interpretation of $P_{\text{ex post}}$ for a market order is similar but less conventional. As an example, if a market buy order causes the bid quote to be revised to the fill price, $P_{\text{ex post}} = 0$. But if no quote revision ensues, $P_{\text{ex post}}$ will be negative. In the latter case, the apparent loss is typically the price of immediacy, not the informational impact of the transaction.

$P_{\text{ex post}}$ is important to the passive trader, the agent who supplies liquidity via a limit order, but suffers no loss if the order is not filled. Such a trader effectively functions as a dealer. The expected dealer profit generally depends on the adverse price movement subsequent to the fill of the original limit order and the strategy used to reverse the trade. The performance measures defined here may be used to compute the profit for a trader who posts a limit order as a passive trader. Suppose that the limit order is filled, and further suppose that the trader wants to “go home flat” by reversing the trade. The dealer profit for this combined strategy (before commissions and other trading costs) is

$$ \Pi = P_{\text{ex post}} + P_{\text{ex ante}}, $$

where the performance measures depend on the strategies employed. Recall that if the order is not actually executed, the calculation of $P_{\text{ex ante}}$ imputes a fill at
the closing opposite-side quote. This may be too severe, since the dealer may be willing to wait longer than the close to reverse the trade. Furthermore, a closing fill may better the opposite-side quote.

C. Analysis Design

The paper examines the two order performance measures in subsamples constructed by prevailing spread, order size, strategy (market vs. limit, limit price position), and side (buy or sell). In comparing subsamples that differ only in strategy, we attribute any differences to strategy. For example, consider all orders of 200 or fewer shares submitted when the prevailing spread was $\frac{1}{4}$. In comparing the mean values of \( P^{\text{ex ante}} \) for market orders and limit orders submitted at the quote, any difference is attributed to order choice. We base our normative statements concerning the relative merits of the two strategies on these comparisons.

This approach possesses the virtue of simplicity, but is subject to certain limitations and qualifications. Most importantly, in comparing order strategies, we are implicitly taking the spread, size, and side as an exogenous and comprehensive characterization of the trader’s information set. The information available to market participants is almost certainly broader, encompassing time-of-day, quote size, cash-futures basis, etc. Investigation of these effects is a sensible direction for further research.

It is likely that traders jointly determine order size and strategy. In principle, this does not affect our conclusions because we are not attempting to establish causal dependencies between the two. It bears emphasizing, however, that the analysis assumes that orders are submitted independently. Our results provide little guidance about when to break up an order into smaller submissions, and our sample does not tell us when large orders have been broken up before submission.

Within a given day, the orders in our sample often overlap, causing dependence among performance measures. To avoid overstating the statistical significance of our results, we compute means and \( t \)-statistics from samples of daily means rather than from samples of individual orders.

Determination of order side effects is complicated by price variation in the sample that is skewed towards positive price changes. It is unlikely that traders anticipated this sample artifact. It is more reasonable to assume that they expected the intraday return distribution to be approximately symmetric about zero. (Harris (1986) and Smirlock and Starks (1986) document such distributions in intraday return data.) Accordingly, in the comparison of the performance measures, we employ a matched subsample of days in which each day with a negative open-to-close return is matched with a day that has a positive return of similar magnitude.

III. Data Description

A. Institutional Background

The data consist of order records for the NYSE. Schwartz (1991) and Hasbrouck, Sofianos, and Sosebee (1993) document NYSE trading procedures. The key features of a limit order are time of submission (order time), quantity, price,
side (buy or sell), time in force (when the order will lapse if not executed), and identifying information. The limit order book ("the book") consists of all active limit orders arrayed in descending price for buys and in ascending price for sells. Executed limit orders and cancellations are removed from the book, and new submissions are added. The specialist is the agent for limit orders: he is responsible for maintaining the book and representing the orders to the market.

Within the limit order book, price priority is strictly enforced. At a given price, orders are generally executed in the sequence in which they were received, although preference may be given to orders large enough to satisfy a particular counterparty order. It is important to note, however, that the limit order book may compete at times with the trading crowd (brokers physically present at the post). Furthermore, although most executed limit orders are filled at the submitted limit price, that price may be bettered on occasion. When a block is crossed at a price better than the price of an existing limit order, for example, these orders may be "cleaned up" at the block price.

A market order demands immediate execution at the best available price. Market orders are often stopped: the specialist guarantees a price for the order (generally, the prevailing opposing quote), but endeavors to execute the order at a better price later. The originator of the order is immediately notified of the stop, but there is no print on the transaction tape until the order is actually executed. Specialists use stops to pair off opposing market orders and to maintain price continuity (Hasbrouck, Sofianos, and Sosebee (1993)).

B. Data Sources

The data are drawn from the NYSE's TORQ (Trades, Orders, Reports, and Quotes) database, which contains detailed information on consolidated transactions, quotes, the NYSE audit trail, and NYSE orders that were handled by the automated SuperDOT system.2 These data cover 144 randomly chosen issues traded on the NYSE from November 1990 through January 1991. The sample consists of orders entered during this period. It is restricted to standard (non-tick-sensitive) market and limit orders, and (for reasons that will be discussed later) to day orders, i.e., orders that were marked on submission to expire at the close of the day.

C. Preliminary Analysis

It is useful to place this sample in the context of total trading activity. The NYSE accounts for 62 percent of transactions in the sample reported to the consolidated tape and 84 percent of the consolidated trading volume. The SuperDOT system accounts for 53 percent of the participants in all transactions, but only 30 percent of the buy and sell volume (twice total volume, as conventionally reported). Of the SuperDOT orders, 50 percent are straight market orders and 45 percent are standard limit orders. The remaining 5 percent included stop orders (2 percent), market at close order (2 percent), and other more rarely used qualifications.

2The data are available to academic researchers and are documented in Hasbrouck, Sofianos, and Sosebee (1993) and Hasbrouck (1992).
Table 1 profiles other characteristics of the SuperDOT system order flow. Buy orders are slightly more common than sell orders for both market and limit orders. A small fraction (6 percent) of orders (roughly the same for market and limit orders) are tick-sensitive. These include “buy-minus” orders, which can only be executed on a downtick and “sell-plus” (and sell short) orders, which can only be executed on an uptick. The time-in-force attribute of an order reflects the horizon over which an order should be considered active. The majority of limit orders (82 percent) are day orders (which expire at the close of the day’s trading session). The table also profiles the size distribution of the orders. It is particularly noteworthy that limit orders tend to be larger.

### TABLE 1

Characteristics of the SuperDOT Orders

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Market</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sell</td>
<td>47%</td>
<td>49%</td>
</tr>
<tr>
<td>Buy</td>
<td>53</td>
<td>51</td>
</tr>
<tr>
<td>Tick-sensitive?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>94</td>
<td>94</td>
</tr>
<tr>
<td>Yes</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Time-in-force</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day</td>
<td>100</td>
<td>82</td>
</tr>
<tr>
<td>Good-till-cancel</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 200 shares</td>
<td>48</td>
<td>21</td>
</tr>
<tr>
<td>201–500 shares</td>
<td>25</td>
<td>21</td>
</tr>
<tr>
<td>501–1,000 shares</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>&gt; 1,000 shares</td>
<td>13</td>
<td>36</td>
</tr>
</tbody>
</table>

The sample consists of all market and limit orders in the System Order Database (SOD) component of the TORQ database (144 representative NYSE issues, November 1990 through January 1991).

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During the sample period, the S&P 500 Index rose 13.1 percent, perhaps in response to the unanticipated Gulf War crisis. Only 26 of the 63 days in the sample have negative price changes. As noted in the discussion of empirical design, this artifact induces a difference in the performance of buy and sell orders in the full sample. Table 2 reports order counts, fill percentages, and ex ante performance measures classified by side and open-to-close price change. Sell limit orders have higher fill rates and perform better on our ex ante measure. Not surprisingly, these differences are greatest when the market rose the most. The average fill rates and

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3On days when the market is moving up, sell limit orders will more likely fill than will buy limit orders placed equally far from the market. On such days, our ex ante measure of performance, \( V^{\text{ex ante}} \), will indicate that sell limit orders performed better than comparable buy limit orders. Our ex post measure of performance, \( V^{\text{ex post}} \), will likewise indicate that executed buy limit orders performed better than comparable executed sell limit orders. These performance differences will depend on the size of the intraday price change. If the intraday price change is large, the measured differences will be quite large.
average ex ante performance measures are monotonic in the open-to-close return. The greater the return, the greater the sell order fill rate and the greater the ex ante performance.\textsuperscript{4} In the full sample, the buy-sell differences in average execution fill rates and in ex ante performance are statistically significant.

More meaningful comparisons of buy and sell order differences are based on our return-matched subsample: all 26 days on which there were negative open-to-close S&P returns plus those 26 (of the remaining 37) positive return days that most closely matched the absolute returns of the negative return days.\textsuperscript{5} By construction, the fill percentage for a given class is defined as the total number of shares that were filled divided by the total number of shares submitted as orders. The ex ante order performance, $P_{\text{ex ante}}$, measures the extent to which the average fill price of an order betters the opposite-side quote prevailing at the time the order is submitted. For orders that are unfilled at the end of the day, a fill is imputed at the closing opposite-side quote for the day.

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\textsuperscript{4}We confirmed (in results not presented) that these differences are not simply due to differences in where the buy and sell limit prices were placed relative to the market.

\textsuperscript{5}The matching algorithm matched the largest negative return day to the nearest positive return day. The next largest negative return day was then matched to the next closest remaining positive return day until all negative return days were exhausted. The excluded positive open-to-close return days were November 9, 14, 27, 30; December 3, 31 of 1990; and January 10, 17, 24, 30, 31 of 1991.

\begin{table}
\centering
\caption{Limit Order Fill Rates and Mean Ex Ante Order Transaction Costs by Open-to-Close Return}
\begin{tabular}{lrrr}
\hline
\textbf{Open-to-Close Return} & \textbf{Sell} & \textbf{Buy} & \textbf{Both} \\
\hline
\multicolumn{4}{c}{Fill Percentages\textsuperscript{a}} \\
$< -0.5\%$ & 39.3\% & 47.1\% & 43.3\% \\
$-0.5-0$ & 43.0 & 43.3 & 43.1 \\
$0-0.5$ & 47.2 & 39.7 & 43.3 \\
$> 0.5$ & 51.6 & 37.6 & 44.7 \\
\textbf{All} & 46.7 & 41.0 & 43.8 \\
\multicolumn{4}{c}{Mean $P_{\text{ex ante}}$ b} \\
$< -0.5\%$ & -0.9\% & 8.5\% & 4.1\% \\
$-0.5-0$ & 1.3 & 5.4 & 3.4 \\
$0-0.5$ & 6.4 & 2.9 & 4.6 \\
$> 0.5$ & 10.0 & -1.1 & 4.3 \\
\textbf{All} & 5.6 & 2.9 & 4.2 \\
\hline
\multicolumn{4}{c}{Number of Limit Orders} \\
$< -0.5\%$ & 20,668 & 23,506 & 44,174 \\
$-0.5-0$ & 17,202 & 19,110 & 36,312 \\
$0-0.5$ & 18,816 & 21,087 & 39,903 \\
$> 0.5$ & 42,940 & 45,887 & 88,827 \\
\textbf{All} & 99,626 & 109,590 & 209,216 \\
\hline
\end{tabular}
\end{table}

The sample consists of all limit orders in the System Order Database (SOD) component of the TORQ database (144 representative NYSE issues, November 1990 through January 1991).
the mean, median, and skewness of the subsample open-to-close return distribution are very close to zero.

The subsample is further restricted to exclude orders submitted when the prevailing bid/ask spread was wider than $\frac{1}{4}$ (5.9 percent of the subsample). They are excluded because the number of observations in many classification cells is insufficient to support useful inferences. When sufficient data are present, those inferences (not reported) are similar to those presented below for $\frac{1}{8}$ and $\frac{1}{4}$ spreads.

Table 3 presents the numbers of orders in the subsample, classified by size, side, and prevailing spread at the time of submission. Market orders account for a greater fraction of the order flow for small order sizes and for smaller spreads. Traders probably use limit orders more often for larger orders because they are more difficult to execute. We shall see in the next section that traders probably use limit orders more often in wide markets because of the high cost of market orders in those markets.

For a given order size, side, and spread, it is interesting to consider which limit order prices are used most often. If traders set their orders in an attempt to control their transaction costs, these order prices should be associated with the highest estimated measures of performance. The modal limit order price is generally at the best quote (limit price position $L = 0$). Smaller orders placed in $\frac{1}{8}$ markets are most often placed at the spread midpoint ($L = \frac{1}{16}$), however. The results in the next section confirm that these orders performed best.

IV. Main Results

A. Fill Rates

Table 4 presents estimates of the fill percentage, defined as the percentage of original order volume that is executed. The unfilled remainder is usually due to price movement away from the order or cancellation. The fill rates are highest for market orders. For a limit order of a given size, the fill rate increases with limit price position: orders that are priced more aggressively achieve higher fill rates. For a given limit price position, the fill rate generally declines as order size increases: larger orders are more difficult to fill.\textsuperscript{6} Sell limit orders generally have higher fill rates than do buy limit orders placed equally far from the market. Paired $t$-statistics for testing equality of the mean daily fill rates indicate statistical significance in a few cases.\textsuperscript{7} The differences are greatest for the larger orders. These results are consistent with the implications of asymmetric information models that assume that large traders tend to be better informed than small traders and that buyers tend to be better informed than sellers (Easley and O'Hara (1987) and Burdett and O'Hara (1987)).

\textsuperscript{6}The fill rates for market orders are generally slightly less than 100 percent. Most of the unfilled market orders appeared to be orders that were either canceled immediately after submission or routed to the broker's booth for special handling.

\textsuperscript{7}Paired $t$-statistics must be used because market-wide changes in value cause the buy and sell means to be inversely correlated.
The sample consists of all market and limit orders in the System Order Database (SOD) component of the TORQ database (144 representative NYSE issues, November 1990 through January 1991) that were entered when the prevailing bid/ask spread was $\frac{1}{4}$ or less and were marked to expire at the end of the trading day. Furthermore, orders entered on November 9, 14, 27, 30, December 3, 31 of 1990, and January 10, 17, 24, 30, 31 of 1991 were excluded to ensure that the distribution of open-to-close index price changes in the analysis sample would be symmetric about zero.

The limit price position is the extent to which the limit order price betters the existing quote. The "Market" order classification also includes marketable limit orders.

B. Ex Ante Performance Measure, $P_{ex \ ante}$

Table 5 reports means of the ex ante performance measure $P_{ex \ ante}$ for different classes of order size, prevailing spread, and side. For each classification cell, a daily mean is first computed for each of the 52 days in the matched subsample. The means reported in the table are averages of these daily means.

Most market orders receive some price improvement. For example, sell orders of 200 shares or less submitted into a market with a $\frac{1}{4}$ spread better the best bid by an average of 1.7 cents. Since $\frac{1}{4}$ is the minimum price variation for the sample, we may rule out executions between the quotes. The price improvement relative to the prevailing quotes reflects stopped orders that are subsequently executed at better prices (see below). The price improvement is greatest for small orders and for orders placed into markets with wide spreads. These results reflect the fact that large orders are more difficult to execute and the fact that many specialists quote...
The fill percentage is the total number of shares that were filled divided by the total number of shares submitted as orders. Each cell reports the mean over all 52 days in the sample of the daily fill percentage. The sample is described in the notes to Table 3.

A f-statistics (paired) for testing the equality of the buy and sell means.

Spreads wider than the effective spread. Sell orders generally receive slightly more price improvement, but the differences are neither statistically nor economically significant.

Limit orders placed behind the best quote \((L \leq \$ - \frac{1}{4} \text{ and } L = \$ - \frac{1}{2})\) do not perform as well under the ex ante performance measure as those placed at the best quote or in the market. Most of these orders do not execute (Table 4). The imputed end-of-day opposite-side execution price imposed by the ex ante performance measure substantially penalizes these orders.

A limit order with a limit price position of \(L = \$0\) is an at-the-quote order. In a $\%$ market, small sell orders placed at the ask better the opposite-side quote by an average of 4.5 cents per share, a gain of 2.8 cents relative to the market sell order. In moving from a market order to an at-the-quote limit order, one would expect an increase in risk as well as an increase in average gain. The standard deviations of \(P_{\text{ex ante}}\) (not reported) are generally consistent with this hypothesis. For example, the standard deviation of \(P_{\text{ex ante}}\) for an at-the-quote limit order is roughly three times as large as that of a market order. The difference is due to limit orders that failed to execute because price moved away. The ex ante performance measure imputes a fill price from the closing bid for these orders.

### Table 4
Mean Daily Order Fill Percentages by Order Size and Limit Price Position

<table>
<thead>
<tr>
<th>Order Size (Shares)</th>
<th>Limit Price Position</th>
<th>Bid/Ask Spread at Time of Order Entry</th>
<th>$%$</th>
<th>$%$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sell</td>
<td>Buy</td>
<td>(t^a)</td>
</tr>
<tr>
<td>(\leq 200)</td>
<td>(\leq -\frac{1}{4})</td>
<td>20.0%</td>
<td>12.7%</td>
<td>-2.65</td>
</tr>
<tr>
<td>(\leq -\frac{1}{2})</td>
<td>43.0</td>
<td>39.9%</td>
<td>-0.61</td>
<td>36.6</td>
</tr>
<tr>
<td>0</td>
<td>69.9</td>
<td>68.3%</td>
<td>-0.61</td>
<td>52.0</td>
</tr>
<tr>
<td>(+\frac{1}{4})</td>
<td>Market</td>
<td>99.8%</td>
<td>99.9%</td>
<td>3.11</td>
</tr>
<tr>
<td>201–500</td>
<td>(\leq -\frac{1}{4})</td>
<td>18.0%</td>
<td>14.8%</td>
<td>-1.06</td>
</tr>
<tr>
<td>(\leq -\frac{1}{2})</td>
<td>37.2</td>
<td>34.6%</td>
<td>-0.88</td>
<td>31.2</td>
</tr>
<tr>
<td>0</td>
<td>65.4</td>
<td>62.5%</td>
<td>-1.49</td>
<td>47.8</td>
</tr>
<tr>
<td>(+\frac{1}{4})</td>
<td>Market</td>
<td>99.5%</td>
<td>99.4%</td>
<td>-1.41</td>
</tr>
<tr>
<td>501–1,000</td>
<td>(\leq -\frac{1}{4})</td>
<td>17.7%</td>
<td>15.2%</td>
<td>-0.93</td>
</tr>
<tr>
<td>(\leq -\frac{1}{2})</td>
<td>34.8</td>
<td>31.7%</td>
<td>-1.16</td>
<td>25.5</td>
</tr>
<tr>
<td>0</td>
<td>60.9</td>
<td>55.6%</td>
<td>-3.05</td>
<td>42.8</td>
</tr>
<tr>
<td>(+\frac{1}{4})</td>
<td>Market</td>
<td>99.2%</td>
<td>98.8%</td>
<td>-2.97</td>
</tr>
<tr>
<td>(&gt; 1,000)</td>
<td>(\leq -\frac{1}{4})</td>
<td>15.5%</td>
<td>13.1%</td>
<td>-0.94</td>
</tr>
<tr>
<td>(\leq -\frac{1}{2})</td>
<td>27.7</td>
<td>26.2%</td>
<td>-0.54</td>
<td>22.5</td>
</tr>
<tr>
<td>0</td>
<td>56.5</td>
<td>50.0%</td>
<td>-3.15</td>
<td>39.0</td>
</tr>
<tr>
<td>(+\frac{1}{4})</td>
<td>Market</td>
<td>95.1%</td>
<td>95.8%</td>
<td>1.42</td>
</tr>
</tbody>
</table>

The fill percentage is the total number of shares that were filled divided by the total number of shares submitted as orders. Each cell reports the mean over all 52 days in the sample of the daily fill percentage. The sample is described in the notes to Table 3. 

\(t\)-statistics (paired) for testing the equality of the buy and sell means.
The ex ante order transaction cost, $p_{\text{ex ante}}$, measures the extent to which the average price at which an order is filled betters the opposite-side quote prevailing at the time the order is submitted. For orders that are unfilled at the end of the day, a fill is imputed at the closing opposite-side quote for the day. Each cell reports the mean over all 52 days in the sample of the daily mean ex ante order transaction costs. The sample is described in the notes to Table 3.

<table>
<thead>
<tr>
<th>Order Size (Shares)</th>
<th>Limit Price Position</th>
<th>$1/4</th>
<th>$3/4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sell</td>
<td>Buy</td>
<td>$t^a$</td>
</tr>
<tr>
<td>$\leq$ 200</td>
<td>$\leq -1/4$</td>
<td>-1.2</td>
<td>-1.0</td>
</tr>
<tr>
<td></td>
<td>$-1/4$</td>
<td>0.4</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>4.5</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>$+1/4$</td>
<td>10.2</td>
<td>10.0</td>
</tr>
<tr>
<td>Market</td>
<td>8.6</td>
<td>8.0</td>
<td>-2.49</td>
</tr>
<tr>
<td>201–500</td>
<td>$\leq -1/4$</td>
<td>-2.1</td>
<td>-3.4</td>
</tr>
<tr>
<td></td>
<td>$-1/4$</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>4.1</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>$+1/4$</td>
<td>9.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Market</td>
<td>7.3</td>
<td>6.7</td>
<td>-2.75</td>
</tr>
<tr>
<td>501–1,000</td>
<td>$\leq -1/4$</td>
<td>-2.5</td>
<td>-4.9</td>
</tr>
<tr>
<td></td>
<td>$-1/4$</td>
<td>1.8</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>3.1</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>$+1/4$</td>
<td>7.7</td>
<td>7.2</td>
</tr>
<tr>
<td>Market</td>
<td>6.0</td>
<td>5.6</td>
<td>-1.65</td>
</tr>
<tr>
<td>$&gt;1,000$</td>
<td>$\leq -1/4$</td>
<td>-2.6</td>
<td>-4.5</td>
</tr>
<tr>
<td></td>
<td>$-1/4$</td>
<td>0.6</td>
<td>-0.2</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>2.2</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>$+1/4$</td>
<td>6.7</td>
<td>5.6</td>
</tr>
<tr>
<td>Market</td>
<td>3.8</td>
<td>3.7</td>
<td>-0.31</td>
</tr>
</tbody>
</table>

The ex ante order transaction cost, $p_{\text{ex ante}}$, measures the extent to which the average price at which an order is filled betters the opposite-side quote prevailing at the time the order is submitted. For orders that are unfilled at the end of the day, a fill is imputed at the closing opposite-side quote for the day. Each cell reports the mean over all 52 days in the sample of the daily mean ex ante order transaction costs. The sample is described in the notes to Table 3.

$t^a$-statistics (paired) for testing the equality of the daily buy and sell means.

Moving down through Table 5 into the larger order size classes, order performance generally declines. Nevertheless, at-the-quote limit orders still appear to dominate market orders in average performance.

Limit orders with a given price placement perform better in markets with wide spreads than in markets with narrow spreads. For example, the mean $P_{\text{ex ante}}$ for small sell orders placed at the best ask in a $1/4$ market is 8.1 cents per share, which is 3.6 cents greater than the same mean in a $3/4$ market. The difference is due to the wider spread: the spread is the potential benefit of an execution at the ask.

When the prevailing spread is $1/4$, limit orders placed in the market ($L > 0$) perform best. These orders have a high probability of execution at prices better than the opposite quote.

Within each order size and spread classification, sell limit orders usually perform slightly better than similarly placed buy limit orders. The advantage increases somewhat as order size increases. These results provide some support for the assumption that large buy orders may come from better informed traders than do sell...
orders. None of the differences in means, however, are statistically significant at a 5-percent confidence level, and most differences are not economically significant. The information in this sample suggests that the processes by which buy and sell orders are filled are very similar.

The results indicate that traders place their limit orders at the prices that our analysis identifies as being most efficient. Within each classification of order size, spread, and side, the most commonly used limit order is almost always the best performing limit order. The only exceptions to this rule in the $\frac{1}{4}$ and $\frac{3}{4}$ spread classifications are for the largest orders placed in $\frac{1}{4}$ spread markets. The most commonly placed orders in this classification are placed at the best quote ($L = 0$), but the best performing orders are placed $\frac{1}{4}$ into the market. The differences are not great, however. The at-the-quote orders perform almost as well as the in-the-market orders, and the in-the-market orders are almost as common as the at-the-quote orders.

Within the market order category, marketable limit orders constitute roughly 13 percent and differ in some respects from ordinary market orders. For orders of 200 or fewer shares, the average performance of a marketable limit order that meets the opposite-side quote ($L = \frac{1}{4}$) is 1.3 cents per share, lower than that of a market order. This is a general result for marketable limit orders found in this study, and may be a consequence of an omitted effect. Traders might be more inclined to submit marketable limit orders, for example, if observable market conditions lead them to believe that the price is likely to move away from the current quote and if they do not wish to “chase” the stock. $T$-tests of equality of $P^{\text{ex ante}}$ means in market order and marketable limit order subsamples reject equality for all order size/spread combinations. The $t$-statistics range between 6.9 and 11.9.

C. Stopping and the Performance of Market Orders

Price improvement for market orders in $\frac{1}{4}$-point markets can arise from crossing and/or stopping. Table 6 reports summary statistics for the ex ante performance measure for market orders classified by whether or not they were stopped. In markets of all spread sizes, stopped market orders receive better execution. In $\frac{1}{4}$-point markets, virtually all of the improvement occurs on stopped orders. Unfortunately, the trader does not know in advance whether his order will be stopped, since stopping is generally at the discretion of the specialist at the time the order is received.

---

8It might appear that the lack of statistical significance is due in part to our aggregation of individual order observations into daily mean observations. At first glance, the resulting reduction in sample size might be thought to account for the weak results. A more careful analysis, however, reveals that the aggregation also decreases the variance of the data proportionately. If the distribution of order values is stable across days, and if order performance is indeed independent, the aggregation should not affect the power of the test. The lack of statistical significance is more likely due to the intraday order dependence of order performance and to the proper use of paired $t$-tests. Since the buy and sell ex ante performance measures are inversely correlated, the variance of their difference is greater than the sum of their variances. This inflation in variance, which reflects the lack of independent information in these two variables, decreases the power of the test.
A broker (generally the specialist) "stops" an order by guaranteeing execution at a specified price (generally the opposite-side quote), but endeavoring to obtain a better price. The sample comprises all market orders from the order sample described in the notes to Table 3.

A f-statistics (paired) for testing the equality of the daily buy and sell means.

The ex ante order transaction cost, $P_{\text{ex ante}}$, measures the extent to which the average price at which an order is filled better the opposite-side quote prevailing at the time the order is submitted. Each cell reports the mean over all 52 days in the sample of the daily mean ex ante order transaction costs.

D. Ex Post Performance Measure, $P_{\text{ex post}}$

Table 7 presents means of our ex post performance measure for orders that were completely filled. In ½-point markets, an executed-at-the-quote sell limit order for 200 shares is associated with an average increase in the ask of 7.1 cents per share five minutes later. The 7.1 cents is at least in part a reflection of the adverse selection component of the trade. It measures the extent to which price moves through the limit order price.

Adverse selection models are often specified in a framework where all transactions arise from market orders hitting limit orders. Considering this view, one might be tempted to assert that the information content of a 200-share market buy order is 7.1 cents. One might, therefore, expect that the ex post performance measure of a 200-share market order in an ½-point market would have a magnitude of 7.1 cents less the 12.5 cent spread, or $-5.4$ cents.

In our sample, however, the average ex post performance measure for a market buy order of 200 shares is much larger at $-11.9$ cents per share. This average implies that the subsequent bid price will increase by 0.6 cents, from which one
The ex post transaction cost, $P_{ex\,post}$, measures the extent to which the same-side quote deteriorates (relative to the fill price of the order) after the order is filled. For example, if a buy order is filled at $20.00 and the bid quote is $19.75 five minutes after the fill, $P_{ex\,post}$ is -25 cents. Each cell reports the mean over all 52 days in the sample of the daily mean ex post order transaction costs. The sample is described in the notes to Table 3.

A $t$-statistic for testing the equality of the daily buy and sell means.

might conclude that the information content of a 200-share market order is virtually zero.

These seemingly inconsistent calculations may be reconciled by remembering that spreads are not constant. The execution of a market order often widens the spread. A market buy order may cause an increase in the ask but no increase in the bid. The calculation of information impact based on the sell limit order ex post performance depends on the change in the ask price. The calculation based on the buy market order ex post performance depends on the change in the bid price. If the bid and offer do not change equally, the two calculations must yield different answers.

<table>
<thead>
<tr>
<th>Order Size (Shares)</th>
<th>Limit Price Position</th>
<th>$%$</th>
<th>$%$</th>
<th>$t^a$</th>
<th>$N$</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 200</td>
<td>≤ $-\frac{1}{4}$</td>
<td>-9.8¢</td>
<td>-7.6¢</td>
<td>0.8¢</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>- $\frac{1}{4}$</td>
<td>-8.5</td>
<td>-7.3</td>
<td>1.08</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-7.1</td>
<td>-6.4</td>
<td>2.02</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>+ $\frac{1}{4}$</td>
<td>-11.8</td>
<td>-11.9</td>
<td>-0.97</td>
<td>52</td>
</tr>
<tr>
<td>Market</td>
<td></td>
<td>-13.6</td>
<td>-14.1</td>
<td>-2.73</td>
<td>52</td>
</tr>
<tr>
<td>201-500</td>
<td>≤ $-\frac{1}{4}$</td>
<td>-7.5</td>
<td>-11.2</td>
<td>-1.83</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>- $\frac{1}{4}$</td>
<td>-6.6</td>
<td>-8.3</td>
<td>-1.49</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-7.3</td>
<td>-6.6</td>
<td>1.93</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>+ $\frac{1}{4}$</td>
<td>-11.9</td>
<td>-11.7</td>
<td>-1.26</td>
<td>52</td>
</tr>
<tr>
<td>Market</td>
<td></td>
<td>-13.9</td>
<td>-14.1</td>
<td>-1.10</td>
<td>52</td>
</tr>
<tr>
<td>501-1,000</td>
<td>≤ $-\frac{1}{4}$</td>
<td>-6.4</td>
<td>-10.1</td>
<td>-2.23</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>- $\frac{1}{4}$</td>
<td>-7.8</td>
<td>-7.7</td>
<td>0.13</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-7.2</td>
<td>-6.8</td>
<td>1.24</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>+ $\frac{1}{4}$</td>
<td>-11.5</td>
<td>-11.2</td>
<td>1.62</td>
<td>52</td>
</tr>
<tr>
<td>Market</td>
<td></td>
<td>-13.9</td>
<td>-13.6</td>
<td>0.96</td>
<td>52</td>
</tr>
<tr>
<td>&gt; 1,000</td>
<td>≤ $-\frac{1}{4}$</td>
<td>-7.4</td>
<td>-10.3</td>
<td>-1.51</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>- $\frac{1}{4}$</td>
<td>-8.6</td>
<td>-9.2</td>
<td>-0.90</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-8.4</td>
<td>-7.8</td>
<td>2.22</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>+ $\frac{1}{4}$</td>
<td>-11.3</td>
<td>-11.0</td>
<td>1.47</td>
<td>52</td>
</tr>
<tr>
<td>Market</td>
<td></td>
<td>-14.3</td>
<td>-13.8</td>
<td>1.57</td>
<td>52</td>
</tr>
</tbody>
</table>

The ex post transaction cost, $P_{ex\,post}$, measures the extent to which the same-side quote deteriorates (relative to the fill price of the order) after the order is filled. For example, if a buy order is filled at $20.00 and the bid quote is $19.75 five minutes after the fill, $P_{ex\,post}$ is -25 cents. Each cell reports the mean over all 52 days in the sample of the daily mean ex post order transaction costs. The sample is described in the notes to Table 3. A $t$-statistic for testing the equality of the daily buy and sell means.

9In pure order driven markets in which no specialist makes a quote, the spread will always widen immediately following the execution of a market order that exhausts the book. In the NYSE market, spreads will widen if the specialist does not choose to fill the gap.

10 Other factors may also account for the different estimates of information impact. First, 200-share limit orders are not always filled by 200-share market orders. They are frequently filled in the course of executing counterparty orders of much larger size. The larger implied information content of the 200-share limit order reflects the possibility of these larger orders. Second, market orders are often executed against other market orders, and similarly for limit orders. Finally, the orders examined here represent only the SuperDOT portion of the total order flow. In particular, since floor traders and specialists have the option of improving the best quote after viewing incoming orders, they may selectively favor...
The most noteworthy pattern in the ex post performance means is that buy orders placed at the market performed slightly better than similarly placed sell orders in \(\%\) spread markets. This pattern appears in all four order-size classes, and is statistically significant in three. No difference is greater than 0.7 cents, however. Orders placed at the best quote and \(\%\) into the market in \(\%\) spread markets generally display the same pattern, but the results are neither uniform nor statistically significant. These results indicate that specialists raise their bid following the execution of a sell limit order by more than they lower their ask following the execution of a buy limit order. Since limit orders are generally executed by market orders, these results suggest that specialists believe buy market orders convey more information than do sell market orders. The ex post performance of the larger market orders provides direct support for this interpretation. Larger market buy orders performed slightly better than equally-sized market sell orders in all spread classes. These differences indicate that specialists raise their bids following a market buy order by more than they lower their asks following a market sell order. Although these differences are not statistically significant, they are consistent with better informed buyers than sellers.

E. Dealing from off the Floor

A trader may act as an off-floor dealer by posting a limit order and (if it is filled) then reversing the trade. The profit for such a trader who must reverse the trade by the end of the day is given by (4). The expected profit for a particular strategy can be approximated using the performance measure estimates. For example, a trader in a \(\%\)-point market who posts a limit sell order for 200 shares at the quote \(L = 0\$\) and reverses the fill using a market buy order has an expected profit of \(-7.1 + 1.5 = -5.6\) cents per share. If the trader attempts to reverse the fill using another buy limit order at the quote, the expected profit is \(-7.1 + 4.8 = -2.3\) cents per share. The negative expected dealer profits appear to characterize most strategies in \(\%\)-point markets. Apparently, spreads are not wide enough to allow an uninformed off-the-floor trader to profit from offering liquidity. In \(\%\)-point markets, the trader who places an at-the-quote limit sell order and reverses it using an at-the-quote limit buy order has an expected profit of \(-8.0 + 7.1 = -0.9\) cents per share. If the trade is reversed by a limit order at the quote midpoint, however, the expected profit is \(-8.0 + 10.0 = 2.0\) cents per share. Although positive, this value is insufficient to recover commissions for an off-floor trader, which are in excess of two cents per share per trade, or four cents per round trip.

Indeed, examination of most pairs of strategies suggests that there are no expected profits available to off-floor traders who act as dealers. From an equilibrium viewpoint, this is not surprising. In supplying liquidity, the off-floor trader must compete not only with the specialist and floor traders (both of whom face lower transaction costs and have better access to order flow information), but also with other off-floor limit order traders who may only be interested in minimizing transaction costs, not turning a positive profit on their trading activities.
These calculations are subject to a number of qualifications. Most importantly, the dealer strategies considered here are dynamic. Since a reversing trade is attempted only if the original limit order is filled, the expectation of $P_{\text{ex ante}}$ that should be used in the calculations is an expectation conditional on execution of the original order. The numerical estimates are, of course, unconditional. It should also be noted that the dealing strategies considered here are fairly simple ones that make no use of market condition information. Traders who can condition their order strategies might obtain better performance.

V. Conclusions

This study examines order execution performance for a sample of New York Stock Exchange market and limit day orders with the aim of characterizing alternative strategies. Our ex ante performance measure compares the fill price per share of an order with the quotes prevailing at the time the order was received, assuming an imputed fill for unexecuted limit orders at the closing quote. The analysis of the ex ante performance measure supports the following conclusions.

i) Market orders frequently better the prevailing opposite-side quote.

ii) In $\frac{1}{4}$ markets, at-the-quote limit orders achieve better average performance than market orders, although at the cost of higher variability.

iii) In $\frac{3}{16}$-point markets, placing limit orders at the quote is an inferior strategy. Limit orders that better the quote by $\frac{1}{4}$ appear to perform well.

iv) The best limit order strategies were the most commonly used strategies.

The analysis of our ex post performance measure, which compares the fill price of an executed order to subsequent quotes suggests that limit orders are subject to adverse selection risk; the expected profits accruing to an off-floor trader who attempts to behave as a dealer are generally negative and, in any case, are almost certainly insufficiently positive to cover commissions.

It is worth emphasizing, however, that our performance measures assume particular order strategies that are, in turn, motivated by the objectives of two extreme types of traders. A trader with an intermediate objective might find neither of our strategies attractive. Furthermore, our conclusions are based on average order outcomes that are conditioned only on spread, order size, and order direction. A trader’s actual choice of order might well depend on broader information, both public and private. Expanding the conditioning set can only (in expectation) improve performance. Our average outcomes might, therefore, imply a level of performance that some or all traders surpass.

References


