The Ecology of An Order-Driven Market System

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Abstract
A securities market is order driven if the limit orders of some public participants establish the prices at which others can trade by market order at any time when the market is open. The paper considers how, without market maker intermediation, a population of public investors separates into limit order and market order traders, and how the order driven market achieves an ecological balance between the suppliers and the demanders of immediacy. It also explains why a bid-ask spread is a natural property of an order driven market, even when the market comprises a large number of participants irrespective of the technology sustaining the market. The paper considers a stylized environment that enables the optimal bid and ask quotes to be solved for, and the bid-ask spread to be analyzed. We summarize empirical evidence concerning price determination in the order driven market, and discuss implications for market structure that are suggested by the analysis.

1. Introduction
A securities market is an ecological system. It comprises various types of participants who operate in different, mutually supporting ways. Some seek to buy shares, and others seek to sell shares. Some buyers and sellers are motivated to trade by the receipt of new information, and others are motivated by their own liquidity needs and changing personal opinions about common information. Some participants announce the prices at which others can trade, and others choose to trade at these prices. Comprehensively viewed, the ecology of the marketplace is complex and delicate.

If a market maker announces the prices at which others can trade, the market is quote driven, as is Nasdaq in the U.S. and Seaq in London. The operations of a quote driven market have been examined extensively in the microstructure literature. (See, for instance, Bagehot (1971), Stoll (1978), Amihud and Mendelson (1980), Ho and Stoll (1981), and Copeland and Galai (1983).) In a quote driven market, investors (the natural buyers and sellers) purchase shares at the market maker's ask price and sell shares at the market maker's bid price. The difference between these two values - the bid-ask spread - is twice the per share payment a market maker receives for providing immediacy to a buyer or a seller. Immediacy is the ability to sell at the bid or to buy at the ask at any time the market is open. Investors in a pure quote driven market all receive the service, and they must all pay its price - the bid-ask spread. Of course, technological innovations can impact the size of the bid-ask spread paid by the investor who seeks immediacy. For example, see Amihud and Mendelson (1988) who argue that liquidity is likely to improve in an automated market.

If the orders of some public participants establish the prices at which others can trade and there is no market maker intermediation, the market is order driven. The New York Stock Exchange is, of course, an example of a market where the quotes are set by both the limit order traders and the market maker. In a pure order driven market, each investor individually determines whether to place a limit order and enable another investor to buy or to sell by market order, or to submit a market order and enable another investor's limit order to execute. Each investor's own tactical trading decision depends on the intensity of his or her desire to trade, and on the configuration of orders posted in the market.

Unlike the quote driven market, liquidity provision in an order driven market has received relatively little attention in the microstructure literature. We know that order driven markets work and work well. The SBF Bourse de Paris's CAC market is a classic example of a successful, electronic order driven market. Other examples include Toronto's TOREX, Tokyo's CORES, and Switzerland's SWX market. But the economics that drive the order driven markets are intricate and their viability is not obvious from theoretical analysis alone. In this paper, we examine how buyers and sellers come together in the ecological environment of an order driven market and trade without the intervention of a market maker. This phenomenon is likely to be further encouraged and facilitated by the advent of information technology. This, in turn, may lead to enhanced liquidity in order driven markets.

Specifically, we examine a continuous, order driven market. In a continuous market, trading takes place over an extended session and a trade can occur at any time that two counterpart orders cross during trading hours. In an alternative
order driven environment, a call market, orders are batched together for simultaneous execution at pre-determined points in time. For a discussion of call market trading, see Economides and Schwartz (1995) and Handa and Schwartz (1996a).

The paper is organized as follows. We first consider how a population of public investors separates into limit order and market order traders, and how the order driven market achieves an ecological balance between the suppliers and the demanders of immediacy. In the following two sections, we explain why a bid-ask spread is a natural property of an order driven market even when the market comprises a very large number of participants, and present a more stylized environment that enables us to solve for optimal bid and ask quotes and to analyze the bid-ask spread. We then summarize empirical evidence concerning price determination in the order driven market, and conclude by discussing a number of implications for market structure that are suggested by the analysis.

2. **Balance Between Limit Order And Market Order Traders**

Microstructure literature recognizes two economic forces that drive trading: liquidity events and information events. The first to make this distinction was Bagehot (1971). (Also see Copeland and Galai (1983), Easley and O'Hara (1987) and Glosten and Milgrom (1985)) A liquidity event is unique to an individual investor (i.e., an individual cash flow receipt or expenditure). An information event is the advent of news that affects all investors' assessment of a security's share value. Participants do not receive news simultaneously, and the risk of transacting with a better informed trader is borne by market makers and limit order placers alike. The market maker is compensated for accepting this risk by earning the spread when transacting with liquidity motivated traders. Handa and Schwartz (1996b) show that a limit order trader is similarly compensated, as we explain in this section.

Consider an investor who has placed a limit order to buy. If bullish news occurs, share value rises and the limit order does not execute. If bearish news occurs and the limit order executes, the investor loses if share value falls below the purchase price of the limit order. Thus, if only information events occur, the investor is in a "heads you win, tails I lose" situation and will never place a limit order.

The arrival of liquidity motivated, market order sellers can also cause share prices to fall and buy limit orders to execute. Unlike with an information event, after a liquidity event, price tends to revert back to its previous level, and the limit order trader profits from the execution. But the arrival of liquidity motivated, market order buyers (rather than sellers) can alternatively cause share price to increase. When this occurs, the limit order buyer either does not trade at all or may buy shares at an inflated price.

The statistical process of price reverting back to a previous level after having been pushed up or down by a liquidity event is called mean reversion. Mean reversion is associated with accentuated short-period price volatility. The accentuated short-period volatility is crucial for the ecology of the order driven market. By offsetting the cost of information events, it induces the more patient traders (those holding relatively unbalanced portfolios) to place limit orders; by making the non-execution of limit orders costly, the accentuated volatility induces the more eager traders (those holding relatively unbalanced portfolios) to place market orders. As we move toward a more technologically sophisticated trading environment, we can expect non-execution costs to be reduced, and consequently expect the bid-ask spread to decline.

Handa and Schwartz (1996b) show that an order driven market achieves a balance between limit order and market order traders when the accentuated short-period volatility is just sufficient to compensate the marginal investor for placing a limit order. To see this, assume that few investors are initially placing limit orders and, consequently, that liquidity events generate unduly large, mean reverting price swings. The compensation implied by the short-run volatility attracts more limit order placers and, as this occurs, the book fills up. As the book fills, liquidity events have less of an impact, the accentuated short-period price volatility is muted, and the compensation for placing a limit order falls. When volatility falls to a level that is just sufficient to compensate the marginal limit order trader, the depth of the book and the accentuated short-period price volatility are equilibrated, and the market achieves an ecological balance.

Because of mean reversion in prices, an individual participant who places limit orders both to buy and to sell, on expectation, profits as prices bounce between higher and lower values with the sporadic arrival of liquidity motivated buy and sell orders. As we discuss further below, we can view this profit (stated as an amount per round trip) as a limit order spread, and can think of the limit order trader as earning the spread.

Unlike market makers, however, the primary objective of most investors is to implement a portfolio decision, rather than to sell immediacy to others. And no investor, of course, is under an obligation to make a two-sided market. But, as is true for a quote driven market, the spread remains as the price of immediacy for market order traders because, as we
next discuss, it endures even in the presence of a large number of limit order placers.

3. Existence Of The Bid-Ask Spread In An Order Driven Market

A minimum tick size establishes a minimum spread size. We refer to a spread larger than the minimum tick as a non-trivial spread. In this section, we consider the existence of non-trivial spreads in an order driven market comprised of a large number of limit order traders. Cohen, Maier, Schwartz and Whitcomb (1981) have shown that a non-infinitesimal spread will exist when price changes can be arbitrarily small.

Existence of a non-trivial market spread in an order driven market is not obvious. The market spread is established by the lowest posted ask and the highest posted bid, as it is in a quote driven market. We observe in an order driven market that gaps between prices on the bid side and on the ask side tend to fill in as the number of order placers increases. Why is it that the gap between the best bid and ask does not also fill in and narrow to the minimum tick size if enough limit orders are present? With a large number of limit order placed, it is the systematic absence of orders between the bid and the ask that needs to be explained. As we argue below, this absence of orders may continue to persist in spite of the increasing role of information technology in the marketplace.

To do so, let us continue to analyze the tactical order placement decision from the buyer's viewpoint. (The analysis is symmetrical from the seller's viewpoint.) The following four relationships provide the key insight into the existence of the spread:

- The per share monetary benefit of buying by limit order rather than by market order is the difference between the market asking price, and the price at which the buy limit is placed. This benefit decreases to zero, as the price of the buy limit is raised to equal the price of an ask already established on the market.

- The probability of a buy order executing increases as its limit price is increased in the price range below the ask, but the probability remains discretely below unity even when the order is placed infinitesimally close to the counterpart quote. Cohen, Maier, Schwartz and Whitcomb (1981) show that the probability of order execution remains discretely below unity even if the limit order is placed infinitesimally close to a counterpart quotation when order arrival is a discrete time statistical process.

- The execution probability is unity for a buy order with a price limit equal to or greater than the ask because, in this range, the buy order executes with certainty at the ask.

- If the trading gain from a limit order (relative to a market order) is infinitesimal if it executes and the probability of it executing is significantly less than one, the investor will submit a market order rather than the limit order.

The first three relationships collectively imply the fourth, and the fourth implies that a limit order to buy will never be placed infinitesimally close to a counterpart limit order to sell that has already been posted on the market. Hence, a non-infinitesimal market spread will exist even when price is a continuous variable. This obviously suggests that a non-trivial market spread may also exist when, because of a minimum tick size, price changes are discrete. For this reason, a reduction in the minimum tick will not necessarily result in tighter spreads, and the institution of penny pricing is unlikely to result in penny spreads.

Intuitively, the market spread can be viewed as resulting from the gravitational pull that a previously posted sell (or buy) order exerts on an incoming buy (or sell) order. The pull is the attractiveness of trading with certainty by market order, and the spread exists because any limit order sitting on the book must be far enough away from a counterpart quote to lie outside the gravitation pull of the counterpart quote. In the next section, we consider how the gravitational pull is manifest in the behavior of a security's bid-ask spread.

4. Optimal Bid And Ask Prices, And The Equilibrium Bid-Ask Spread

The objective of this section is to understand the optimal bid and ask prices of individual participants, and to obtain the equilibrium bid-ask spread for the market. To do so, we draw on Handa, Schwartz, and Tiwari (HST, 1997), where trading is driven by (i) information events and (ii) difference of opinion. (Also see Foucault (1996)) Difference of opinion plays a role similar to that of the liquidity events discussed in above. In fact, an individual's own reassessment of share value can be considered the cause of a liquidity event, and differential reassessments imply difference of opinion.

Relatively little attention has been given in the literature to traders having different opinions based on the same public information, although difference of opinion no doubt drives much trading and, in all likelihood, is independent of the technological sophistication of the marketplace. For simplicity, HST assume two groups of investors, both of which have access to the same public
information. One group places a relatively high value on the
security, $V_h$, and the other group places a relatively low
value, $V_l$. Investors who assess share value at $V_h$ seek to
purchase shares, while those who assess share value at $V_l$
seek to sell shares.

In this setting, difference of opinion has two
dimensions: (i) the divergence of opinion, $V_h - V_l$, and (ii)
the proportion, $k$, of investors with valuation $V_h$. The
difference of opinion disappears at the extreme values of $k$ (0
and 1) and is maximum for $k$ equal to 0.5.

HST's simplified trading environment is structured as
follows. Participants come to the market sequentially and
decide whether to trade by a market order or by a limit order.
If the latter, a participant also specifies the price at which his
or her limit order is to be placed. There is a probability that
an informationally motivated order will arrive and impact
price. If a limit order is placed, at the time of the next event
(the arrival either of another limit order or of a market order
to buy or to sell), the limit order either executes or is
canceled. Placing a limit order in this environment involves
the two costs that we have noted above: (i) the cost of trading
with a better informed participant (i.e., post-trade
regret) and (ii) the cost of not realizing an execution (i.e., the
opportunity cost of lost gain from trade).

In HST, we derive the bid and ask prices posted by
buyers (whose share valuation is $V_b$) and by sellers (whose
share valuation is $V_s$). HST assume that all participants know
$V_b$, $V_s$, and $k$, and that they can therefore determine the limit
order prices that will just induce a counterparty to trade by
market order. They also assume the participants know the
probability of trading with an informed agent and the
probability of an information event occurring. They solve for
a set of trading decisions where each participant's strategy is
optimal for that individual, given the strategies that are
optimal for all other participants. The solution provides
equilibrium values for the market bid ($B^*$), ask ($A^*$), and
thus the bid-ask spread.

Consistent with the gravitational pull effect discussed in
Section 2 above, they find that $B^*$ and $A^*$ depend, in part,
on the non-execution risks faced by buyers relative to sellers.
Non-execution risk for every participant depends on the
relative proportion of buyers, $k$. For $k$ close to unity, non-
execution risk is high for buyers and low for sellers, and vice
versa for $k$ close to zero. As they show, the equilibrium
spread, $A^*-B^*$, also depends on $k$. They show that the spread
in an order driven market is widest for $k=0.5$, and that it is at
a minimum when $k$ is at either of its extreme values (0 or 1).
They further show that this is borne out by data from the
Paris Bourse.

It is interesting to consider the continuing presence of
the spread at an extreme value of $k$, where the spread is at a
minimum. Let the preponderance of participants assess share
value at $V_h$, so that there are many potential buyers and few
potential sellers. The participants all know that a buy limit
order placed at a price close to $V_h$ has little chance of
executing because the probability of a seller arriving on the
market is low. Thus, to avoid the non-execution cost, the
buyer is willing to pay a price that is close to his or her own
assessment, $V_h$. The sellers know this and consequently, in
the limit as $k$ goes to 1, $A^*$ goes to $V_h$.

However, in the limit as $k$ goes to 1, $B^*$ does not go to
$V_h$ but to a value discretely below $V_h$. The explanation is
two-fold. First, the buyer may indeed place a limit order even
though the probability of its executing is low, because of the
low monetary benefit of buying at an asking price
infinitesimally close to $V_h$. Second, the buyer places the limit
order a discrete distance below $V_h$, at a price where the
buyer knows that a seller (if one does arrive) will just be
induced to trade by market order because of the
attractiveness to the seller of trading with certainty. In other
words, $B^*$ is placed just within the gravitational range of an
arriving seller. Similarly, $A^*$ is placed just within the
gravitational range of an arriving buyer. And a non-trivial
spread, $A^*-B^*$, results. (Our mathematical solution in HST
(1997) yields simultaneous values for $A^*$ and $B^*$ that lie at the
edge of the buyers' and sellers' gravitational range. That is, if
$A^*$ is epsilon lower it results in a buyer submitting a market
order and if $A^*$ is epsilon higher it results in a buyer
submitting a limit order. The location of $B^*$ can be similarly
interpreted.)

5. Empirical Evidence

In this section, we consider empirical findings
concerning the profitability of limit order trading and the
behavior of the bid-ask spread in an order driven market.
Handa and Schwartz (1996b) assess the returns to limit order
trading relative to market order trading, using data for the
thirty Dow Jones Industrial firms traded on the New York
Stock Exchange. The data source was the 1988 "Trades and
Quotes" transaction file for NYSE stocks supplied by the
Institute For the Study of Security Markets (ISSM).

Returns to Limit Order Trading To assess the returns
to limit order trading relative to market order trading, Handa
and Schwartz (HS, 1996b) conducted experiments using the
ISSM transaction record to assess the profitability of
entering one-share market and limit orders (i.e., orders too
small to affect market prices). In the experiments, HS placed
limit orders to buy at prices 1%, 2%, and 3% below current
market prices. Orders are kept on the book for a maximum of
1, 2, and 3 days for the three pricing alternatives,
points. The observations are presented separately for executed limit orders and for unexecuted limit orders that were converted to market orders at the end of an allotted trading period. As discussed in Section 1 above, one would expect to observe positive differential returns for executed limit orders and negative differential returns for unexecuted limit orders.

For executed limit orders, the middle column in Table 1 shows positive differential returns of 36, 52, and 160 basis points for the 1%, 2%, and 3% tests, respectively. Each of the three statistics was significant at the 1% level. For unexecuted limit orders, the right hand column in Table 1 shows a positive differential return of 10 basis points for the 1% test that was not statistically significant; a positive differential return of 23 basis points for the 2% test that was significant at the 5% level; and a negative differential return of 77 basis points for the 3% test that was significant at the 1% level.

A Multiple Limit Order Strategy. HS also tested a multiple limit order strategy. For each Dow stock, their hypothetical trader cast a network of limit orders around the opening price, $P_0$, for the first trading day in a test period. The orders were placed a fixed percentage distance apart ($S\%$). Buy orders were placed at $(1-S)P_0, (1-2S)P_0$, and so forth, while sell orders were placed at $(1+S)P_0, (1+2S)P_0$, and so forth. $S$ was assigned five alternative values: 1%, 2%, 3%, 4%, and 5%. All orders were rounded to the nearest 1/8th of a point and, as executions were realized, limit orders were appropriately reinstated to keep the network intact. There were no further revisions of the quotes and no inventory control until the end of a trading period. Trades, inventory levels, and profits were followed for 30 trading days during 1988. Any excess inventory (long or short) was cleared at the prevailing market price at the end of each period.

The profitability of the multiple limit order strategy was computed in two ways. First, the dollar value of all purchases was subtracted from the dollar value of all sales to obtain the total dollar return to the strategy. Second, the total dollar return was divided by the number of round trips to obtain the limit order spread. The findings for these two measures are shown in Table 2. The returns for all five tests were positive. As seen in the middle column of Table 2, the total dollar return ranged from $16.33 for the 1% test to $3.80 for the 5% test (total dollar profits decreased with increases of $S$ because fewer trades were made when the limit orders were placed further apart). As seen in the right hand column of Table 2, the limit order spread ranged from $0.23 for the 1% test to $1.24 for the 5% test (not surprisingly, placing the limit orders a greater distance apart increased the limit order spread). (Additional test results concerning the profitability of limit order trading presented in Handa and Schwartz (1996b) confirm those we have discussed here.)

Behavior of the Bid-Ask Spread. Handa, Schwartz and Tiwari (HST, 1997) have assessed the relationship between spread size, the variable $k$ (discussed above), and the divergence of opinion (that they estimate from their model) for all equities traded on the SBF Bourse de Paris's CAC market. This study used the Paris Bourse BDM (Base de Donnees de Marche) data base, which consists of intraday data for all equities traded on the Bourse. To examine the determinants of the bid-ask spread in an order driven market, HST used the size of the bid (in number of shares) relative to the sum of the bid size and the ask size as a proxy for the variable $k$ discussed in Section 3 above. As noted in Section 3, one would expect the spread to be largest at $k=0.5$, and to decrease as $k$ goes to either of its extreme values (0 or 1). Table 3 shows the average relative spread for quintile values of $k$ for all of 1995 and for six sub-periods of the year. (The relative spread is $100(bid - ask)/(bid + ask)$.) For the full year, the relative spread is largest for the middle quintile (it averages 0.287 for quintile 3) and is smallest for the extreme quintiles (it averages 0.274 for quintile 1 and averages 0.269 for quintile 5). This pattern, with minor variations, is replicated in each of the six subperiods, and the finding is statistically significant. (HST present further tests, including Generalized Method of Moments results, of the effect of $k$ on spreads. As the findings consistently show, in an order driven market, the spread widens as $k$ approaches one-half.)

The Bigger Picture. We have obtained a consistent picture of the dynamics of the order driven market.

• The discussion in Section 1 suggests that (i) the differential returns for executed limit orders and (ii) the returns realized from a multiple limit order strategy, would both be positive, and we find that they both are.
This is compelling evidence that the mean reversion and accentuated price volatility which exist in short-period returns make a limit order strategy profitable for the patient trader.

- The stylized model discussed in Section 3 suggests that the spread would be larger the greater the difference of opinion in the market and, based on our proxy measure of \( k \), we find that it is. This is compelling evidence that, as suggested by our discussion of the gravitational pull effect, participants in an order driven market take execution probabilities into account when placing their orders.

- The differential returns for unexecuted limit orders were expected to be negative. The evidence here is mixed. The average differential return is significantly negative for the 3% strategy, but it is significantly positive for the 2% strategy and insignificantly different from zero for the 1% strategy. However, we do find that the differential returns to unexecuted limit orders are appreciably lower than the differential returns to executed limit orders.

We conclude that patient traders are rewarded for placing limit orders and that eager traders are best advised to place market orders. And so it must be for the ecology of the order driven market to be viable.

6. Implications For Market Structure

We have analyzed the order driven market as an ecological system. The focus yields a number of implications for market structure and regulatory policy which we consider in this Section.

Balance Between Limit Order and Market Order Traders. Climatologists are concerned about global warming. The regulators of a securities market should take heed. Like any ecology, the order driven market requires a reasonable balance between various types of participants. Any imposed change that turns limit order traders in an order driven market — or dealers in a quote driven market — into an endangered species could result in a market's ecological system breaking down.

Accentuated Short-Period Volatility. Mean reversion is the dynamic that divides participants into limit order and market order traders. With mean reversion, short-period price volatility is accentuated. Our discussion suggests that accentuated short-period price volatility will be observed in an order driven market regardless of how low explicit trading costs might be, the speed with which orders can be submitted and turned into trades, or the size of the minimum price variation.

Bid-Ask Spreads. Our discussion suggests that bid-ask spreads are a natural property of the order driven market — they exist because of the value participants place on trading with certainty. Consequently, reducing the size of the minimum tick will not necessarily reduce bid-ask spreads. Only if the tick size is large enough to force spreads above their equilibrium values will changing the tick size have any clear effect.

Transparency and Order Flow Consolidation. Transparency and order flow consolidation are particularly important to participants in an order driven market. Seeing orders on the book helps traders assess their non-execution risks, thereby enabling them to make better order placement decisions. The depth of the book increases and market spreads tighten when limit orders are consolidated and executed according to strict price and time priorities. All else equal, we expect order driven markets to operate more efficiently when they are transparent and consolidated. Transparency of markets can certainly be considerably enhanced by the advent of new technology.

Price Discovery. In our discussion, we have assumed that each participant knows every other participant's assessment of share value and the proportion of buyers and sellers in the market. In actual markets, participants do not know these parameters and hence do not know the equilibrium values of the bid and the ask. As trading progresses with the sequential arrival of orders, the market searches for its equilibrium price level. Price discovery is a complex process that is itself facilitated by transparency and order flow consolidation.

Thin Markets and Large Traders. Thus far, we have implicitly assumed a market comprised of a sizable number of participants who are each of small size. What happens to the balance between the suppliers and the demanders of immediacy when the number of participants is small, as it is for small capitalization stocks, or when some participants submit large block orders, as do the institutional investors? The order driven market may not be viable for all stocks and for all investors. When the order flow becomes too thin or too lumpy, the ecology of the order driven market may break down. Consequently, alternative trading environments such as the quote driven market and the electronic call market are needed.

Multiple Trading Modalities: The NYSE. A key problem facing markets today is how best to combine alternative trading venues in one marketplace. Few markets are, in fact, purely order driven. Consider the New York Stock Exchange, for instance. Over the years, the NYSE has evolved into a market that successfully combines a variety of different trading systems. A non-electronic call procedure is
used to start each trading session. During the continuous trading that follows, limit orders are kept on the books of the NYSE specialists, and the NYSE is largely order driven. The specialist, however, commonly trades from his or her own account as a dealer, and upstairs market makers also take positions in block trades which they arrange. In addition, NYSE floor brokers work customer orders on a not held basis, feeding the orders to the market in smaller pieces without ever placing them on the book. Thus far, successfully achieving this kind of a multiple modality system in an electronic marketplace has proven to be a difficult task.

**Le Nouveau Marché and Xetra.** Le Nouveau Marché, which was launched by the SBF Bourse de Paris in March 1996, is a particularly interesting example of a marketplace based on two alternative trading venues, a quote driven market and a call market. Recent experience on that market suggests that an effective ecological balance exists between the two trading modalities, as each supplies effective competitive pressure on the other and, collectively, the two together attract increased order flow and hence liquidity to the market. (See SBF Bourse de Paris (1997))

In Germany, the Deutsche Börse has developed a new electronic trading system, Xetra, which includes a continuous, order-driven component and three calls a day (at the opening, intraday, and at the close). In addition, market makers (Betreuers) set bid and ask quotes on request for the purpose of providing additional liquidity to the market. (The betreuer's role is similar to that of the animateur in the Paris market) The flexible modularity offered by the system should enable both institutional and retail participants to enter their orders for both large and small capitalization stocks. Moreover, the competitive pressure each of the three trading venues places on the other two should keep the overall market efficient and responsive to customer needs.

**Market Structure Regulation.** In recent years, the United States Securities and Exchange Commission has taken an increasingly active role with regard to market structure. To a large extent, the regulators have focused on issues such as systemic risk, fairness, transparency, and order flow consolidation. Systemic risk is critical and government should be concerned. Fairness is a noble objective, but pursuing it as a regulatory goal can have costly, unintended consequences. (See Clemons and Weber (1996) for regulatory implications of new technology.) As discussed above, transparency and order flow consolidation are desirable but, unfortunately, regulatory control of these market features can result in the regulators micro-managing market structure. The ecology of the marketplace is too complicated for regulators to have all the answers to market design issues. Markets must be allowed to evolve naturally as they compete with one another for order flow. Those that succeed will be the ones that provide the most ecologically viable environment to their customers.

7. **References**


[13] Handa, Puneet, Robert Schwartz and Ashish Tiwari,


Table 1: Limit Order Returns Relative to Market Order Returns

<table>
<thead>
<tr>
<th>Limit Buy Order 1%, 2%, or 3% below current market price</th>
<th>Differential return to executed limit orders (b.p.) R_{limit} - R_{market}</th>
<th>Differential return to unexecuted limit orders (b.p.) R_{limit} - R_{market}</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>36**</td>
<td>10</td>
</tr>
<tr>
<td>2%</td>
<td>52**</td>
<td>23*</td>
</tr>
<tr>
<td>3%</td>
<td>160**</td>
<td>-77**</td>
</tr>
</tbody>
</table>

* Significantly different from zero at 5% level.
** Significantly different from zero at 1% level.
Source: Handa and Schwartz (1996b)

Table 2: Profitability of the Multiple Limit Order Strategy

<table>
<thead>
<tr>
<th>Limit Orders are Placed 1%...5% Apart</th>
<th>Total Return (in $)</th>
<th>Limit Order Spread* (in $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>16.33</td>
<td>0.23</td>
</tr>
<tr>
<td>2%</td>
<td>6.99</td>
<td>0.47</td>
</tr>
<tr>
<td>3%</td>
<td>5.05</td>
<td>0.67</td>
</tr>
<tr>
<td>4%</td>
<td>4.67</td>
<td>0.95</td>
</tr>
<tr>
<td>5%</td>
<td>3.80</td>
<td>1.24</td>
</tr>
</tbody>
</table>

Source: Handa and Schwartz (1996b).
Table 3: Mean Relative Spread Classified by Quintiles of Proportion of Buy Orders in the Market (k) for the CAC40 at the Paris Bourse in 1995

<table>
<thead>
<tr>
<th>Spread</th>
<th>Total Period</th>
<th>Jan-Feb</th>
<th>Mar-Apr</th>
<th>May-Jun</th>
<th>Jul-Aug</th>
<th>Sept-Oct</th>
<th>Nov-Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quintile 1</td>
<td>0.247</td>
<td>0.261</td>
<td>0.283</td>
<td>0.247</td>
<td>0.259</td>
<td>0.314</td>
<td>0.282</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>0.286</td>
<td>0.277</td>
<td>0.297</td>
<td>0.261</td>
<td>0.268</td>
<td>0.322</td>
<td>0.290</td>
</tr>
<tr>
<td>Quintile 3</td>
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<td>0.277</td>
<td>0.303</td>
<td>0.263</td>
<td>0.265</td>
<td>0.322</td>
<td>0.293</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>0.286</td>
<td>0.277</td>
<td>0.299</td>
<td>0.261</td>
<td>0.264</td>
<td>0.323</td>
<td>0.289</td>
</tr>
<tr>
<td>Quintile 5</td>
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<td>0.312</td>
<td>0.272</td>
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<tr>
<td>Average</td>
<td>0.280</td>
<td>0.270</td>
<td>0.293</td>
<td>0.255</td>
<td>0.261</td>
<td>0.319</td>
<td>0.285</td>
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</table>

Source: Handa, Schwartz and Tiwari (1997)