Competition for Order Flow and Smart Order Routing Systems

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(paper available on the authors’ web sites)
Introduction

Proliferation of new marketplaces (Inet, Archipelago, BATS, Chi-X etc...) \implies \textbf{Intensified competition for order flow.}

and \textbf{renewed concerns about the effect of market fragmentation:}

1. Does intermarket competition enhance/impair liquidity?
2. Do violations of price priority (best execution) harm market liquidity?
3. How to link fragmented liquidity pools to avoid violations of price priority? Is regulatory intervention needed? Can we expect automation of routing decisions to solve the problem?
These questions stand high in recent regulatory initiatives, both in Europe ("MiFID") and in the U.S ("RegNMS"):

- SEC release n°34-42450 (2000):
  
  “To what extent is fragmentation of the buying and selling interest in individual securities among multiple market centers a problem in today’s markets? For example, has fragmentation isolated orders [...] reducing liquidity?”

  “Will the greater potential provided by advancing technology for the development of broker order-by-order routing systems [...] address fragmentation problems without the need for Commission action?”
Regulations NMS in the U.S. require markets to develop linkages to avoid trade-throughs (i.e. violation of price priority) arguing that:

"Price protection encourages the display of limit orders by increasing the likelihood that they will receive an execution in a timely manner and helping preserve investors’ expectations that their orders will be executed when they represent the best displayed quotation."

(see SEC, Release on Regulation NMS (p.36))

Is it the case?
This study

- **We address some of these issues:**
  1. We compare theoretically and empirically measures of market depth when (i) trading concentrates in one market and (ii) trading is fragmented between two markets.
  2. We analyze whether trade-throughs at the expense of one market impairs liquidity provision in this market.

- **There exist several empirical studies on these questions** (e.g. Battalio et al. (2004), Barclay, Hendershott and McCormick (2003), Hendershott and Jones (2005), Biais, Bisière and Spatt (2004)).

- **Novelty:**
  1. We consider pure electronic limit order markets and we focus on consolidated liquidity.
  2. We analyze an environment in which trade-throughs are not strictly regulated.
A European Experiment: LSE vs Euronext

- The Dutch Stock Market
  1. Until May 23, 2004: A large fraction of the order flow was centralized in a single LOB (NSC) operated by Euronext.
  2. May 24, 2004: The LSE launched a new LOB (EuroSETS) allowing investors to trade Dutch stocks listed on Euronext (traded on NSC).

- EuroSETS and NSC:
  1. Same trading mechanisms: pure limit order markets
  2. Almost same membership
  3. Same clearing and settlement systems

- Ideal environment to test (i) whether competition for order flow enhances liquidity, (ii) whether trade-throughs occur and (iii) harm liquidity provision.
Our analysis

- We proceed in **two steps**.

1. We first develop a model of limit trading in which limit order traders can access (a) **two different markets** ("NSC/EuroSETS") or (b) **only one** ("NSC"). **Two key predictions emerge:**
   - Consolidated depth should increase after EuroSETS entry.
   - Cumulative depth in EuroSETS is inversely related to the likelihood of trade-throughs at EuroSETS expense.

2. **We test these predictions using five minutes snapshots of EuroSETS and Euronext limit order books over different periods after EuroSETS entry.**
Similar to Parlour and Seppi (2003) but focuses on competition between pure limit order markets.

We compare the case in which traders have access to two identical limit order markets with the case in which they can have access to only one.

**Important assumption:** time priority is enforced within each trading system but not across systems.

Our focus is on the effect of competition on consolidated depth and cumulative depth in each market.
## Consolidated depth

<table>
<thead>
<tr>
<th></th>
<th>NSC alone</th>
<th>NSC+EuroSETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ask</td>
<td>#shares (cumulative)</td>
<td>#shares (consolidated)</td>
</tr>
<tr>
<td>23</td>
<td>4,000</td>
<td>&lt;&gt;?4,000</td>
</tr>
<tr>
<td>22</td>
<td>3,000</td>
<td>&lt;&gt;?3,000</td>
</tr>
<tr>
<td>21</td>
<td>1,000</td>
<td>&lt;&gt;?1,000</td>
</tr>
</tbody>
</table>
Key Modelling Choices

- **Liquidity supply:**
  1. Limit order traders **trade-off their expected revenue in case of execution and the cost of submitting a limit order (fee+monitoring cost).**
  2. As the queue of limit orders in one limit order book increases, the expected revenue of joining the queue declines because the execution probability of the marginal share declines.
  3. Equilibrium is reached when marginal orders at each price in each limit order book breaks even.

- **Liquidity demand:** Brokers execute market orders against limit order book(s). **Two types of brokers:**
  1. **Smart routers** (proportion $\gamma$): split their orders optimally between the two markets to minimize execution cost.
  2. **Non smart routers** (proportion $(1 - \gamma)$): exclusively trade in one market (the "incumbent") and therefore may generate trade-throughs.
A broker must buy 4,000 shares. A smart router buys 3,000 in NSC and 1,000 in EuroSETS at 23.
Testable hypotheses 1/2

- Consolidated depth is larger with two limit order markets.
- Why? Queue-jumping effect.
  1. Limit orders ahead of the queue at a given price get a strictly positive expected profit (earn the "tick")
  2. The absence of time priority across markets allows "late" limit order traders to "jump ahead" of the queue in one market by submitting a limit order in the competing market.
  3. Jockeying between queues effectively intensifies competition between limit order traders.
Testable hypotheses 2/2

- The liquidity of the "entrant" market relative to that of the incumbent market increases with the proportion of smart routers (i.e. decreases with the frequency of trade-throughs), across stocks.

Why?

1. An increase in the proportion of smart routers (i.e. decrease in trade-throughs) raises the execution probability of limit orders in the entrant market.
2. More incentive to supply liquidity in this market.

- The consolidated depth increases, under some technical conditions, with the proportion of smart routers.
The role of fees

- A decrease in order submission fee in one market (i) increases cumulative depth in this market and (ii) consolidated depth:
  1. Simulations show that the effect can be large.

- LSE enters the Dutch market with smaller fees on limit orders than Euronext and triggers a 50% reduction in Euronext fees.
  1. The reduction in fees should amplify the increase in consolidated depth due to the queue jumping effect.
  2. The effect of LSE entry on Euronext depth is ambiguous.
Competition for Order Flow and Smart Order Routing Systems

Empirical Results

Background

Data

- **Snapshots of EuroSETS and NSC** books every 5 minutes (up to 10 quotes on each side of the books) **before and after** the entry of EuroSETS for 22 stocks constituents of the AEX index.
- Best quotes and quoted depth in each market in continuous time.
- **We focus on 3 periods** (21 trading days in each period):
  1. **Pre-entry period**: April, 23-May, 21 2004.
  2. **Post-entry period 1 (PE1)**: August, 2-August, 30 2004.
- We group our sample stocks in quartiles based on 2003 volume (Q1, Q2, Q3, Q4). Stocks in Q1 are the most active (more than 4,500 trades per day on average).
- Presentation focuses on PE1 as findings for PE2 are qualitatively similar (and stronger).
Market Shares

- EuroSETS market share is in general small (comparable to that of some regional exchanges in the U.S. for Q1).

<table>
<thead>
<tr>
<th></th>
<th>Pre-Entry</th>
<th>Post-Entry 1</th>
<th>Post-Entry 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consoli-</td>
<td>%-age</td>
<td>Consoli-</td>
</tr>
<tr>
<td></td>
<td>dated</td>
<td>LSE</td>
<td>dated</td>
</tr>
<tr>
<td>Daily volume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(euro mio) Q1</td>
<td>167.33</td>
<td>147.36</td>
<td>5.1%</td>
</tr>
<tr>
<td>Q2</td>
<td>57.12</td>
<td>48.85</td>
<td>0.3%</td>
</tr>
<tr>
<td>Q3</td>
<td>25.29</td>
<td>19.43</td>
<td>0.3%</td>
</tr>
<tr>
<td>Q4</td>
<td>9.40</td>
<td>9.25</td>
<td>0.2%</td>
</tr>
<tr>
<td>All</td>
<td>69.10</td>
<td>60.03</td>
<td>3.5%</td>
</tr>
</tbody>
</table>

- **Note:** off-market block trades are not included in our calculations.
Liquidity share vs. Market Share

- Is the small EuroSETS market share due to:
  1. Bad Quotes (absence of liquidity in EuroSETS)?
  2. Bad routing decisions: high proportion of trade-throughs?

- **Finding:** EuroSETS is less liquid than NSC but frequently matches the best offers in NSC with significant depth (> 60% of average trade sizes for stocks in Q1 and Q2)

- **EuroSETS "liquidity share" >> EuroSETS market share** → price factors alone cannot explain the small market share of EuroSETS.
EuroSETS liquidity share—Example (PE1)
Effect of EuroSETS Introduction on Liquidity

To analyze the effect of EuroSETS entry on measures of market liquidity, we run the following regression (one observation per day/per stock):

\[ y_{it} = \mu_i + \theta_i 1[t \text{ in post-entry period}] + \beta^t X_{it} + \varepsilon_{it}, \]  
\[ \varepsilon_{it} = \zeta_t + \eta_{it}, \]

- \( y_{it} \) is a daily measure of liquidity (e.g. average daily consolidated depth up to \( k \) ticks behind the best quotes).
- We isolate the change due to LSE entry (\( \theta_i \)) by adding the control variables (\( X_{it} \)) (i) volume, (ii) volatility, and (iii) price.
Change in Liquidity due to LSE Entry, P-E 1

**Result:** No change or small decline in bid-ask spreads/Large increase in consolidated depth.

<table>
<thead>
<tr>
<th></th>
<th>Spread (basispoints)</th>
<th>Depth0</th>
<th>Depth4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>-1.16** (-4.77)</td>
<td>-15%</td>
<td>0.56**</td>
</tr>
<tr>
<td>Q2</td>
<td>-0.28 (-1.04)</td>
<td>-2%</td>
<td>0.65**</td>
</tr>
<tr>
<td>Q3</td>
<td>3.49 (1.18)</td>
<td>16%</td>
<td>0.33</td>
</tr>
<tr>
<td>Q4</td>
<td>3.11 (1.68)</td>
<td>7%</td>
<td>0.57**</td>
</tr>
</tbody>
</table>

**Note:** */**: significant at a 95%/99% significance level. Depth is measured in 100K euros.
Price Impact of hypothetical buy market orders in PE1 (Q1).
Effect on NSC cumulative depth

- We also find a significant increase in NSC cumulative depth after EuroSETS entry.
  1. Other things equal, it should decrease since the diversion of order flow to EuroSETS means smaller execution probabilities in NSC.
  2. But fees have declined in NSC around EuroSETS entry. This may be the cause of the increase in NSC cumulative depth.

- This suggests that the reduction in fees for liquidity suppliers has played an important role in the liquidity effects that we observe.
Consider the sample of trades occurring when EuroSETS is posting a strictly better price (on the trade side).

Let $\hat{\gamma}_1$ be the proportion of these trades occurring in EuroSETS $\longrightarrow (1 - \hat{\gamma}_1) = \text{trade-through rate at the expense of EuroSETS}$.

We show in the theory that $\hat{\gamma}_1$ is a proxy for what we call the proportion of smart routers.

We use additional proxies-findings (not reported) are identical.
We estimate the **proportion of smart routers in both post-entry periods**:

<table>
<thead>
<tr>
<th></th>
<th>P-E 1</th>
<th>P-E 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>54%</td>
<td>54%</td>
</tr>
<tr>
<td>Q2</td>
<td>22%</td>
<td>11%</td>
</tr>
<tr>
<td>Q3</td>
<td>10%</td>
<td>4%</td>
</tr>
<tr>
<td>Q4</td>
<td>23%</td>
<td>18%</td>
</tr>
<tr>
<td>All</td>
<td>27%</td>
<td>18%</td>
</tr>
</tbody>
</table>

**Note:** The estimates indicate a high level of trade-throughs. Best execution does not emerge spontaneously...
Trade-Througths and Liquidity 1/2

Do cross-sectional variations in trade-throughs affect EuroSETS liquidity?

Two measures of EuroSETS contribution to consolidated liquidity:

1. **Depth Ratio**: EuroSETS quoted depth/NSC quoted depth
2. **Spread Ratio**: The NSC bid-ask spread/The EuroSETS bid-ask spread
Empirical Results

Effect of Trade-Throughs

NSC/EuroSET bid-ask spread against smart routers (PE1)
Cross-sectional regressions yield:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Spread Ratio</th>
<th>Depth Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P-E 1</td>
<td>P-E 2</td>
</tr>
<tr>
<td>$\hat{\gamma}_1$</td>
<td>0.393**</td>
<td>1.012**</td>
</tr>
<tr>
<td>Volume</td>
<td>0.001**</td>
<td>0.000</td>
</tr>
<tr>
<td>Annualized Volatility</td>
<td>-0.004*</td>
<td>0.003</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.77</td>
<td>0.89</td>
</tr>
</tbody>
</table>

* / **: significant at a 90%/95% significance level.

We also find a **positive and significant relationship** between the change in consolidated depth due to EuroSETS entry and the proportion of smart routers.
Trade-throughs and liquidity provision

- Trade-throughs discourage the incentive to post limit orders: EuroSETS is less competitive (larger spreads/smaller depth) in stocks with a high proportion of trade-throughs.

- Surprisingly, the frequency of trade-throughs does not diminish over time.

- They largely explain the wedge between EuroSETS market share and its liquidity share (see paper).

- Why don’t brokers take advantage of the liquidity in EuroSETS?
Interpretation 1/2

- Checking quotes in multiple markets and splitting orders across markets manually is costly (it takes time), especially in fast moving markets.

My team and I spent a considerable amount of effort “selling” the exchange to traders. However, although they all signed up as member, they did not use the market. [...] Even when better bids and offers appeared on our order book, the inferior prices on the LSE were hit and lifted. Potential users simply could not see, nor easily access the market. **If the Tradepoint terminal was at the end of the desk, it was not accessible**—Nic Stuchfield, former CEO Tradepoint

- **Solution:** automate the routing decision/use smart routing technologies. But these are costly to develop.
Interpretation 2/2

- We estimate the money left on the table (both with and without accounting for trading fees) for trade-throughs and find it **small per order**.

- The benefit of using a smart router remains small compared to the cost of developing it.

- But this situation is self-fulfilling as it generates
  1. High trade-through rate at the expense of EuroSETS.
  2. Lower execution probability for limit orders in EuroSETS.
  3. Less aggressive offers in EuroSETS-Less depth in EuroSETS.
  4. Little incentives for brokerage firms to check quotes in EuroSETS.
Conclusions

- **The "Dutch" experiment provides an example in which:**
  1. Increased competition between pure limit order books is associated with a more liquid environment.
  2. Trade-throughs matter: they adversely affect market liquidity. Best execution rules are important.

- **Why do trade-throughs occur?** Lack incentives to automate routing decisions because of (i) **coordination problems** in adoption of a new technology and/or (ii) **agency problems**.

- **Trading fees seem to have a large impact on liquidity provision.** Future studies should attempt to document the elasticities of liquidity supply/demand to these fees.