Do regulatory hurdles on algorithmic trading work?

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Background

- Advances in technology have altered the microstructure of the markets.
- Algorithmic trading (AT, or its close kin, HFT) dominates trading activity worldwide.
- Benefits indisputable, but concerns regarding the negative externalities imposed by these traders.
- AT/HFT has been a subject of intense focus amongst the regulators. Pressure on the regulators to ‘do something’.
- Consequence: Several policy proposals being contemplated to curb AT/HFT activity (MiFID II, HFT Act etc).
The question

A regulatory intervention is justified if

1. there is an identified market failure.
2. the proposed intervention addresses the market failure appropriately.
3. the costs are outweighed by the gains to the society from the intervention.

When the above considerations are ignored, the intervention can result in unintended consequences.
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This paper: examines the effect of one such intervention in the context of Indian equity markets.
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- This paper: examines the effect of one such intervention in the context of Indian equity markets.

- The intervention: Charge fees/penalise traders with high orders to trades (OTR) ratio.
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- **This paper** examines the effect of one such intervention in the context of Indian equity markets.

- **The intervention**: Charge fees/penalise traders with high orders to trades (OTR) ratio.

- **The question**:
  1. Did the intervention address the market failure?
  2. Were there some unintended consequences of the intervention?
OTR fee: The rationale

- **Intended target**: Reduce the high levels of OTR.

- Market failure: Negative externality by way of
  1. Increased load on exchange's infrastructure,
  2. Lot of such orders could be unproductive in nature by rarely resulting into a trade. This raises concerns such as
  2.1 Increased latency in order placement and execution for other traders,
  2.2 Market manipulation.

- The solution prescribed: Impose a fee if the OTR crosses a certain threshold.

- Expected outcome: Costs of high OTR internalised by those who generate it, resulting in lower OTR.

- Unexpected outcome: If not designed appropriately, has potential to adversely affect market quality, liquidity provisioning.

- Our focus: Analyse the intervention in terms of these two outcomes – was the expected effect realised? were there unexpected consequences?
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Advantages in this paper
Internationally, exchanges including the NASDAQ, NYSE Euronext, OSE, Borsa Italiana, TSX have implemented the fee.

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At NSE,

1. the fee implementation in 2009 was an exchange initiative (to reduce load on its infrastructure).
2. the fee hike in 2012 was due to regulatory initiative.
Timeline of the events at the NSE

- AT permitted: 2009-10-01
- Fee introduced: 2010-07-01
- Fee reduced: 2012-07-02
- Fee levied on algo orders: 2013-05-27
- Fee doubled: 2013-05-27
Fee implementation details

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     - Orders within +/-1% LTP price limits not included.
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  3. Fee computed at a member level on a daily basis.
  4. Fee implemented only on the derivatives segment.

- Offers a neat research design to evaluate the impact of the fee by using cash market as a control.

- We focus on the 1st and the last event:
  1. **Event 1**: Fee implementation by the exchange in 2009.
  2. **Event 2**: Fee doubled by the regulator in 2013.
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What we find

- **Impact of Event 1:**
  1. A significant *reduction* in the average OTR after the event, indicating that the exchange managed to achieve what it intended.
  2. However, this impact was accompanied by a significant *deterioration* in the market quality variables – an unintended consequence.
What we find

- **Impact of Event 1:**
  1. A significant *reduction* in the average OTR after the event, indicating that the exchange managed to achieve what it intended.
  2. However, this impact was accompanied by a significant *deterioration* in the market quality variables – an unintended consequence.

- **Impact of Event 2:**
  1. The event, did not see any shift. Neither in the trading behavior of the participants by way of OTR, nor in the market quality variables.
  2. Indicates the insignificance of the event.
Research setting
Data details

- **Period of the study:**
     a) Pre event: Jun - Aug 2009
     b) Post event: Oct - Dec 2009
     a) Pre event: Mar - May 2013
     b) Post event: Jun - Jul 2013

- **Sample:** Nifty stocks in the period between 2009 and 2013.
- **Segment analysed:** Near month single stock futures.
- **Data used:** Tick by tick orders and trades data, with flags identifying if an order or a trade is AT or non AT, and trader category. Flag on type of order event: entry, modification or cancellation.
Some facts
Features of trading on the NSE single stock futures market

<table>
<thead>
<tr>
<th>Source of orders events</th>
<th>Event 1 Pre</th>
<th>Event 1 Post</th>
<th>Event 2 Pre</th>
<th>Event 2 Post</th>
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<td>6.12</td>
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<td>0.65</td>
<td>0.50</td>
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<tr>
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<td>0.37</td>
<td>0.50</td>
<td>0.29</td>
<td>0.25</td>
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<tr>
<td>Non algo</td>
<td>3.69</td>
<td>5.23</td>
<td>0.77</td>
<td>0.55</td>
</tr>
</tbody>
</table>
Measurement
**OTR measurement**

- At an order level, compute
  1. $\text{OTR} = \frac{\text{Number of orders events}}{1 + \text{Number of trades}}$
  2. $\text{OTR intensity} = \frac{\text{OTR}}{\text{Average time between modifications}}$

- For each stock, we compute value weighted average OTR for the day.

- For the day, we compute market cap weighted OTR across all stocks.
OTR graph pre and post the event

Event 1

Event days

Mean = 4.25
Mean = 3.74

Event 2

Event days

Mean = 6.79
Mean = 6.86
Market quality measures

- **Liquidity**

  1. **Transactions costs**
     1.1 **QSPREAD** (in %): \((\text{best ask} - \text{best sell}) \times 100 / \text{mid-quote price}\).
     1.2 **Price impact** (**PRICE IMPACT**, %): execution cost of a market order at a size of Rs 250,00 relative to the mid-quote price.

  2. **Depth**
     2.1 **TOP1DEPTH** (in Rs.): Rupee depth available at the best bid and ask prices.
     2.2 **TOP5DEPTH** (in Rs.): Cumulated Rupee depth available at top five best bid and ask prices.
     2.3 **DEPTH** (# of shares): Average of the outstanding buy side and sell side number of shares.

  3. Amihud's illiquidity measure, **ILLIQ**: Ratio of daily absolute stock return to traded value.
Market quality measures (contd..)

▶ Efficiency

1. \( v_r \): Ratio of ten-minutes variance of returns to two times the variance of five-minutes returns in a day.
2. \( \text{BASIS} \) (%): Difference in the actual and implied futures price, relative to the spot price.

▶ Volatility

1. Price risk, \( \text{RVOL} \): Standard deviation of five-minutes returns.
2. Liquidity risk, \( \text{LRISK} \): Standard deviation of price impact.
3. Basis risk, \( \sigma_{\text{BASIS}} \): Standard deviation of the basis.
Methodology
Impact evaluation: The approach

- **On OTR and OTR intensity:**
  1. Estimate a fixed effects panel regression specified as:
     \[
     
     \text{VWTD-OTR}_{i,t} = \alpha_i + \beta_1 \times \text{FEEDUMMY}_t + \beta_2 \times \text{AT-INTENSITY}_{i,t} + \\
     \beta_3 \times \text{MCAP}_{i,t} + \beta_4 \times \text{INVERSE-PRICE}_{i,t} + \\
     \beta_5 \times \text{NIFTY-VOL}_t + \epsilon_{i,t}
     \]
  2. Hypothesis: If the event had an impact on OTR, \( \beta_1 < 0 \).

- **On market quality:**
  1. The fee only implemented on derivatives, not on cash.
  2. Use cash market as a control to evaluate the impact using a DID regression:
     \[
     
     \text{mkt-quality}_{i,t} = \alpha + \beta_1 \times \text{treated}_{i} + \beta_2 \times \text{feedummy}_t + \\
     \beta_3 \times \text{treated}_i \times \text{feedummy}_t + \beta_4 \times \text{AT-INTENSITY}_{i,t} + \\
     \beta_5 \times \text{MCAP}_{i,t} + \beta_6 \times \text{INVERSE-PRICE}_{i,t} + \\
     \beta_7 \times \text{NIFTY-VOL}_t + \epsilon_{i,t}
     \]
  3. Hypothesis: If the event did not have any impact on market quality, \( \beta_3 = 0 \).
Impact evaluation: The approach

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  1. Estimate a fixed effects panel regression specified as:

     \[ \text{VWTD-OTR}_{i,t} = \alpha_i + \beta_1 \times \text{FEEDUMMY}_t + \beta_2 \times \text{AT-INTENSITY}_{i,t} + \beta_3 \times \text{MCAP}_{i,t} + \beta_4 \times \text{INVERSE-PRICE}_{i,t} + \beta_5 \times \text{NIFTY-VOL}_t + \epsilon_{i,t} \]

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- **On market quality:**
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     \[ \text{MKT-QUALITY}_{i,t} = \alpha + \beta_1 \times \text{TREATED}_i + \beta_2 \times \text{FEEDUMMY}_t + \beta_3 \times \text{TREATED}_i \times \text{FEEDUMMY}_t + \beta_4 \times \text{AT-INTENSITY}_{i,t} + \beta_5 \times \text{MCAP}_{i,t} + \beta_6 \times \text{INVERSE-PRICE}_{i,t} + \beta_7 \times \text{NIFTY-VOL}_t + \epsilon_{i,t} \]

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Results
Impact on OTR: Panel regression

\[ \text{VWTD-OTR}_{i,t} = \alpha_i + \beta_1 \times \text{FEEDUMMY}_t + \beta_2 \times \text{AT-INTENSITY}_{i,t} + \beta_3 \times \text{MCAP}_{i,t} + \beta_4 \times \text{INVERSE-PRICE}_{i,t} + \beta_5 \times \text{NIFTY-VOL}_t + \epsilon_{i,t} \]

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<th></th>
<th>Event 1</th>
<th></th>
<th>Event 2</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>$\hat{\beta}_1$</td>
<td>t-stat</td>
<td>$R^2$</td>
<td>$\hat{\beta}_1$</td>
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<tr>
<td>OTR</td>
<td>-0.65</td>
<td>-4.60</td>
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<td>OTR-INTENSITY</td>
<td>-0.39</td>
<td>-5.29</td>
<td>0.11</td>
<td>48.35</td>
</tr>
</tbody>
</table>

Significant impact on OTR and OTR intensity post event 1, but no such impact post event 2.
Impact on market quality: DID regression

\[ \text{MKT-QUALITY}_{i,t} = \alpha + \beta_1 \times \text{TREATED}_i + \beta_2 \times \text{FEEDUMMY}_t + \]
\[ \beta_3 \times \text{TREATED}_i \times \text{FEEDUMMY}_t + \beta_4 \times \text{AT-INTENSITY}_{i,t} + \]
\[ \beta_5 \times \text{MCAP}_{i,t} + \beta_6 \times \text{INVERSE-PRICE}_{i,t} + \]
\[ \beta_7 \times \text{NIFTY-VOL}_t + \epsilon_{i,t} \]

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<td>$\hat{\beta}_3$</td>
<td>t-stat</td>
<td>$R^2$</td>
<td>$\hat{\beta}_3$</td>
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<tr>
<td>QSPREAD</td>
<td>0.06</td>
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<td>PRICE IMPACT</td>
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<td>0.08</td>
<td>11.98</td>
<td>0.24</td>
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</tr>
</tbody>
</table>
Impact on informational efficiency: basis and basis risk

\[
\text{BASIS}_{i,t} = \alpha_i + \beta_1 \times \text{VWTD-OTR}_{i,t} + \beta_2 \times \text{FEEDUMMY}_t + \beta_3 \times \text{VWTD-OTR}_{i,t} \times \text{FEEDUMMY}_t + \beta_4 \times \text{AT-INTENSITY}_{i,t} + \beta_5 \times \text{MCAP}_t + \beta_6 \times \text{INVERSE-PRICE}_{i,t} + \beta_7 \times \text{NIFTY-VOL}_t + \epsilon_{i,t}
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<td>$R^2$</td>
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<td>-0.02</td>
<td>0.10</td>
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</tr>
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</table>

Adverse impact on the informational efficiency in terms of basis post event 1. No effect post event 2.
A closer look at the Event 2 implementation
The 1% LTP limit: % of orders that breached the limit

Event 2:

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
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<td>Median</td>
<td>1.07</td>
<td>1.02</td>
<td>0.24</td>
</tr>
</tbody>
</table>
The 1% LTP limit: % of orders that breached the limit

Event 2:

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>1.60</td>
<td>1.39</td>
<td>0.07</td>
</tr>
<tr>
<td>Median</td>
<td>1.07</td>
<td>1.02</td>
<td>0.24</td>
</tr>
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Question: If on an average, the % of orders that breached the price limit on a stock in a day was less than 2%, was that the intended target?
Conclusion
Worldwide, a lot of concerns about AT/HFT penetration in to the markets.

The need for a corrective action could be justified.
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Before taking the action, important to know where the problem lies.
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For Event 1, the analysis suggests

1. that the exchange knew the root cause of the problem, and what was to be achieved (and how). However,
2. the design was sub-optimal, since the fee adversely affected the market quality.

The analysis for Event 2 suggests

1. that the regulator issued the guidelines, motivated by the need to 'do something'. But,
2. the objective was not well defined.

The study makes a case for the need of scientific evidence-based policy formulation with defined objectives.
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Extensions
Examine the impact of the other two events:

a) When the fee was reduced by the exchange on July 1, 2010.

b) When the fee was levied on high algo orders on July 2, 2012.

Expand the sample universe to all stocks traded on the derivatives segment to understand the impact of the fee on small cap stocks versus the large cap stocks.

Examine the profitability of AT to understand if the fee was too small for it to be binding on the actions of algorithmic traders.
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Examine the impact on liquidity provision post the event.

Examine the profitability of AT to understand if the fee was too small for it to be binding on the actions of algorithmic traders.
Thank you

Comments / Questions?