Throttling hyperactive robots - Message to trade ratios at the Oslo Stock Exchange

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Executive Summary

Issue
- Change of fee calculation for traders at the Oslo Stock Exchange

Targeted at
- High Frequency / Algorithmic Traders

Who potentially pays?
- Traders sending lots of messages (orders/order updates/order withdrawals) with little trading. (Ratio 70:1)

Questions
- Do traders change their behaviour?
- Are there any undesirable effects?
Find

- Traders do change their behaviour
  - Less messages per trade, slightly larger order size
- Little evidence of undesirable effects at the OSE.
  - Trading quality measures (liquidity) at the Oslo Stock Exchange are not changing
- Apparent effects on OSE’s competitors in trading of Norwegian Stocks (Stockholm, Chi-X...)
  - Spreads – widen (liquidity worsen)
  - Depth – no effect
  - Trading volume (turnover) – falling at all lit markets
Talk Overview

- Theoretical background
  - High Frequency Trading / Automatization
- Liquidity at the OSE - long term
- Introduction of regulation at OSE
- Do traders change behaviour?
- What happens to trading quality at OSE?
- Links to other exchanges
Algorithmic trading

Algorithmic Trading – Definition

▶ Direct order submission by computer, where the computer generates the order as part of a broader trading strategy, not as a “dumb terminal.”

▶ Will often be used interchangeably with “High Frequency Trading,” when one wants to emphasize the reaction time of the algorithms, but

▶ High Frequency Trading is a subset of algorithmic trading
The Worlds Equity Markets

Facts

▶ Equity Markets evolved into fully automatic, interconnected market places:
  ▶ “Lit markets:” limit order markets competing for order flow in the same stocks.
  ▶ “Dark Pools:” Trading without a limit order book, e.g. crossing networks.
▶ “Most” of the world’s equity trading is now algorithmic.
▶ Interconnectedness: Trading has become fragmented across market places.
▶ Market voice: Need for extreme speeds (colocation)
High Frequency Trading (HFT)

High Frequency Trading – What is it?
Roughly: HFT is algorithmic trading that relies on extreme speed. Hard to “pin down,” as it covers many types of behaviour. Better: What are the typical trading strategies followed by High Frequency Traders? (from Jones [2013])

- Market Making.
  - Posting bid and asks, earning the spread on average
- Relative value and arbitrage trading
  - Exploiting price differences between same/similar assets
- Directional trading
  - Be first to estimate direction of price movements
Concerns about current equity markets

Popular Concerns

- Popular press: Unfair advantage to robots
- Regulators: Fragile system (Flash Crash)
- Underlying: Hard to understand what HFT are about? What is the benefit to society of being able to trade at nanosecond intervals?

Need to go from concerns to specifics, e.g.

- Is fragmentation a result of alternative market places getting price discovery “for free”?
- Is HFT speed a “game changer”?
Classical results: [Glosten, 1994, Chowdhry and Nanda, 1991]

- Expect trading to gravitate towards one marketplace (winner takes most)
  Both informed and uninformed traders prefer the largest trading crowd.
  Informed: Easier to “hide” in a large crowd.
  Uninformed: The large the crowd, the lower the fraction of informed traders

Insight:
Public Good nature of price discovery (information aggregation)
Important feature of markets that we should want to maintain:
Efficient Pricing
What has changed?
Technology
- Computerization: Lowered fixed costs of maintaining a market place
- Communication: Lowered costs of maintaining the same price across multiple market places

However
- To aggregate information want to see whole demand/supply picture.
- To what extent does the technology changes – multiple market places – allow us to do so?
Theoretical work directly on algorithmic trading

Biais et al. [2013]:
- large fixed costs of gaining a speed advantage.
- may be used to act on information more quickly than others
- \(\rightarrow\) adverse selection for all other users of the system

However: Network effect
- The presence of HFT increases the likelihood of finding counter-parties.

See also
- Jovanovic and Menkveld [2012]
- Foucalt et al. [2012].
Empirical work on algorithmic trading

Generally positive

- Hendershott et al. [2011]: increases in algorithmic trading at the NYSE led to a lowering of spreads.
- Boehmer et al. [2012]: international exchanges, “greater AT intensity improves liquidity and informational efficiency, but increases volatility.”

However, some problems

- Flash Crash [Kirilenko et al., 2011]
Algorithmic trading – Where are we?

**Academic View**

*Practice ahead of Theory*

The changes in the market place have been tremendous, but we are not sure they are not just matters of degree (of speed)

**Popular view**

*Something should be done about High Frequency Trading*

We are just not sure what...
Regulatory proposals

Enter regulators
Large menu of possible regulatory changes
US: SEC, Europe: MiFID (I,II)
Example proposals:
  ▶ Transaction Tax (Tobin tax)
  ▶ Minimum Resting Time
  ▶ Increased Tick Sizes
  ▶ Market Making Obligations
  ▶ Circuit Breakers
  ▶ Order to Trade Ratios

However:
Any regulation need to be designed to fix a specified problem.
Possible externality: Excessive Communications

High frequency trading in a limit order market involves

- *Entering* new orders (to the limit order book)
- *Modifying* existing orders (in the limit order book)
- * Cancelling* orders

All these “messages” rely on very high speed. This imposes costs on

- Other traders – “fleeting orders” in the limit order book are hard for others to catch, unless they have high powered IT/communications equipment.
- The Exchange – Need for large IT investments to cater to HFT traders.

Particularly so if the orders are not meant to be executed

- “stuffing”
- “smoking”
- “spoofing”
Possible Reaction to Externality

Given the externality
Traders with excessive messages relative to transactions should be paying for the costs they impose on others.
How to measure excessive?

Implementation
Calculate a ratio of messages to transactions.
Set some (arbitrary) limit.
Traders with ratios above limit pay for messages above limit.
Our research

Investigate introduction of such a message to trade ratio at the Oslo Stock Exchange.

Research issues

- The Regulation itself
  - Is this a justifiable regulatory intervention?
  - Does it achieve its purpose?
  - Does it have any unintended (negative/positive) consequences?
- Can we use this as input in a broader understanding of the consequences of HFT?
The Oslo Stock Exchange

Main market for trading Norwegian stocks.

- Until MiFID introduction most trading of Norwegian stocks at the OSE.
- Currently trading fragmented across many markets

Evolution of market value since 2000
The Oslo Stock Exchange - liquidity evolution - Relative Bid/Ask Spread

Relative Bid/Ask Spread

Year

Rel B/A Spread

2000 2005 2010

0.02 0.03 0.04 0.05 0.06
The Oslo Stock Exchange - liquidity evolution - Turnover
The Oslo Stock Exchange - Fragmentation

Fraction Trading Volume – OSE vs other markets in XBO

Decomposing Reuters XBO
Size sorted portfolios
Introduction of the “Order to Executed Order Ratio” at the OSE

Measure was announced by the Exchange on May 25, 2012. To be implemented starting September 1, 2012

From the press release (exerpts)

With effect from 1 September, Oslo Børs will introduce a fee that will affect unnecessarily high order activity in the stock market. The purpose of the fee is to discourage orders that do not contribute to the effective and sound conduct of stock market trading.

The fee will be linked to an “Order to Executed Order Ratio (OEO R)” of 1:70. This means that the fee will be charged where the number of orders input relative to each order carried out exceeds 70.

...
Implementation details

More details about the actual fees:
The calculation is done on a monthly basis.
The actual fee is NOK 0.05 per order that exceeds the ratio of 70:1 during the month.
In the calculation the OSE does not count every order.
Specifically, the following activity is not counted:
  ▶ Orders that rest unchanged for more than one second from order entry.
  ▶ Order amendments that improve price, volume, or both.
  ▶ Execute and Eliminate (ENE) and Fill or Kill (FOK) orders
What does count
  ▶ Orders residing less than one second, from order insert or the last amendment, before cancelation
  ▶ Order amendments that degrade price, volume, or both, of an order that has resided for less than one second in the trading system.
Implementation details, ctd

The way executed orders are counted is also specified

- Orders that result in one or many transactions are counted as one executed order
- Executed orders, orders that have been involved in one or more trade, but with total executed value of less than NOK 500 will not be counted as an executed order.

Observation:
The OSE wants to differentiate between different types of HFT traders.
Example: Market making, with both bid and asks: when prices move, one of the bid and ask will be price improving, and not be counted.
In microstructure terminology, the Norwegian regulation reward liquidity provision.
Introduction of similar regulation

**Italy**
Introduced a similar scheme in April 2010
Slightly different calculation
  - Daily payments
  - No “reward” for liquidity provision

Academic investigation [Friederich and Payne, 2013]
  - Liquidity deteriorates
    - Inside spread (+25%)
    - Total depth (−15%)
    - Depth away from the best quotes.
    - Also on “satellite” exchanges
What happens - trader behaviour

Two dates of interest:
- 25 May 2012 – when measure was announced
- 1 Sep 2012 – when measure is implemented

Expect market participants to reprogram their computers in the interim.

Show graphs of daily cross-sectional (Windsorized) averages in 2012.

- Message to Trade Ratios
- Fraction involving automated traders
- Trade Size
- Depth (at best bid/ask)
- Fraction just outside best bid/ask
What happens to Message to Trade Ratios
What happens to Fraction Automated

Fraction of trades involving automated traders

Time

Fraction of trades involving automated traders

Jan Mar May Jul Sep Nov

0.70 0.75 0.80 0.85 0.90

Frac

Fraction of trades involving automated traders
What happens to trade size?
What happens to Depth

![Graph showing depth changes over time]

- Depth values from Jan to Nov:
  - Jan: 250000
  - Mar: 350000
  - May: 450000

- Time: Jan, Mar, May, Jul, Sep, Nov

- Depth range: 250000 to 450000
What happens to fraction at best bid/ask

Fraction at Inner Spread

Time

Fraction

Jan Mar May Jul Sep Nov

0.44 0.48 0.52
Trading quality at the OSE

Investigate what happens to trade quality.
Implementation:
Calculate common measures of trade quality
- Relative Spread (intraday average)
- Trading costs (Roll measure)
- Realized Volatility - RV (intraday)
- Turnover
Investigate their changes from before to after the OEOE
What happens to Relative Spread

Relative Bid/Ask Spread

Year
Rel B/A Spread
Jan Mar May Jul Sep Nov
0.038 0.042 0.046 0.050

Graph showing the relative bid/ask spread over different months of the year.
What happens to Trading costs (Roll)?
What happens to Realized Volatility (RV)?
What happens to turnover?

Daily Turnover

Time

Turnover

0.0010 0.0015 0.0020

Jan Mar May Jul Sep Nov Jan

Time

Jan Mar May Jul Sep Nov Jan

Turnover

0.0020

0.0015

0.0010

Jan

Mar

May

Jul

Sep

Nov

Jan
Bringing in trading of Norwegian Stocks at other exchanges

Potential traders of e.g. Statoil can
  ▶ Trade at the OSE
  ▶ Trade at more than 20 other European lit market places.
  ▶ Trade in dark pools/OTC.

What is the effect of introducing the OEOR at the OSE?
  ▶ Potentially more costly to trade at OSE
  ▶ Makes the alternative market places more attractive?
  ▶ → Improve liquidity in Norwegian Shares outside of Oslo?
Example: Statoil relative spreads

Oslo Stock Exchange (STL.OL)
Example: Statoil relative spreads

Stockholm (STLNOK.ST)
Example: Statoil relative spreads

Chi-X (STLo.CH1)
Generic econometric methodology: Diff in diff. 

Policy Intervention where it is possible to split into

- Treated Sample
- Untreated Sample

Evaluate effect of policy intervention by comparing change in treated vs change in untreated
Posited relationship to be estimated

\[ y_{it} = \theta_t + \mathbf{X}_it'\beta + \gamma C_i + u_i + \epsilon_{it} \]  \hspace{1cm} (1)

where

- \( y_{it} \) – liquidity measure.
- \( \mathbf{X}_{it} \) – Controls – Variables related to stock, e.g.
  - variability
  - size of the underlying company
  - degree of asymmetric information
- \( C_i \), treatment variable, equal to one for “Oslo after 1 sep.”
- \( u_t \) is some unobserved individual effect.
To get rid of the individual effect analysis is done on the differenced version of (1):

$$\Delta y_{it} = (\theta_1 - \theta_0) + (\Delta X_{it})'\beta + \gamma \Delta C_i + \Delta \epsilon_{it}$$

(2)

This will remove any individual effects. In our application we can simplify the estimation further. Matched sample of observations of trading of the same stock in two markets, for example Statoil in Oslo vs Statoil in Stockholm. Taking difference of matched observations in equation (2), The control variables ($X_{it}$) are the same for both cases. The control variable falls out of the estimation, only need to estimate

$$\widehat{\gamma} = [\Delta y|\Delta C = 1] - [\Delta y|\Delta C = 0],$$

the simple difference in differences estimator, to estimate the effect of the policy intervention.
## Results, Diff in Diff

### Change in Relative Spread

<table>
<thead>
<tr>
<th></th>
<th>Oslo</th>
<th>Comparison</th>
<th>$\hat{\gamma}$ (Diff if diff)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average change in Spread(%)</td>
<td>5.06</td>
<td>30.43</td>
<td>-25.36</td>
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<tr>
<td></td>
<td>(0.1410)</td>
<td>(0.0002)</td>
<td>(0.0020)</td>
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<tr>
<td>Median change in Spread(%)</td>
<td>1.33</td>
<td>25.44</td>
<td>-14.22</td>
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</table>
## Results, Diff in Diff

### Change in Depth

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<th>Comparison</th>
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<tr>
<td>Average Change in Depth(%)</td>
<td>113.1</td>
<td>-3.8</td>
<td>116.9</td>
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<tr>
<td></td>
<td>(0.273)</td>
<td>(0.620)</td>
<td>(0.258)</td>
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<tr>
<td>Median Change in Depth(%)</td>
<td>-3.1</td>
<td>-14.1</td>
<td>6.3</td>
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</table>

## Results, Diff in Diff

### Change in Turnover

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<th>Comparison</th>
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</thead>
<tbody>
<tr>
<td>Average Change in Turnover(%)</td>
<td>-5.64678</td>
<td>-5.89261</td>
<td>0.24583</td>
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<tr>
<td></td>
<td>(0.461)</td>
<td>(0.727)</td>
<td>(0.986)</td>
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<tr>
<td>Median Change in Turnover(%)</td>
<td>-22.56970</td>
<td>-28.35079</td>
<td>0.17948</td>
</tr>
</tbody>
</table>
Investigated:
Introduction of fee for high “message to trade” participants at the Oslo Stock Exchange

Find:
*Nothing much happens* in terms of trading quality in Oslo. Spreads *deteriorate* for Norwegian Stocks traded outside of Oslo. This latter result intriguing, bear further investigation

- more detailed look at cross market trading?
- investigate where price discovery happens?


