

# CAPITAL MARKETS, TRADING, AND TECHNOLOGY

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**SAINT LOUIS  
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— EST. 1818 —

# INTRODUCTION

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# INTRODUCTION

Bidisha Chakrabarty

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Meds & Food For Kids

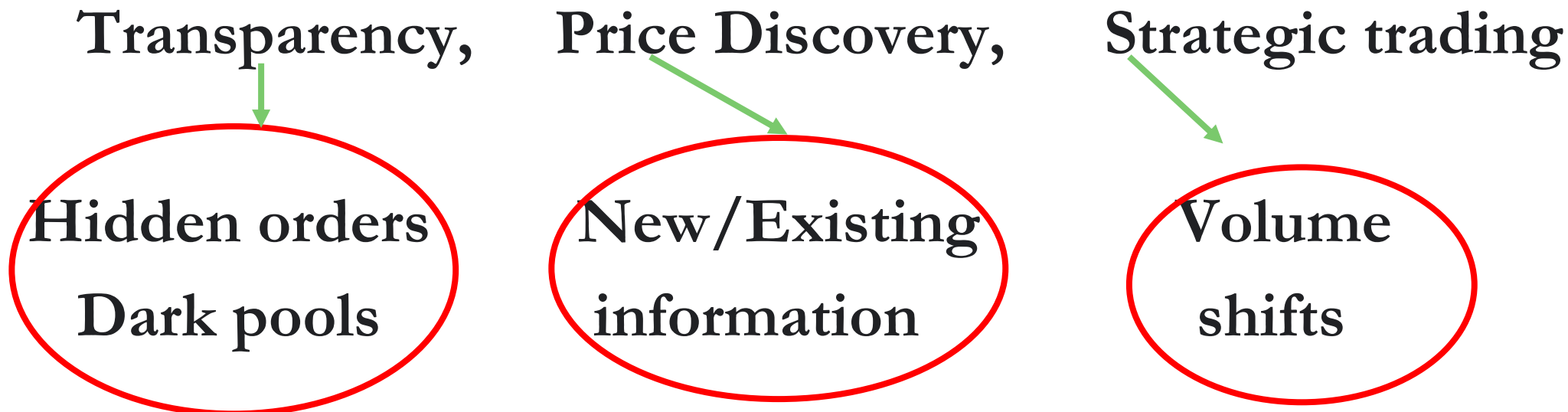


# CAPITAL MARKETS, TRADING, AND TECHNOLOGY

- **Financial markets**
  - **Bring buyers and sellers together (trading)**
- **To trade financial assets (assets traded)**
  - **stocks, bonds, currencies, derivatives, other financial assets**
- **Transparency, Price Discovery / Market Structure, Strategic trading**

# CAPITAL MARKETS, TRADING, AND TECHNOLOGY

- **Financial markets**
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  - stocks, bonds, currencies, derivatives, other financial assets



# DESIGN OF CAPITAL MARKETS

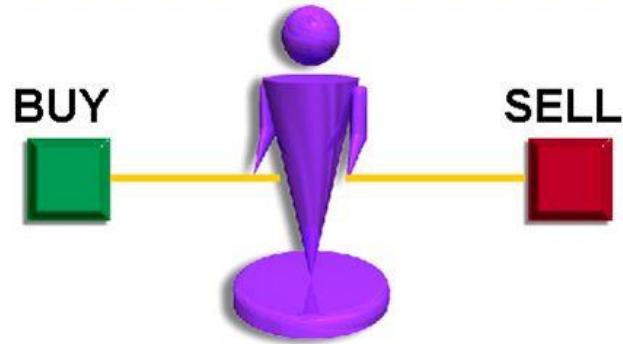
Two main forms

1. Intermediaries to facilitate trading - NYSE – prior to 2007
2. Completely electronic – NSE, Nasdaq
3. **Then** there is a hybrid form (mix of 1 and 2 above) – NYSE now

# INTERMEDIARIES IN ALL TRADES – THE SPECIALIST MODEL

## NYSE specialists

### Auction Market Model



- ▶ Floor-based
- ▶ Single Specialist
- ▶ Order-driven
- ▶ Capital commitment limited to one firm
- ▶ Trade halts for volume imbalances

# THE SPECIALIST MODEL – RESEARCH EVIDENCE

## NYSE specialists

Relationships **mitigate asymmetric information**; **lean against the wind**

Dealers facilitate **better price discovery** at the open compared to auctions

Adjustment **lags in inventories** vary across stock

**Mean reversion** sometimes take **weeks/months** (positive autocorrelations)

Main source of **specialist profits** (**very high**, see seat prices) is **short term**

Trades with specialist participation have **higher impact on quotes**

Advent of **automated trading technology** and **Reg NMS**



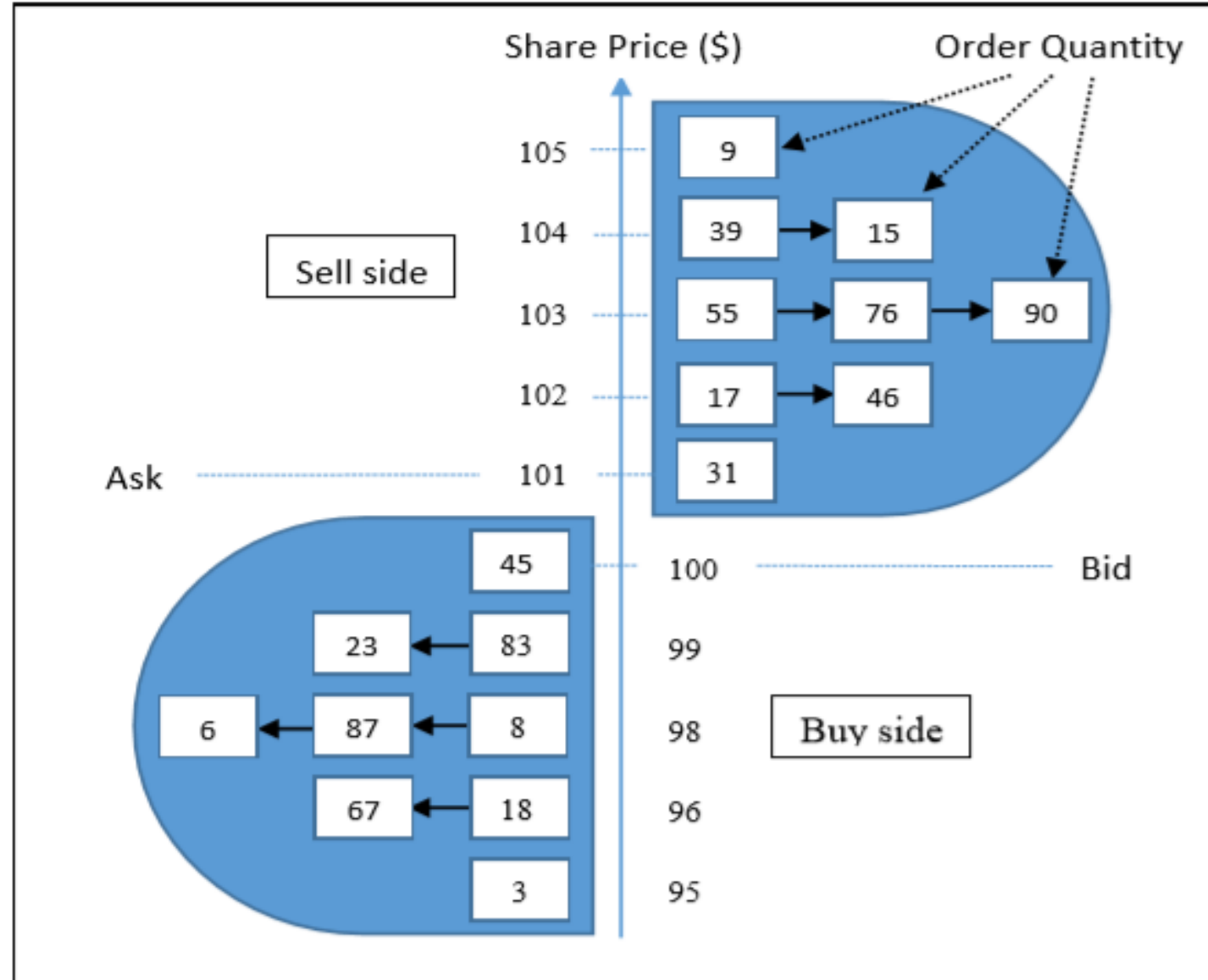
# COMPLETELY ELECTRONIC – THE NSE/NASDAQ MODEL

## Automated limit order book

Ask or sell orders upper half

Bid or buy orders lower half

There may be market makers but no affirmative obligations (Nasdaq)



# COMPLETELY ELECTRONIC – THE NSE/NASDAQ MODEL

## Automated limit order book

Bid ask spread = \$1

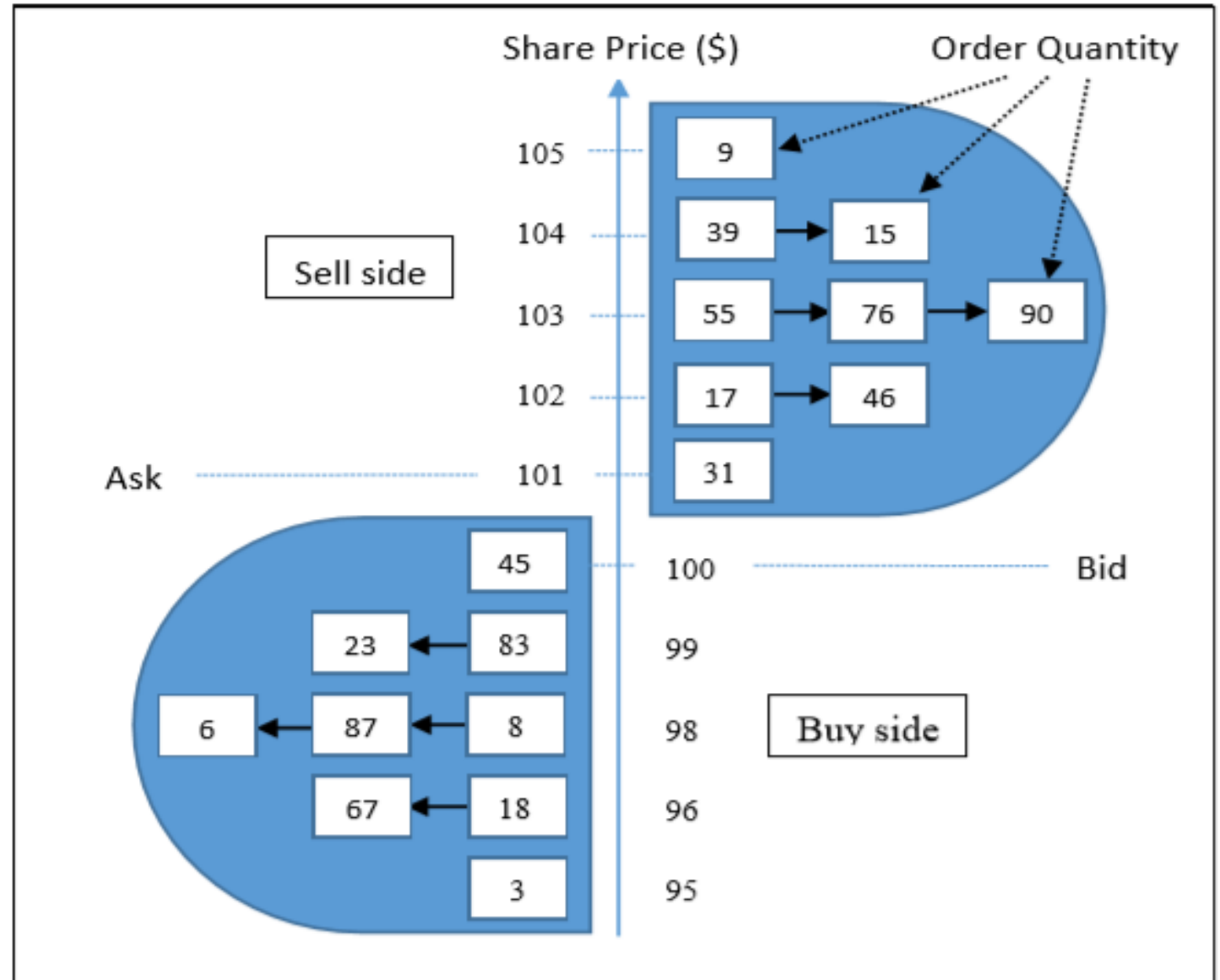
Best ask depth is 31 shares

Best bid depth is 45 shares

Exchange's goal

-Reduce spread

-Increase depth



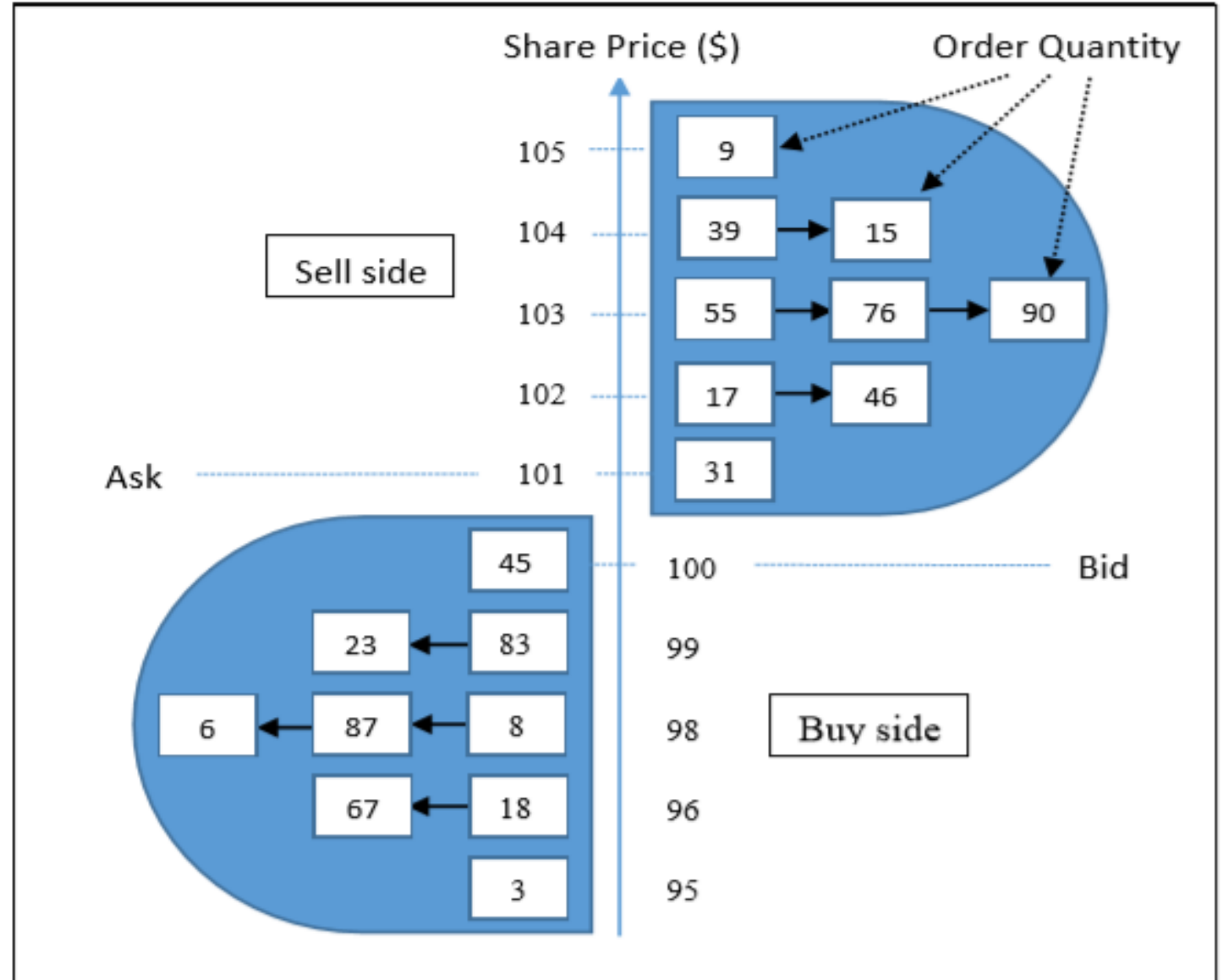
# COMPLETELY ELECTRONIC – THE NSE/NASDAQ MODEL

## Automated limit order book

**Price-Time** priority =>

83 shares buy limit order at \$99 was entered before the 23 shares buy order also at \$99 limit price

Likewise on the ask side



# COMPLETELY ELECTRONIC – THE NSE/NASDAQ MODEL

Automated limit order book

Price-Display-Time priority =>

**DISPLAY?**

On the NSE

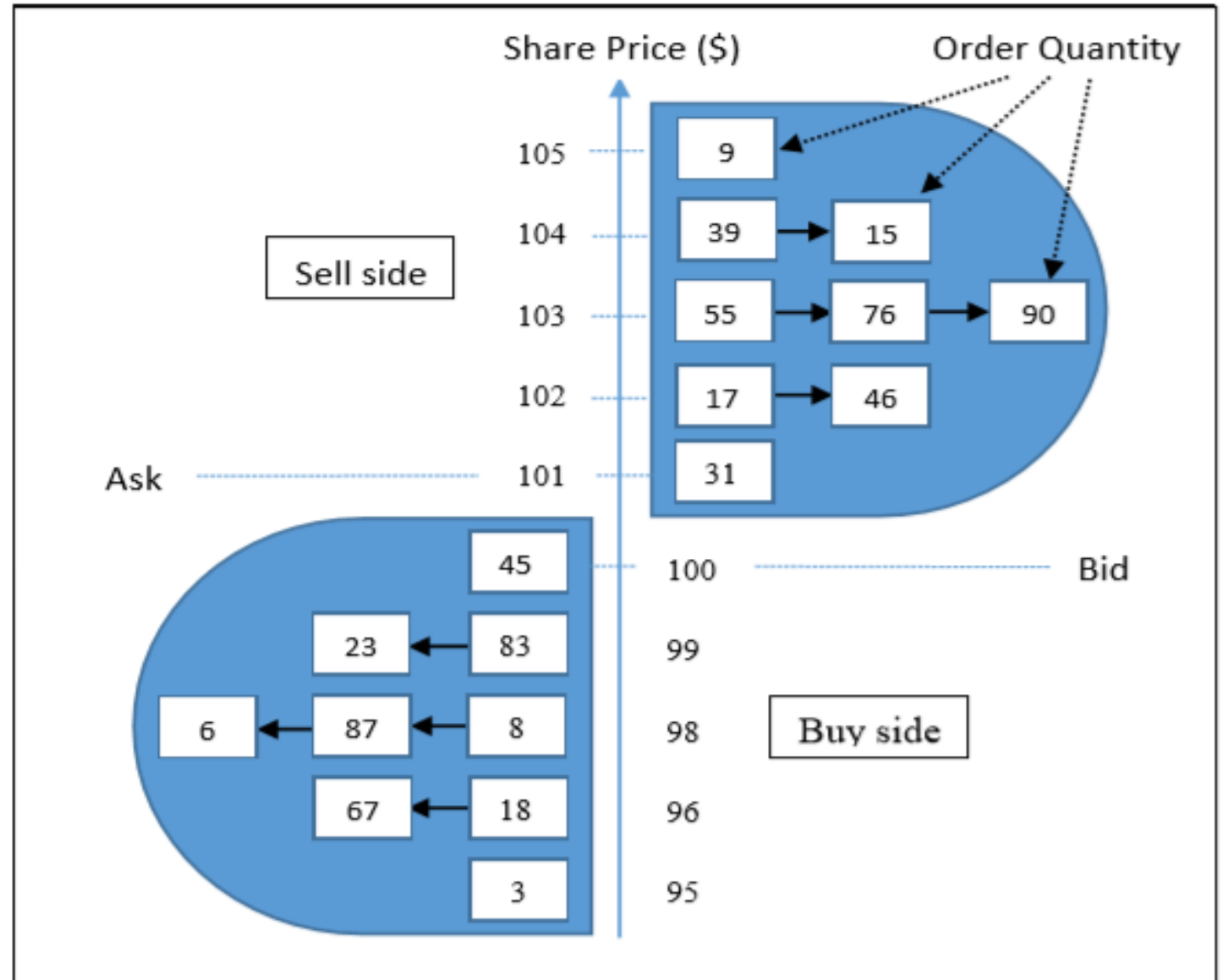
Best ask depth may be up to 310

Best bid depth may be up to 450

Allows iceberg orders

10% minimum display size

NASDAQ different



# HYBRID – MARKET MAKERS PLUS ELECTRONIC (NYSE NOW)

Automated limit order book

+

DMMs

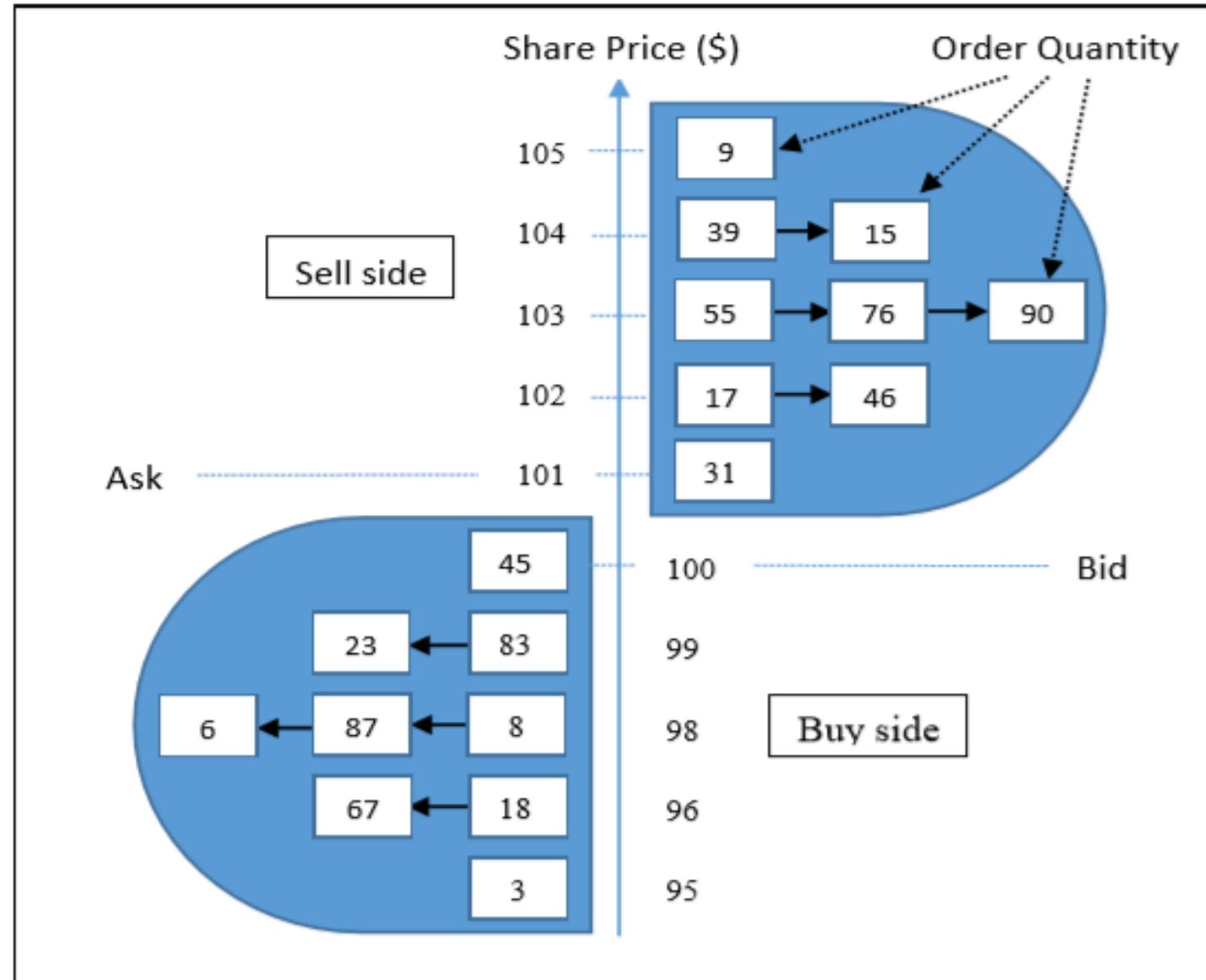
If spreads increase a lot

+

Depth falls

DMMs step in (**contractual**)

Most markets rely on **ELPs**



## EVIDENCE ON ELPs

- Brogaard, Hendershott, Riordan (2014, 2019) – ELPs increase price efficiency
- Anand and Venkataraman (2015) – MMs scale back in unfavorable markets
- Kirilenko et al. (2017) – liquidity withdrawal (Flash Crash)
- Brogaard et al. (2019) – different for single vs. multiple stocks
- Joseph-Clark and Ye (2017) – Trading glitch, DMM improve liquidity
- Bessembinder et al. (2020) – Positive externality of DMMs

# MY CURRENT RESEARCH – JUMP/Sync measures new info in prices

➤ Enhanced DMM obligations ↑ price informativeness at EAs.

## JUMP

	Bandwidth			
	CCT Optimal Bandwidth	0.2 Million Shares	CCT Optimal Bandwidth	0.2 Million Shares
	<i>JUMP [-11,1]</i>		<i>JUMP [-21,1]</i>	
<i>DMM</i>	-0.193** (-2.35)	-0.216** (-2.24)	-0.200* (-1.97)	-0.198* (-1.89)
<i>Controls, FFE, YMFE</i>	Yes	Yes	Yes	Yes
Economic Effect	31.12%	46.51%		

## Synchronicity

	Bandwidth			
	CCT Optimal Bandwidth	0.2 Million Shares	CCT Optimal Bandwidth	0.2 Million Shares
	<i>Synch [-11,1]</i>		<i>Synch [-21,1]</i>	
<i>DMM</i>	-0.332*** (-3.80)	-0.291*** (-2.70)	-0.197*** (-2.66)	-0.193** (-2.31)
<i>Controls, FFE, YMFE</i>	Yes	Yes	Yes	Yes
Economic Effect	28.25%	17.88%		

# TT TRADER TYPES on NSE

- Recall the limit order book (LOB) of the exchange

Depending on how traders interact with the LOB of the exchange, classify:

	“Client account”	
“Order entry mode”	Proprietary	Agency
Algorithmic trader (AT)	High-frequency traders ( <b>HFTs</b> )	Agency Algorithmic Traders ( <b>AATs</b> )
Non-AT	Non-algorithmic traders ( <b>NATs</b> )	

- Algorithmic order entry for prop trading = SEC definition of HFT



# AGENCY AT

- Offered by brokers / software developers to their “buy-side” clients **to minimize the costs** of implementing changes in their investment portfolios.
- **Algos implement** but do not take the trading decisions.
- Their success **does not depend on speed**; clients have long investing (or holding) horizons
- Use historical estimates, do not require much **real-time input**.

# PROPREITARY AT OR HFT

**Banks and sell-side institutions** - Algos to trade on their **own account**  
(e.g., Goldman Sachs, JP Morgan, Citigroup)

## **Hedge Funds**

(e.g., Citadel, Renaissance, D.E. Shaw, SAC, Worldquant, Millenium, etc.)

## **“Pure-play” proprietary AT → HFT**

KCG, Citadel, Virtu, Flow Traders, Jump Trading, Getco, Tradebot, IMC, Optiver, Sun Trading, QuantLab, Tibra, Allston Trading, Infinitum, Capital Management, Hudson River Trading, etc.

# HFT OR PURE PLAY PROP AT

## HFTs

### 1. Varied strategies

market making

opportunistic

arbitrage, directional

# HFT OR PURE PLAY PROP AT

## Proprietary AT

1. Varied strategies

2. Short-lived profit opportunities:

sub-second duration; not exploitable by humans → speed is the “key to their success”

Speed on NSE measured in jiffies (65,536) → seq number within jiffy 😊

# HFT OR PURE PLAY PROP AT

## **Proprietary AT**

- 1. Varied strategies**
- 2. Short-lived profit opportunities**
- 3. Low latency technology and services**

High-speed technology and ultra-fast sophisticated computer programs for generating, routing and executing orders

Very fast/direct access to trading platforms [...] and market information

# HFT OR PURE PLAY PROP AT

## Proprietary AT

1. Varied strategies
2. Short-lived profit opportunities
3. Low latency technology and services:
4. Trading (rather than investing) horizon:
  - Very short-time frames for establishing and liquidating positions
  - Always trading in small quantities
  - Ending the trading day with close-to-zero inventory

# HFT OR PURE PLAY PROP AT

## Proprietary AT

1. Varied strategies
2. Short-lived profit opportunities
3. Low latency technology and services
4. Trading (rather than investing) horizon
- 5. Intensive message traffic** (high message-to-trade ratios):
  - Intensive order monitoring (risk management)
  - Submission of numerous orders cancelled shortly after submission
  - Large message-to-trade and cancellation-to-trade ratios

# HFT OR PURE PLAY PROP AT

## Proprietary AT

2. Short-lived profit opportunities

4. Trading (rather than investing) horizon

1. Varied strategies

3. Low latency technology and services

5. Intensive message traffic

## 6. Trading in liquid assets:

- Ease of trading (immediacy, lower inventory-risk, lower information asymmetries)
- High liquidity (low implicit costs/ high depth) -- profits per trade are low
- Trading is more fragmented (+ profit opportunities)
- Do not invest in OTC-traded assets (like corporate bonds)



# HFTs ON THE NSE (INDIA)

Name	HQ	Name	HQ
WorldQuant LLC	USA	Estee Advisors	INDIA
Tower Research	USA	Two Roads Tech	INDIA
Goldman Sachs	USA	Acceletrade Technologies	INDIA
Morgan Stanley	USA	Dolat Group	INDIA
Alphagrep	INDIA	Edelweiss	INDIA
iRageCapital	INDIA	Futures First	INDIA
Quadeye Securities	INDIA	Samssara Capital Technologies	INDIA
APT Portfolios	INDIA	QuantAI Capital	INDIA
Graviton Research	INDIA	Wallsoft	INDIA

# SOME CHARACTERISTICS OF HFTs ON THE NSE

Metric	Trader type		
	HFT	AAT	NAT
<i>Mess</i>	654.08 (405.44)	204.12 *** (86.16)	55.76 *** (38.29)
<i>Can</i>	16.51 (10.23)	17.27 (7.76)	2.10 *** (1.43)
<i>MonInt</i>	293.18 (192.78)	61.62 *** (29.73)	6.87 *** (5.82)
<i>FleetOrd</i>	82.24 (58.93)	26.89 *** (12.20)	6.46 *** (4.46)
<i>QuoteInt</i>	137.91 (80.81)	88.84 *** (30.74)	36.72 *** (22.56)
<i>Flick(x1000)</i>	4.30 (4.55)	2.16 ** (1.69)	1.07 *** (0.75)
<i>SResp</i>	38.27 (36.87)	11.93 *** (8.81)	0.55 *** (0.42)
<i>SRuns</i>	10.49 (9.39)	0.51 *** (0.44)	0.02 *** (0.03)
<i>IOC</i>	10.85 (6.51)	8.05 ** (3.75)	0.17 *** (0.11)

Measures based on NSE data to identify HFT

Data: May – July 2015

Nifty 50 stocks

Source: Chakrabarty, Comerton-Forde, and Pascual (2022)

# MOTIVATION (HFT VS AT)      VERSUS      TECHNOLOGY (AT VS NAT)

Source: Chakrabarty, Hendershott, Nawn, and Pascual (2022)

Data Source: NSE

Panel B: Message traffic per traders' technology and motivation				
Variable	Technology		Motivation	
	ATs	NATs	HFTs	AATs
MT	1226.72	37.09 ***	1098.98	127.74 ***
MT/Trd	69.67	2.31 ***	233.31	23.47 ***
CAN/Trd	3.08	0.25 ***	9.55	1.90 ***
Share in MT	82.68	17.32 ***	56.41	26.27 ***

# RISE OF HFT IN INDIA

- > 50% of the trading volume in NSE is contributed by algorithmic trading.
- HFT accounted for 10–30% of trading volume during 2010–15.
- HFT accounted for around Rs.8,000 cr of volume daily between 2010–15.
- ET: One (mid-sized) HFT 250 crore worth volume daily in 2021
- It is estimated that 80% of this profit was captured by three big HFT firms in India - Shaastra (Tower research), Alpha grep (Way2wealth), and Quadeye, more recently Virtu.

# HIDDEN ORDERS ON THE NSE – SOME STOCK MEASURES

Panel A: All stocks		Technology			Motivation		
Variable	Subs.	AT	NAT		HFT	AAT	
		Vol.	Vol.		Vol.	Vol.	
HLO (%)		14.19	30.88 ***		8.62	34.26 ***	
Share of DLO (%)		63.45	36.55 ***		55.18	8.28 ***	
Share of HLO (%)		33.98	66.02 ***		2.98	31.00 ***	
Panel B: 10 stocks with smallest relative tick size							
Relative use of		16.77	36.96 ***		10.99	41.60 ***	
Share of DLO (%)		77.51	22.49 ***		70.58	6.92 ***	
Share of HLO (%)		45.42	54.58 ***		4.83	40.59 ***	
Panel C: 10 stocks with highest volatility							
Relative use of		18.63	24.52 ***		14.20	29.54 ***	
Share of DLO (%)		46.69	53.31		36.08	10.60 ***	
Share of HLO (%)		25.43	74.57 ***		2.76	22.67 ***	
Panel D: 10 stocks with lowest incidence of tick constraint conditions							
Relative use of		22.24	33.20 ***		19.34	31.42 ***	
Share of DLO (%)		59.77	40.23 ***		52.72	7.04 ***	
Share of HLO (%)		25.95	74.05 ***		6.37	19.58 ***	

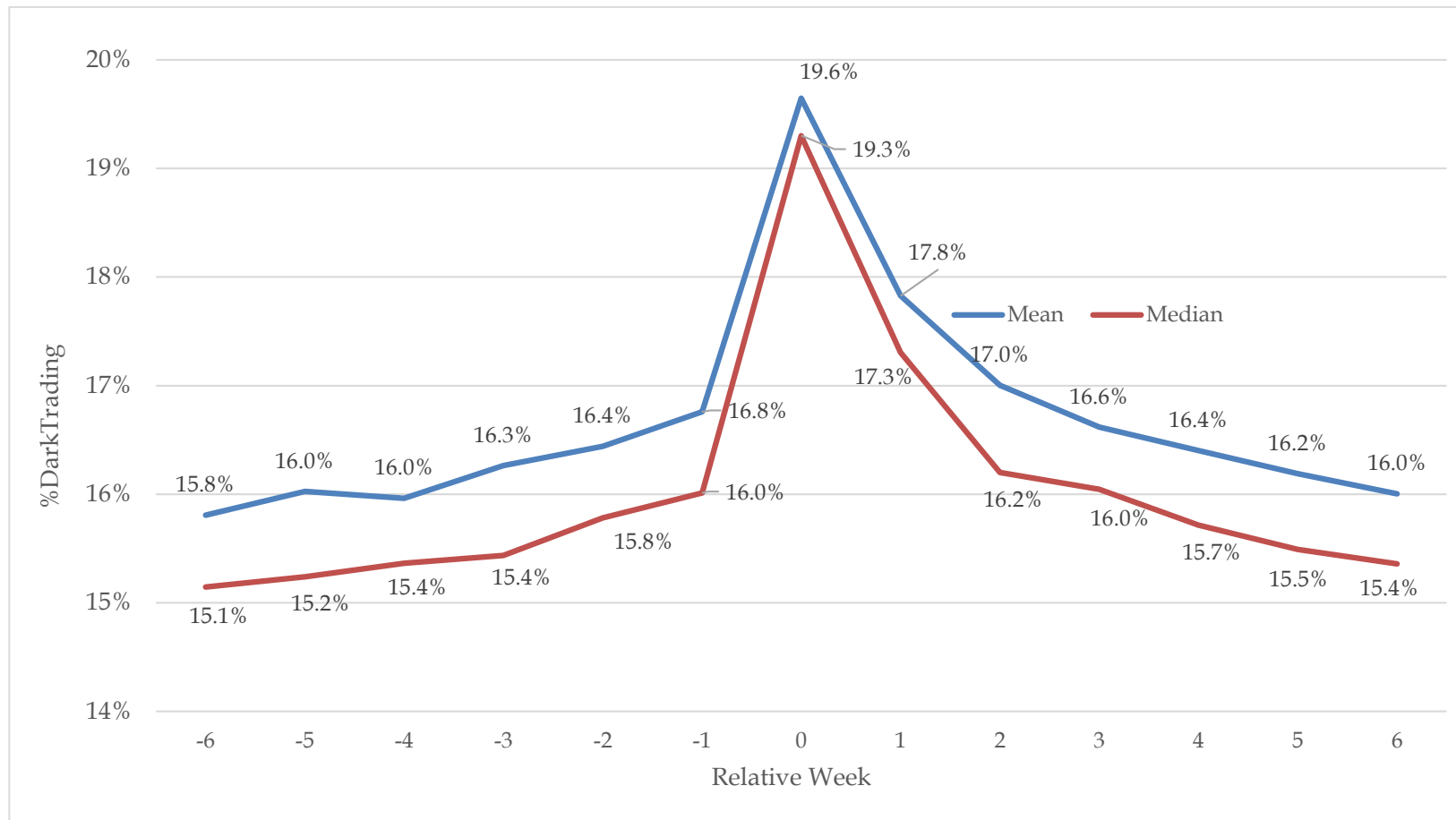
# HIDDEN ORDERS ON THE NSE – LOB PLACEMENT

Panel A: All stocks							
	Technology				Motivation		
	Volume placement				Volume placement		
Aggressiveness	ATs	NATs			HFTs	AATs	
Better	10.49	10.43			48.98	9.55	***
At	41.72	26.21	***		23.53	42.19	***
Near	30.22	27.27	**		24.36	30.46	***
Far	17.57	36.09	***		3.14	17.80	***
Panel B: 10 stocks with smallest relative tick size							
Better	15.53	13.14	**		50.89	14.08	***
At	42.56	15.67	***		19.75	43.51	***
Near	27.62	24.65	*		25.54	27.76	
Far	14.29	46.52	***		3.82	14.65	***
Panel C: 10 stocks with highest volatility							
Better	6.87	9.34	**		44.24	5.82	***
At	35.65	26.43	**		28.52	36.08	
Near	39.92	28.05	*		24.31	40.34	**
Far	17.55	36.18	***		2.93	17.76	**
Panel D: 10 stocks with lowest incidence of tick constraint conditions							
Better	20.04	20.86			52.26	16.39	***
At	33.06	12.86	***		17.24	35.18	***
Near	23.63	27.73			27.14	23.70	
Far	23.27	38.54	***		3.37	24.73	***

# DARK POOLS

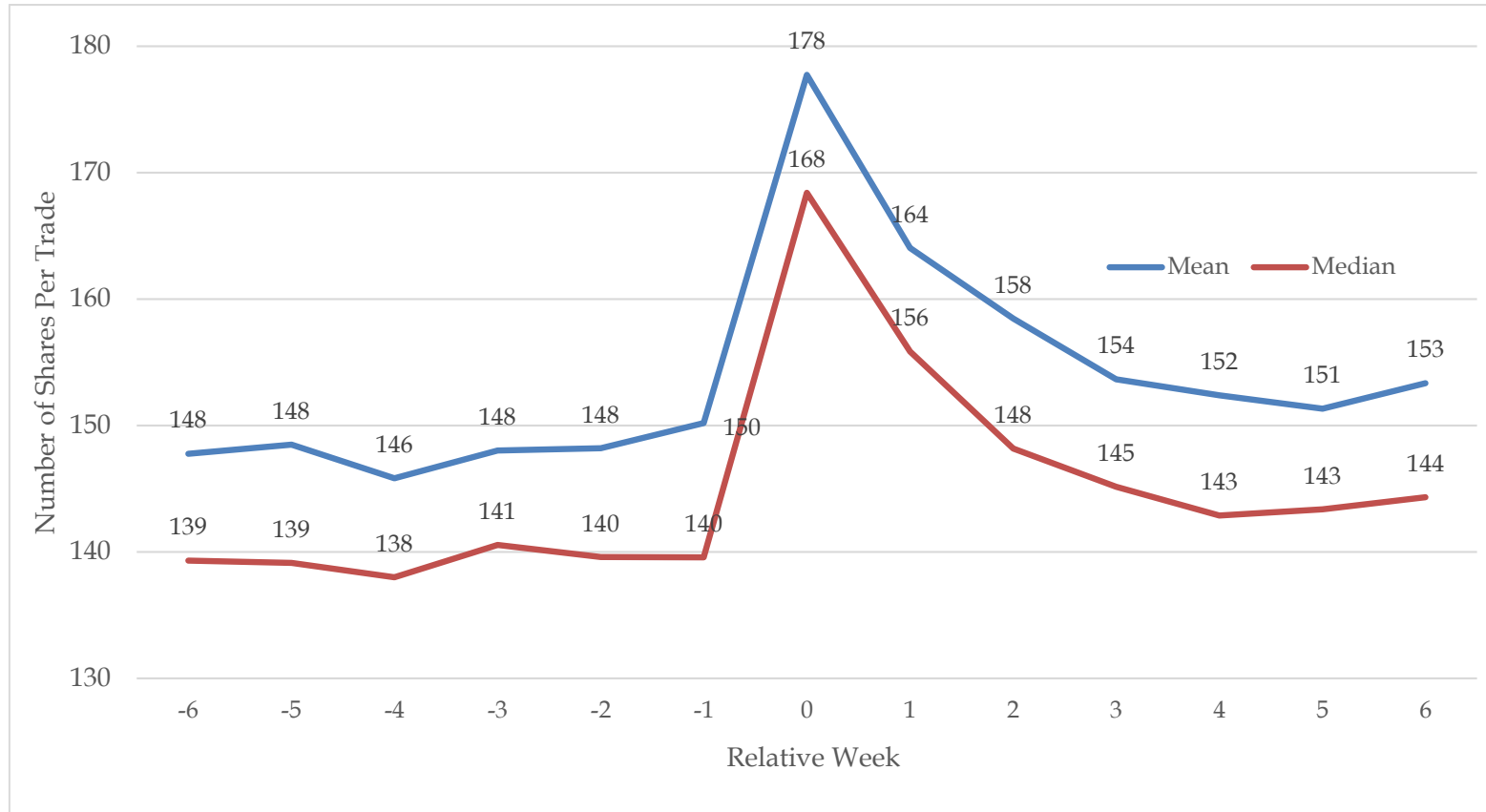
- 47.2% of U.S. equity volume in Jan 2021 executed off exchange, up from 39.9% a year earlier (Rosenblatt Securities) and 7.5% in 2008 (Brogaard & Pan 2021)
- Volume migration to dark venues around earnings announcements (Balakrishnan, Gkougkousi, Landsman and Taori 2021)
- Longer post-earnings announcement drift (Thomas, Zhang, and Zhu 2021)
- Increased fundamental information acquisition (Brogaard and Pan 2021)
- Fewer management earnings forecasts (Hope and Liu 2021)

# %DARK TRADING VOLUME AROUND CRASH WEEKS





# DARK TRADE SIZE AROUND CRASH WEEKS



THANK YOU!

I APPRECIATE YOUR TIME AND INTEREST  
AND LOOK FORWARD TO YOUR QUESTIONS/COMMENTS.