Market quality in the time of algorithmic trading

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The problem

- Since 2000, escalating use of technology in trading on equities markets.
- AT now dominates exchanges worldwide. Concerns about reduced liquidity, ‘flash crashes’, etc.
- Regulators all over the world are contemplating interventions on AT.
- In search of finding a market failure that justifies regulatory intervention, numerous researchers have asked: What is the effect of AT on liquidity and volatility?
- Main findings: AT generally lowers transactions costs. AT may or may not improve depth. AT may or may not lower volatility.
- Weaknesses of this literature.

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Solving the weaknesses of the literature

A design that solves the weaknesses of the literature:

1. *Clean microstructure*: An exchange with 80% market share of all trading, one of the largest exchange in the world by transaction intensity.
2. *An exogenous event*: Introduction of co-location services in Jan 2010, which was followed by an S-curve of adoption.
3. *Recording data well*: Perfect data with every order tagged as “AT” or “non-AT” for every security at the exchange.

Methodology

- Use the AT flag on the orders and trades to measure the AT intensity, both security specific and market average.
- Use the introduction of co-location services (CO-LO) – January 2010 – to divide the time period into low and high AT-INTENSITY periods.
- Pick a sample of one month from the period of low and from the high AT-INTENSITY as the LOW-AT and HIGH-AT samples.
- The difference between the market quality in the HIGH-AT and LOW-AT samples can be attributed to the rise of AT.
- Control for changes in other things such as macroeconomic conditions.

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What we find

- AT-INTENSITY in the market rose significantly after the introduction of co-lo *but* stabilised with a significant lag.
- On average, the intra-day market quality measures
  - Improved: transactions costs (spread, impact cost), risk (intraday volatility, volatility of impact cost).
  - Worsened: depth (either as value or as number of shares) available for trade, order imbalance.

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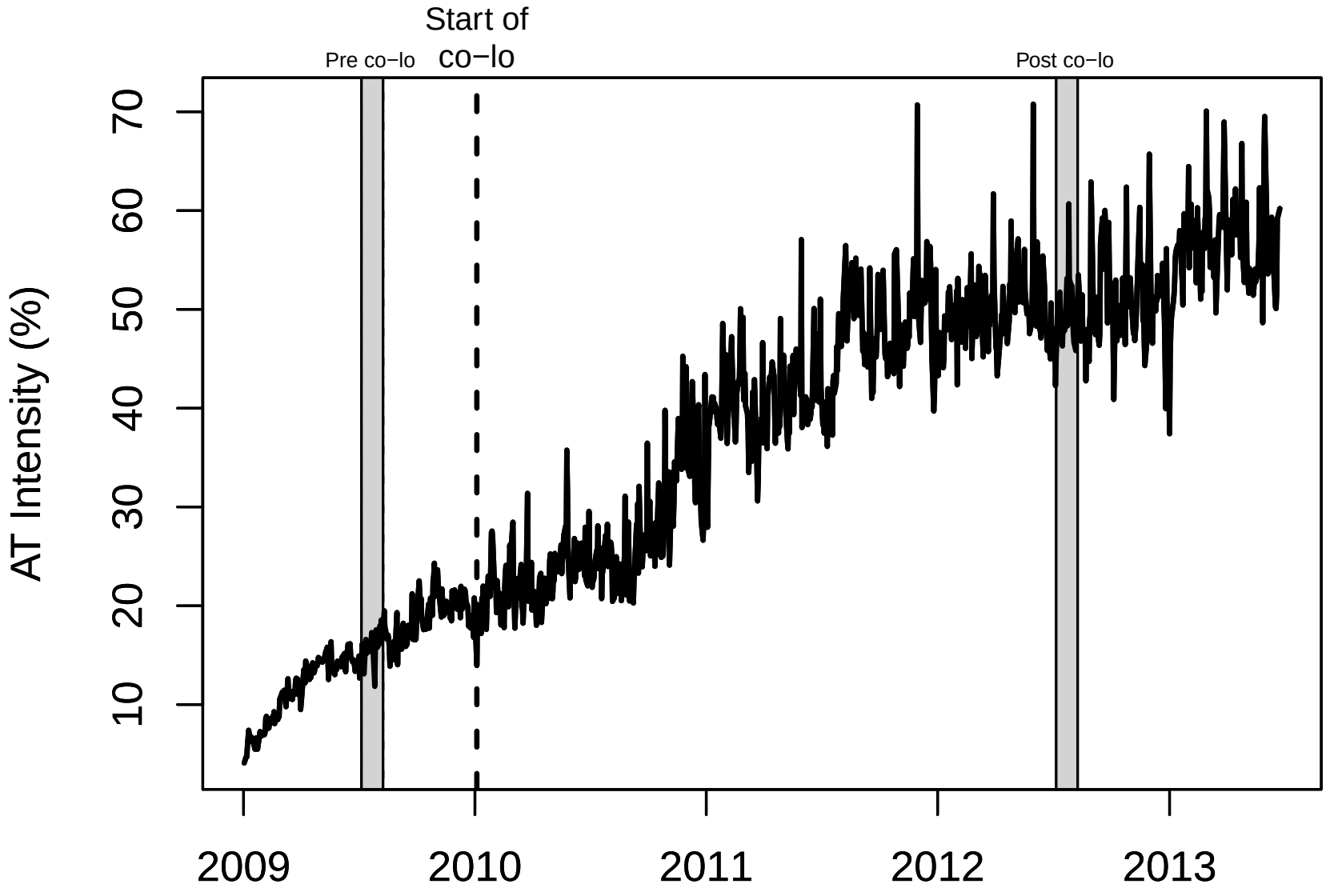
Implementation details

Data

- Period:
  - Pre co-lo: Jan '09 to Dec '09
  - Post co-lo: Jul '12 to Aug '13
- Sample of stocks: CNX100 (as in 2012)
- Sample period analysed: (One month sample)
  - LOW-AT PERIOD: Jul 6, 2009 to Aug 8, 2009 (23 trading days)
  - HIGH-AT PERIOD: Jul 6, 2012 to Aug 8, 2012 (25 trading days)
- Frequency used: Tick by tick.
- Data Source: NSE, India

AT intensity between 2009-13



Concentration of AT across stocks

Market quality measures

- Liquidity
  1. Transactions costs
     - 1.1 QSPREAD (in %): (Best Ask Price - Best Sell Price)$\times$ 100 / Mid-quote price.
     - 1.2 IC (%): at the transaction size of Rs 25,000.
  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.
     - 2.4 |OIB| (in %): Difference in buy and sell side depth as a percentage of the total depth, on average.
- Volatility
  1. LRISK: Standard deviation of IC in five-minutes interval.
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Methodology

- Identify an exogenous event that affected AT intensity in the markets: co-location facilities.
- Two approaches:
  1. Comparative analysis of average levels of market quality variables in the LOW-AT and HIGH-AT period.
  2. Cross sectional analysis using fixed effects model (Model 1):

$$\text{MKT-QUALITY}_{i,t} = \alpha_i + \beta_1 \text{AT-INTENSITY}_{i,t-1} + \beta_2 \text{COLO-DUMMY}_t + \epsilon_{i,t}$$

where 't' = 1...T indexes of five minute time intervals

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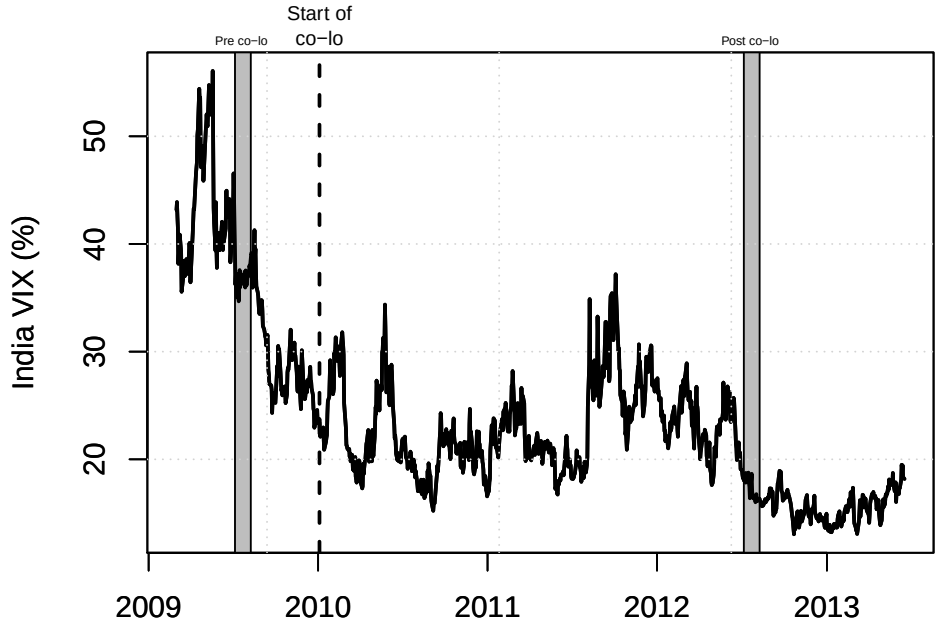
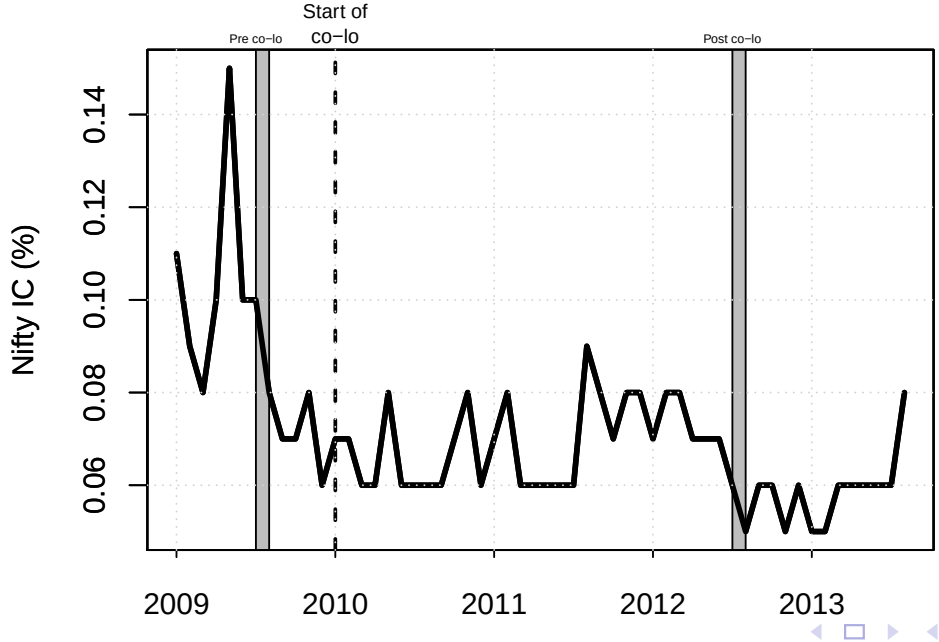
Threats to validity





How to control for the changes in macroeconomic conditions?

1. Regression based approach:

$$\begin{aligned}\text{MKT-QUALITY}_{i,t} &= \alpha_i + \beta_1 \text{CO-LO-DUMMY}_t + \beta_2 \text{AT-INTENSITY}_{i,t-} \\ &\quad + \beta_3 \text{NIFTY-VOL}_t + \epsilon_{i,t}\end{aligned}$$

   where $\text{NIFTY-VOL}_{i,t}$ is the variance of five-minute returns on the market index.

2. Matched sample approach:
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   - Matched Sample: 41 dates in each period.

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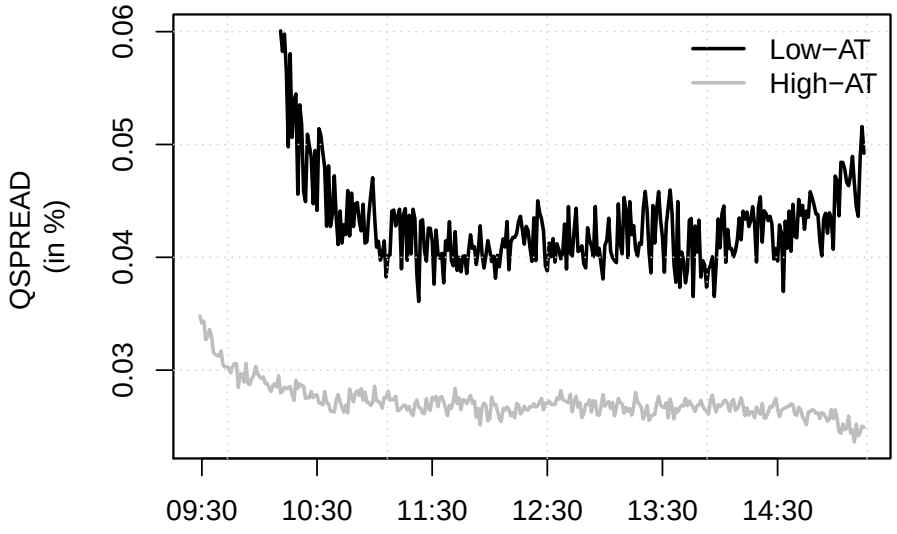
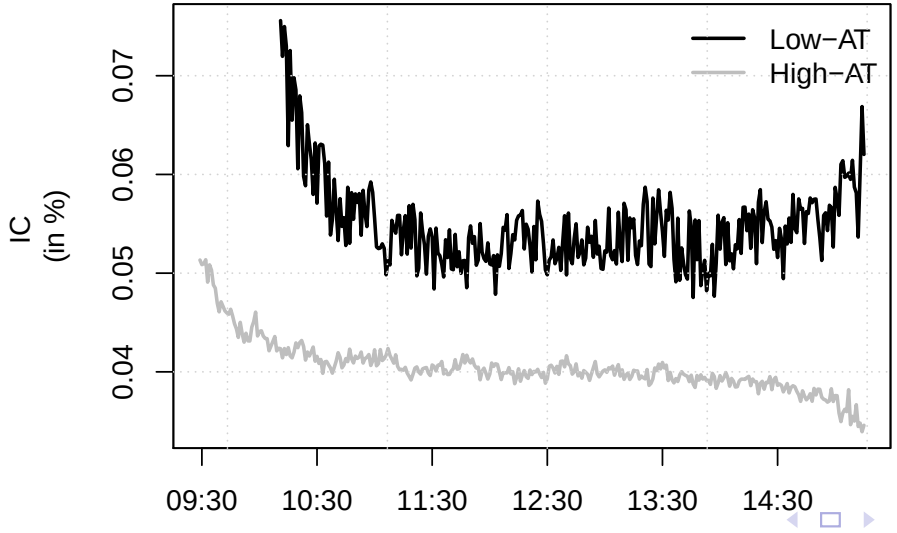
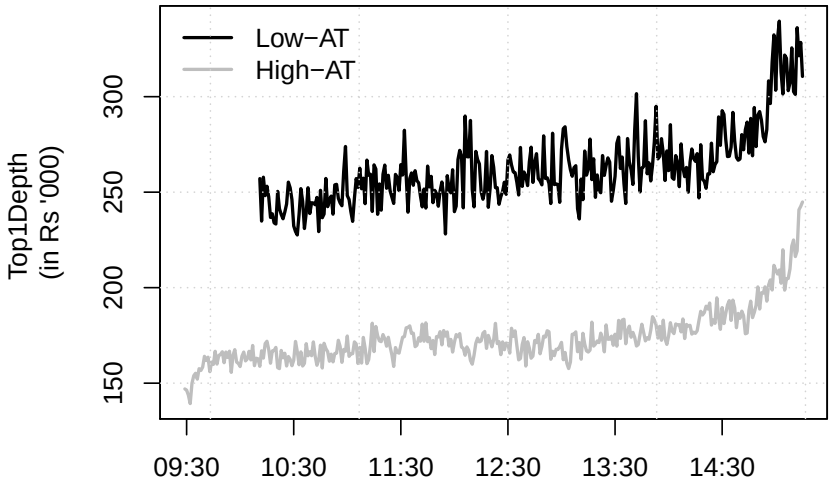
Results

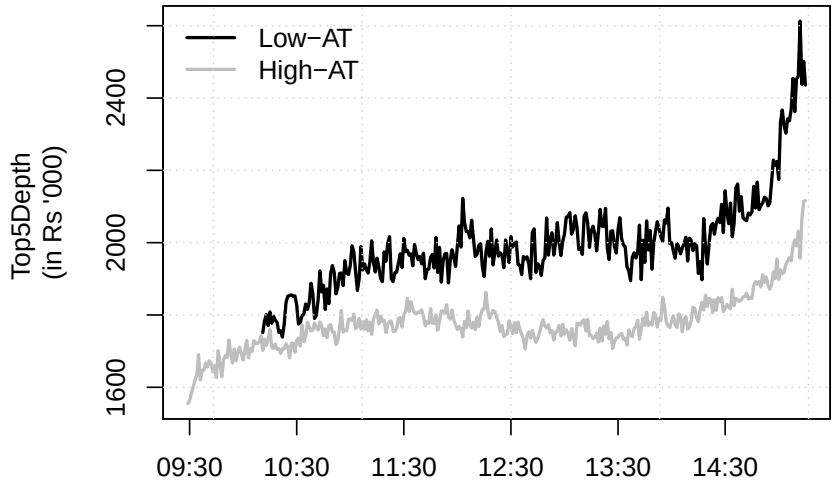
Comparing liquidity costs in the HIGH-AT & LOW-AT sample

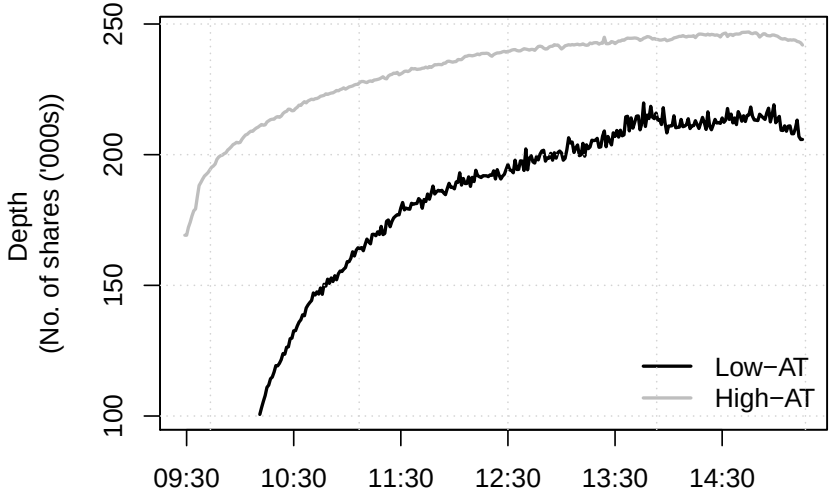


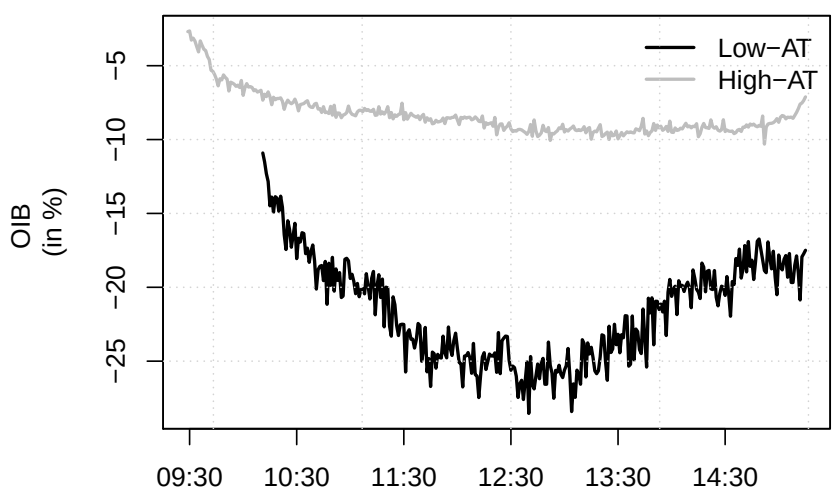


Depth behavior in the HIGH-AT & LOW-AT period









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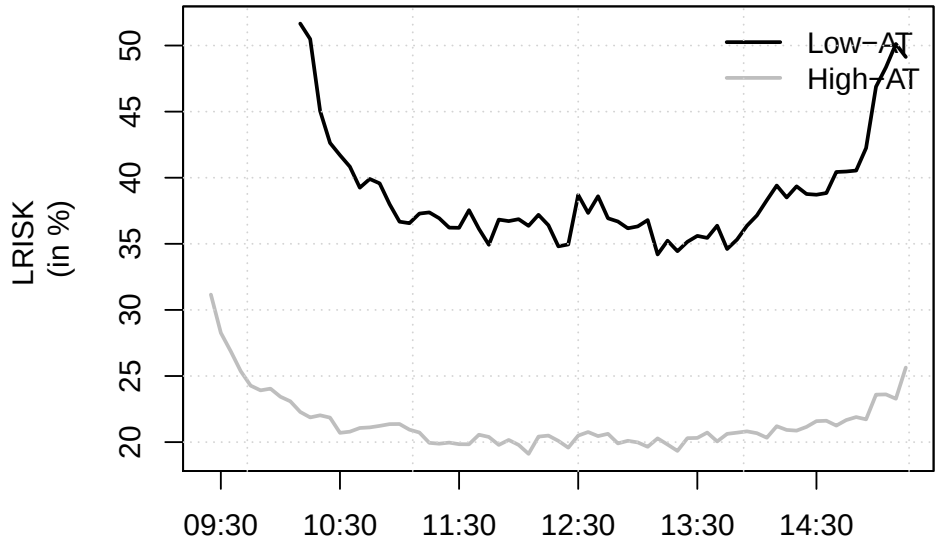

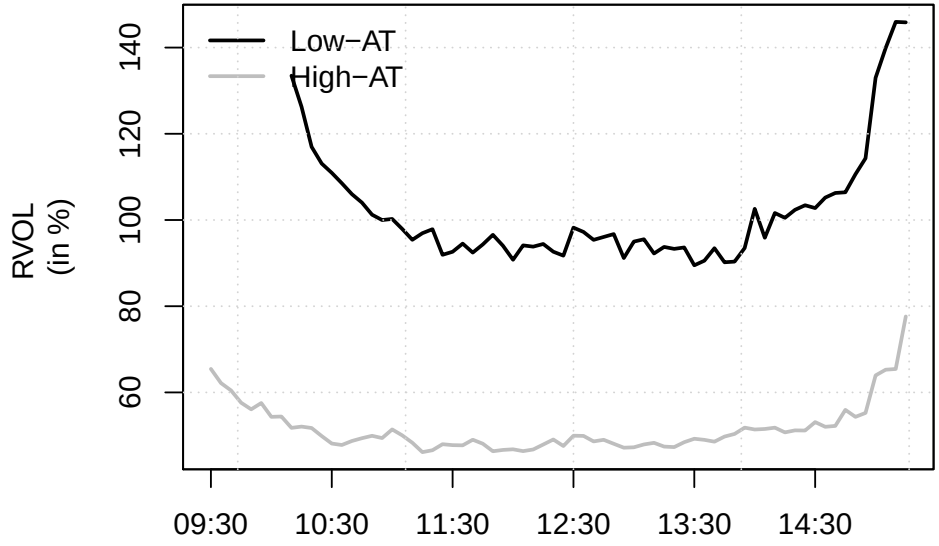

Results: Effect of AT on market quality variables

$$\text{M1}: \text{MKT-QUALITY}_{i,t} = \alpha_i + \beta_1 \text{AT-INTENSITY}_{i,t-1} + \beta_2 \text{CO-LO-DUMMY}_t + \epsilon_{i,t}$$

Panel A: Transactions costs and Rupee depth				
	QSPREAD	IC	TOP1DEPTH	TOP5DEPTH
AT-INTENSITY	-0.01^{+}	-0.01^{+}	-0.09^{+}	-0.17^{+}
	(0.00)	(0.00)	(0.02)	(0.01)
CO-LO-DUMMY	-0.01^{+}	-0.01^{+}	-0.81^{+}	-0.46^{+}
	(0.00)	(0.00)	(0.01)	(0.01)
$Obs.$	315,115	315,115	315,115	315,115
R^2	0.10	0.07	0.24	0.15
Panel B: Depth and Volatility				
	DEPTH	|OIB|	LRISK	RVOL
AT-INTENSITY	0.10^{+}	4.54^{+}	-0.001**	-5.15^{+}
	(0.01)	(0.49)	(0.000)	(1.12)
CO-LO-DUMMY	0.35^{+}	-30.18^{+}	-0.01^{+}	-46.40^{+}
	(0.01)	(0.96)	(0.00)	(1.77)
R^2	0.18	0.26	0.20	0.26

Dealing with threats to validity

$$\text{M1}: \text{MKT-QUALITY}_{i,t} = \alpha_i + \beta_1 \text{AT-INTENSITY}_{i,t-1} + \beta_2 \text{CO-LO-DUMMY}_t + \epsilon_{i,t}$$

$$\text{M4}: \text{MKT-QUALITY}_{i,t} = \alpha_i + \beta_1 \text{AT-INTENSITY}_{i,t-1} + \beta_2 \text{CO-LO-DUMMY}_t + \beta_3 \text{NIFTY-VOL}_t + \beta_4 \text{INTRADAY-DUMMY}_t + \beta_5 \text{LTP}_{i,t} + \epsilon_{i,t}$$

	Value of $\hat{\beta}_1$			
	One month sample		Matched sample	
	M1	M4	M1	M4
QSPREAD	-0.01^{+}	-0.01^{+}	-0.02^{+}	-0.02^{+}
IC	-0.01^{+}	-0.01^{+}	-0.02^{+}	-0.02^{+}
TOP1DEPTH	-0.09^{+}	-0.10^{+}	-0.08^{+}	-0.10^{+}
TOP5DEPTH	-0.17^{+}	-0.17^{+}	-0.12^{+}	-0.13^{+}
DEPTH	0.10^{+}	0.12^{+}	-0.04^{+}	0.021
OIB	4.54^{+}	4.91^{+}	1.45^{+}	2.02^{+}
RVOL	-5.15^{+}	-2.56^{+}	-17.23^{+}	-12.44^{+}
LRISK	-0.001**	-0.00	-0.003^{+}	-0.002^{+}

Conclusion

- The world has shifted from manual to computer-supported trading in a stunningly short time
- A major new phenomenon that requires analysis
- All the regulators of the world are interested
- Numerous existing papers, but three flaws: (a) Fragmented microstructure (b) Endogenous adoption of AT and (c) Lack of underlying data infrastructure.
- Our research design solves these three problems, and reports on one of the biggest exchanges of the world by order intensity.
- Matching-based strategy that controls for changes in macroeconomic conditions.
- Main result: AT is good for market quality but depth visible goes down.

Thank you

Comments / Questions?

http://www.ifrogs.org/