Do regulatory hurdles work on algorithmic trading?

Nidhi Aggarwal
(Finance Research Group, IGIDR)

Venkatesh Panchapagesan
(IIM Bangalore)

Susan Thomas
(Finance Research Group, IGIDR)

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Cause and consequences of regulatory inventions

- Traditional view: regulatory intervention is justified if these conditions hold -

  • There is an identified market failure; • Proposed intervention addresses the market failure appropriately; • Costs are outweighed by gains.

- If not, interventions can result in unintended consequences.

  Examples: the Andhra Pradesh ban on microfinance in 2010 (Sane and Thomas, 2016); interventions on exchange currency derivatives (loss in international competitiveness of Indian currency markets, 2010-).

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  Examples: the Andhra Pradesh ban on microfinance in 2010 (Sane and Thomas, 2016); interventions on exchange currency derivatives (loss in international competitiveness of Indian currency markets, 2010-).

- Recent view: regulatory interventions on algorithmic / high frequency trading appear to be driven by public interest concerns.

  Concerns arise despite research evidence on benefits of algorithmic trading on market quality.

This paper

- Examines the effect of a regulatory 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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- Examines the effect of a regulatory intervention in the context of Indian equity markets.
- **The intervention**: Charge fees/penalise traders with high orders to trades (OTR) ratio.
- Unique: same intervention – OTR fee, same target market, multiple episodes, by different regulatory agencies.
- **The question**:
  1. Was there a stated market failure?
  2. Was there a stated target outcome?
  3. Did the intervention achieve the target outcome?
  4. Did the intervention address the market failure?
  5. Did the intervention have unintended consequences?

OTR fee: The rationale

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- **Solution**: Impose a fee if the OTR $>$ threshold.
- **Outcome**: Higher costs on order placement $\rightarrow$ lower number of orders.
- **Unexpected outcome**: Higher cost $\rightarrow$ lower liquidity provisioning.

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- Answer to how the OTR fee impacts the market is complicated.

Empirical studies on the impact

- Internationally, exchanges including the NASDAQ, NYSE Euronext, OSE, Borsa Italiana, TSX have implemented the fee.

  Jorgensen et al (2014), Friederich and Payne (2015), Malinova et al (2013).

  Objective: appears to be public interest concerns.

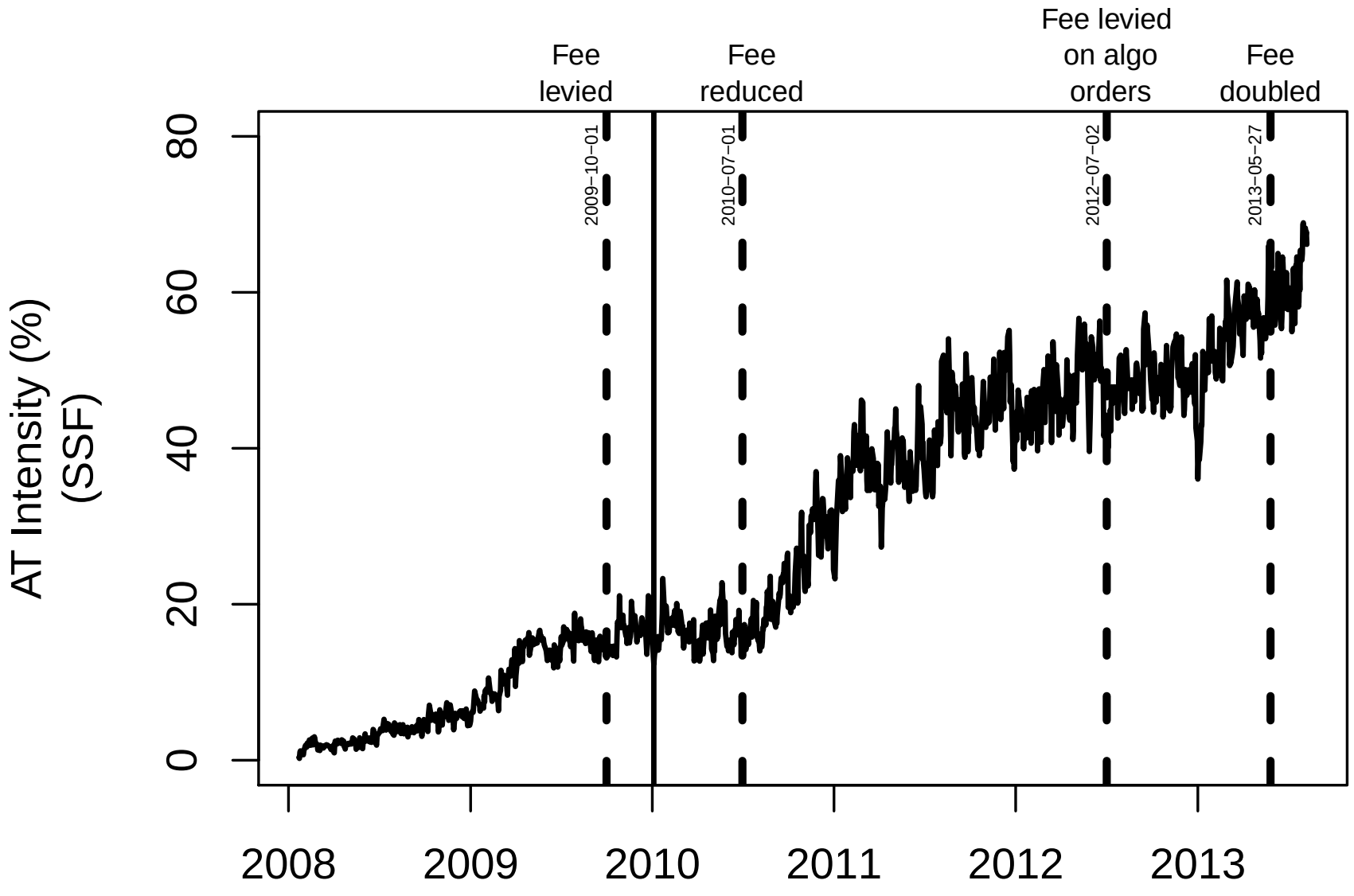
- India had two sets of episodes:

  1. NSE implements an OTR fee in 2009 to reduce load on its infrastructure. (Removed a year later, in 2010.)
  2. SEBI implements the fee in 2012 to address public interest concerns.

- Research opportunity: Possible opportunity to understand if the objectives matter?

  How does the regulatory intervention work in an emerging economy with different standards of regulatory enforcement and governance?

Growth of algorithmic trading in India and the interventions



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  1. Orders within +/-1% LTP price limits not included.
  2. Members covered under the LES excluded.
  3. Additional penalty of no trading in the first 15 minutes on the next trading day if OTR $>$ 500.
- Fee computed at a member level on a daily basis.
- Fee **only** on derivatives.

Data

- **Focus:** 1^{st} and the 3^{rd} event
- Methodology: Event study, difference-in-difference regressions.
- Event window: Three months around implementation.
- Dates:
  1. Event 1: Imposition of OTR fee by NSE on Oct 1, 2009.
     a) Pre event: Jul - Sep 2009
     b) Post event: Oct - Dec 2009
  2. Event 2: Fee hike on SEBI direction on July 2, 2012
     a) Pre event: Apr - Jun 2012
     b) Post event: Jul - Sep 2012
- Sample: All securities traded on NSE equity segment; Near month single stock futures.
- Data type and frequency: 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.

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- Need a different set of controls.

  Our candidate: underlying stocks as treated and matched stocks (equity spot) as controls.
- Difference-in-difference regressions on both sets of treated-control samples: coefficients should tell the same story.

Research design we use

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  1. Stock should be in the top 500 stocks in terms of average **daily market capitalisation** and **average daily traded value** in the previous six months on a rolling basis.
  2. The stock's median quarter-sigma **order size** over the last six months shall be not less than Rs. 10 lakhs.
  3. The **market wide position limit** (determined by number of shares held by non-promoters) in the stock shall not be less than Rs. 300 crores.

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- Some non-derivatives stocks **may not** meet the above criteria **just near** the above threshold(s).
- We **exploit** this setting, and **match** the non-derivative stocks with derivative stock for each event.

Obtaining matched firms

- Define
  - **'Treated'**: stocks with derivatives contract within the event window.
  - **'Control'**: stocks without derivatives contract.
  - *Leave out* the firms that got **excluded** from derivatives trading within the event window.
- Matching stocks using data **before** the fee implementation :
- **Distance** measure: Propensity scores.
- **Covariates**: log(average daily market cap), price, turnover, number of trades and percentage of floating stock.
- Estimate a logit model.
- One-to-one matching on estimated propensity scores using the **nearest neighbor** algorithm (without replacement), and a tight caliper of **0.05**.

Difference-in-difference equations

- Use the treated and control (matched) securities and estimate the following equation:

$$\begin{aligned}\text{MEASURE}_{i,t} = \; & \alpha + \beta_1 \times \text{TREATED}_i + \beta_2 \times \text{FEEDUMMY}_t + \\ & \beta_3 \times \text{TREATED}_i \times \text{FEEDUMMY}_t + \\ & \beta_4 \times \text{MCAP}_{i,t} + \beta_5 \times \text{INVERSE-PRICE}_{i,t} + \\ & \beta_6 \times \text{NIFTY-VOL}_t + \epsilon_{i,t}\end{aligned}$$

- **Hytpothesis**: If the event did not have any impact on the level of OTR or market quality, $\beta_3 = 0$.

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- **Hytpothesis**: If the event did not have any impact on the level of OTR or market quality, $\beta_3 = 0$.
- We estimate two sets of regressions:
  1. To determine the impact on cash market: DiD regression using cash market data.
  2. To determine the impact on futures market using these:
     Regresssion 1: (treated) futures and (control) **underlying** stocks on cash market.
     Regression 2: (treated) stocks (underlying of the futures) and (control, matched) stocks.
- Measure are OTR and market quality (liquidity, efficiency).

Measurement

OTR measures

- At an order level for each stock, compute
  1. OTR = Number of orders events / (1 + Number of trades)
  2. OTR intensity = OTR/(Average time between modifications)

  This is the value weighted average OTR for the day.
- At the level of each stock: Total number of messages on a stock to total number of trades on the stock within a day.

Market quality measures

- Liquidity:

  Qspread, Impact cost (at two different sizes), Depth (in INR) at the best price and at the top five, Amihud's illiquidity measure.

- Efficiency:

  Variance ratio (ten minutes to five minutes), returns volatility, impact cost volatility (at two different sizes).

Results

Event 1: DiD regression

$$
\begin{aligned}
\text{OTR}_{i,t} \quad = \quad & \alpha + \beta_1 \times \text{TREATED}_i + \beta_2 \times \text{FEE}_t + \\
& \beta_3 \times \text{TREATED}_i \times \text{FEE}_t + \\
& \beta_4 \times \text{MCAP}_{i,t} + \beta_5 \times \text{INVERSE-PRICE}_{i,t} + \\
& \beta_6 \times \text{NIFTY-VOL}_t + \epsilon_{i,t}
\end{aligned}
$$

Event 1, impact on OTR

	SSF-Spot(treated)		Spot(treated)-Spot(control)	
	VWTD OTR	OTR NAIVE	VWTD OTR	OTR NAIVE
Treated × Fee	**-1.74**	**-6.04**	**1.18**	**0.33**
	(-5.19)	(-5.03)	(5.27)	(7.14)
R^2	0.25	0.57	0.46	0.15
Treated units	37	37	37	37
Control units	37	37	36	36
# of obs.	7738	7738	8208	8208

Event 2, impact on OTR

	SSF-Spot(treated)		**Spot(treated)-Spot(control)**	
	VWtd OTR	OTR naive	VWtd OTR	OTR naive
Treated × Fee	-0.106	**31.504**	**-0.929**	0.098
	(-0.29)	(2.63)	(-2.34)	(0.12)
R^2	0.19	0.13	0.25	0.13
Treated units	47	47	47	47
Control units	47	47	45	45
# of obs.	9030	9030	10233	10233

Market quality

DiD on market quality

$$
\begin{aligned}
\textsc{Market quality}_{i,t} \quad = \quad & \alpha + \beta_1 \times \textsc{treated}_i + \beta_2 \times \textsc{fee}_t + \\
& \beta_3 \times \textsc{treated}_i \times \textsc{fee}_t + \\
& \beta_4 \times \textsc{mcap}_{i,t} + \beta_5 \times \textsc{inverse-price}_{i,t} + \\
& \beta_6 \times \textsc{nifty-vol}_t + \epsilon_{i,t}
\end{aligned}
$$

Event 1, Liquidity impact

	SPREAD	IC_{25k}	IC_{250k}	1DEPTH	5DEPTH	ILLIQ
Panel A: SSF-Spot(Treated)						
Treated × Fee	**-0.05**	**-0.05**	**-0.04**	-0.055	-0.06225	**0**
	(-6.87)	(-6.17)	(-4.11)	(-1.16)	(-1.03)	(-4.04)
R^2	0.53	0.48	0.29	0.76	0.73	0.1
Treated units	37	37	37	37	37	37
Control units	37	37	37	37	37	37
# of obs	7738	7738	7738	7738	7738	7738
Panel B: Spot(Treated)-Spot(Control)						
Treated × Fee	-0.002	-0.002	-0.001	**0.123**	0.112	0
	(-0.40)	(-0.29)	(-0.04)	(2.29)	(1.89)	(-0.60)
R^2	0.03	0.05	0.08	0.46	0.48	0.03
Treated units	37	37	37	37	37	37
Control units	36	36	36	36	36	36
# of obs	8208	8208	8193	8208	8208	8207

Event 2, Liquidity impact

	Spread	IC_{25k}	IC_{250k}	1Dpth	5Dpth	illi
Panel A: SSF-Spot(treated)						
Treated × Fee	-0.004	-0.001	0.017	**-0.133**	-0.094	
	(-0.494)	(-0.110)	(1.654)	(-2.623)	(-1.714)	(1.764
R^2	0.32	0.24	0.09	0.71	0.62	0.0
Treated	47	47	47	47	47	4
Control units	47	47	47	47	47	4
# of obs.	9030	9030	9030	9030	9030	903
Panel B: Spot(treated)-Spot(control)						
Treated × Fee	0	0	0	0.054	0.036	
	(0.037)	(0.067)	(0.003)	(0.959)	(0.609)	(-0.184
R^2	0.380	0.230	0.160	0.490	0.420	0.06
Treated units	47	47	47	47	47	4
Control units	45	45	45	45	45	4
# of obs.	10233	10233	10223	10233	10233	1023

Event 1, Efficiency impact

	σ_r	$\sigma_{\mathrm{IC},25k}$	$\sigma_{\mathrm{IC},250k}$	$\lvert VR-1\rvert$
Panel A: SSF-Spot(Treated)				
Treated × Fee	**-6.038**	**-0.052**	**-0.043**	-0.005
	(-3.80)	(-5.72)	(-4.26)	(-0.64)
R^2	0.35	0.27	0.19	0.02
Treated units	37	37	37	37
Control units	37	37	37	37
# of obs	7738	7738	7738	7730
Panel B: Spot(treated)-Spot(control)				
Treated × Fee	**4.157**	-0.025	-0.012	-0.008
	(2.47)	(-1.02)	(-1.02)	(-1.13)
R^2	0.24	0.040	0.07	0.01
Treated units	37	37	37	37
Control units	36	36	36	36
# of obs	8203	8208	8192	8135

Event 2, Efficiency impact

	σ_r	$\sigma_{\mathrm{IC},25k}$	$\sigma_{\mathrm{IC},250k}$	$\lvert VR-1\rvert$
Panel A: SSF-Spot(treated)				
Treated × Fee	**-6.066**	**0.017**	**0.022**	-0.014
	-3.185	2.017	2.297	-1.561
R^2	0.30	0.15	0.02	0.03
Treated units	47	47	47	47
Control units	47	47	47	47
# of obs.	8964	9030	9030	8782
Panel B: Spot(treated)-Spot(control)				
Treated × Fee	**-2.355**	0.005	**0.029**	0.012
	-1.996	0.823	2.796	1.637
R^2	0.22	0.04	0.03	0.02
Treated units	47	47	47	47
Control units	45	45	45	45
# of obs.	10233	10233	10218	10226

Summary

- What was the impact of the fee on the OTR?
  Event 1 was effective in reducing the OTR – both the measures are lower for the futures.
  It is higher for the underlying spot compared to their control, which suggests that trading shifted.
  (Yet to be done: what happened to the volumes at BSE?)

Summary

- What was the impact of the fee on the OTR?
  Event 1 was effective in reducing the OTR – both the measures are lower for the futures.
  It is higher for the underlying spot compared to their control, which suggests that trading shifted.
  (Yet to be done: what happened to the volumes at BSE?)
  Event 2 was not as effective: the averages appear untouched; some evidence that it increased.
  Preliminary research suggests that it may have increased at the touch but decreased away from the touch *rightarrow* design of the fee.

Summary, contd.

- What was the impact of the fee on the market liquidity?
  Event 1 led to reduced liquidity – higher impact cost for all sizes.
  Event 2 had little impact. The only place where any evidence shows up is in the depth at the touch.

Summary, contd.

- What was the impact of the fee on the market liquidity?
  Event 1 led to reduced liquidity – higher impact cost for all sizes.
  Event 2 had little impact. The only place where any evidence shows up is in the depth at the touch.
- What was the impact of the fee on market efficiency?
  Event 1 led to reduced liquidity risk as volatility of the impact cost. (Cautionary note: volatility in the market was higher in the period after the fee was imposed.)
  Event 2 had little impact. Some evidence that the liquidity risk has increased at the *higher order sizes*. Has the liquidity become less stable at higher orders?

Next steps

Research question going forward

- Analyse the impact of the fee for the 2010 and the 2013 event as well.
  Does the market behave as expected?
- Link the higher levels of AT in the 2012 and 2013 to how we should think about the impact of fee on market quality.
- Shift explicitly to behaviour of traders when there is regulatory intervention.
  How does this response change when there is clarity of the regulatory objective vs. not?

Thank you

Comments / Questions?

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