In the Blink of an Eye: Exchange-to-SIP Latency and Trade Classification Accuracy

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TME, March 5th 2024

Agenda

1 Background: Market Data

2 Motivation and Research Question

3 Three New Facts in Today's Fast Market
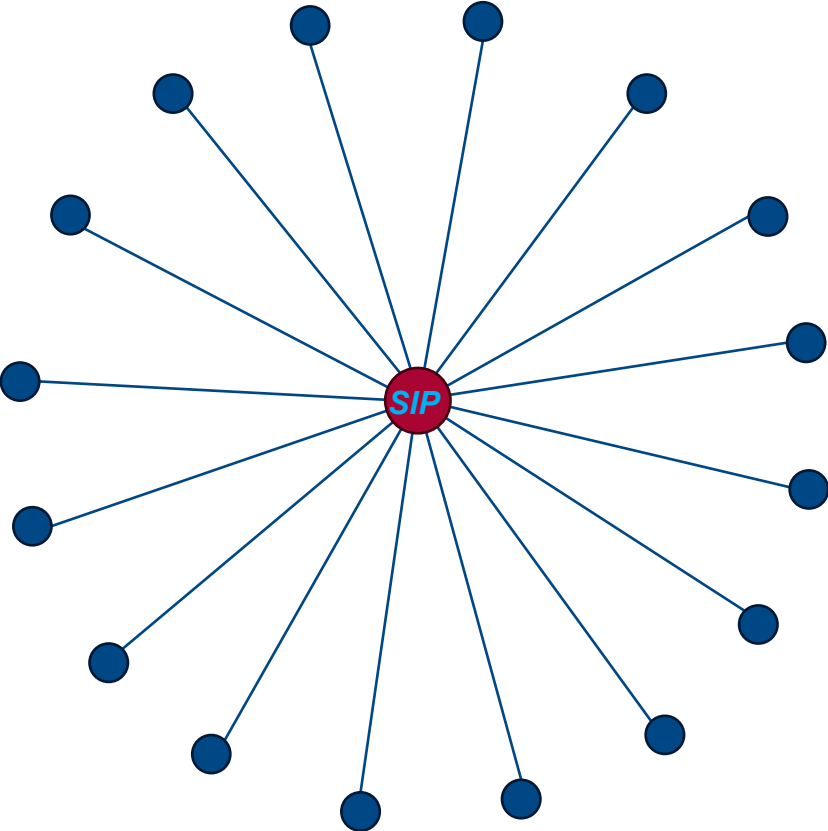
4 Literature and (Pause)

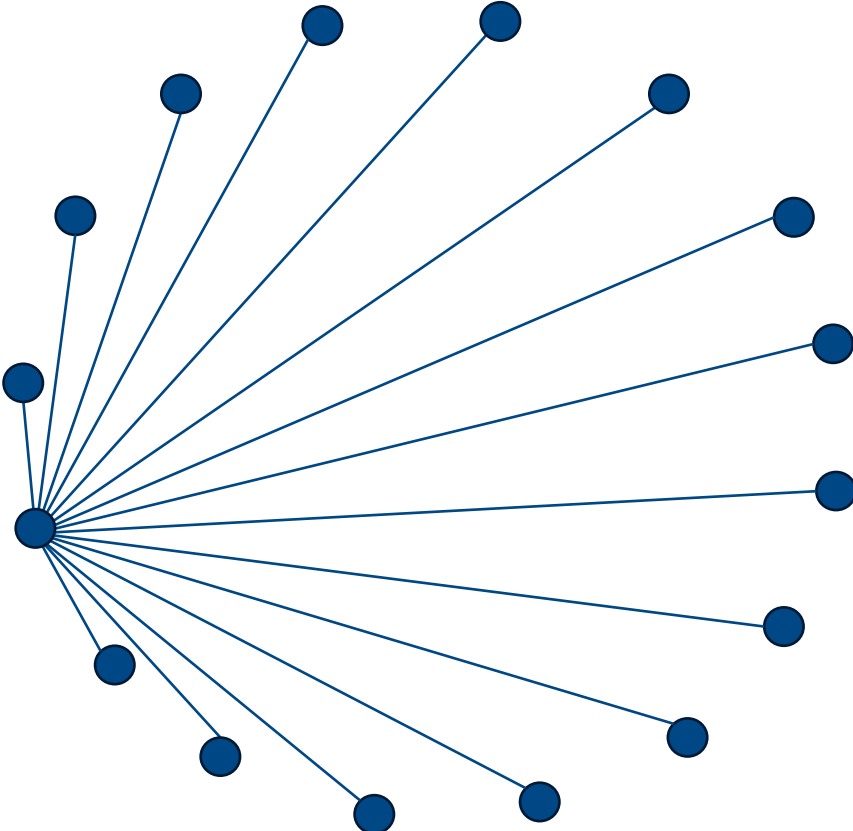**5** Two Latency Adjustment Methods

6 Results and Why Latency Matters
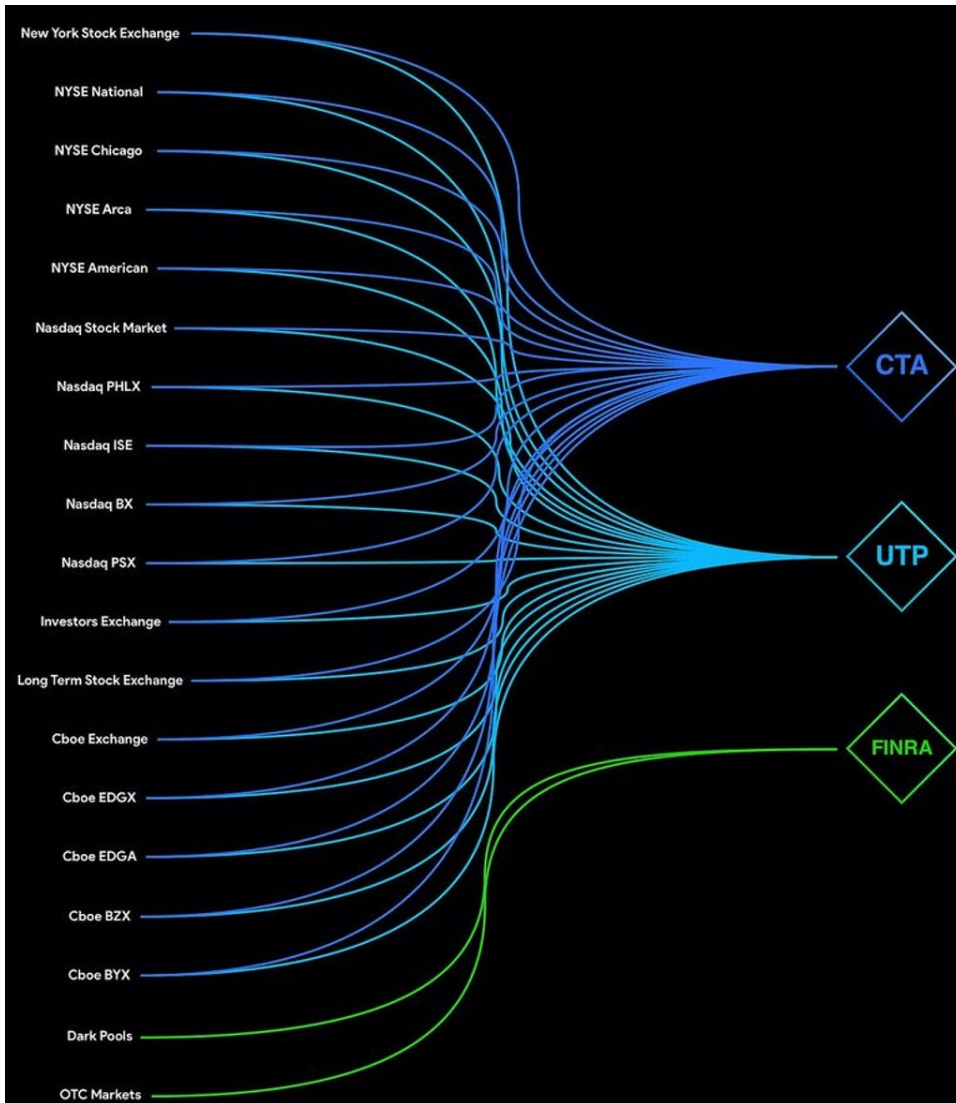
Background: How Exchanges Communicate

Consolidated/SIP Feed

Direct Feed

Background: Consolidated Feed in US

Source: Polygon.io

FEDERAL REGISTER
The Daily Journal of the United States Government

Ⓝ Notice

Joint Industry Plan; Notice of Filing of a National Market System Plan Regarding Consolidated Equity Market Data

A Notice by the Securities and Exchange Commission on 01/25/2024

On September 1, 2023, the Commission ordered the SROs to act jointly in developing and filing with the Commission by October 23, 2023, a proposed new single NMS plan to govern the public dissemination of real-time consolidated equity market data for NMS stocks.[7] The SROs are filing the proposed Plan, as directed in the Amended Order. Following the implementation timelines discussed in Section A.3 below, the Plan would replace (1) the Consolidated Tape Association Plan ("CTA Plan"), (2) the Consolidated Quotation Plan ("CQ Plan"), and (3) the Joint Self-Regulatory Organization Plan Governing the Collection, Consolidation, and Dissemination of Quotation and Transaction Information for Nasdaq-Listed Securities Traded on Exchanges on an Unlisted Trading Privileges Basis ("UTP Plan"). The SROs propose that the Plan be in the form of a limited liability company agreement for a new company, CT Plan LLC (the "Company"), with each SRO being a "Member" of the Company.

Background: Consolidated Feed in Europe

BUSINESS

Why Europe Is Trying to Create a 'Consolidated Tape' for Traders

Analysis by Alice Gledhill | Bloomberg
June 29, 2023 at 12:32 a.m. EDT

What are the advantages?

The biggest selling point is better transparency, making it easier for investors of all stripes to access information and determine whether they obtained the best price for their trade (known as best execution). The European Commission, the EU's executive arm, also argues that it will make the region's capital markets more attractive, both domestically and among international investors, thanks to greater efficiencies and data quality at a pan-European level.

The trading floor at the Frankfurt Stock Exchange, operated by Deutsche Boerse AG, in Frankfurt, Germany, on Monday. Dec. 19, 2022. Porsche AG enters Germany's main equity benchmark, the DAX Index, replacing sports-goods maker Puma SE. Photographer Alex Kraus/Bloomberg
Photographer: Alex Kraus/Bloomberg (Bloomberg)

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Our Motivation

Market Data (TAQ) has been improving over the past 30 years

- How the trade-to-quote matching methodology has evolved with timestamp:

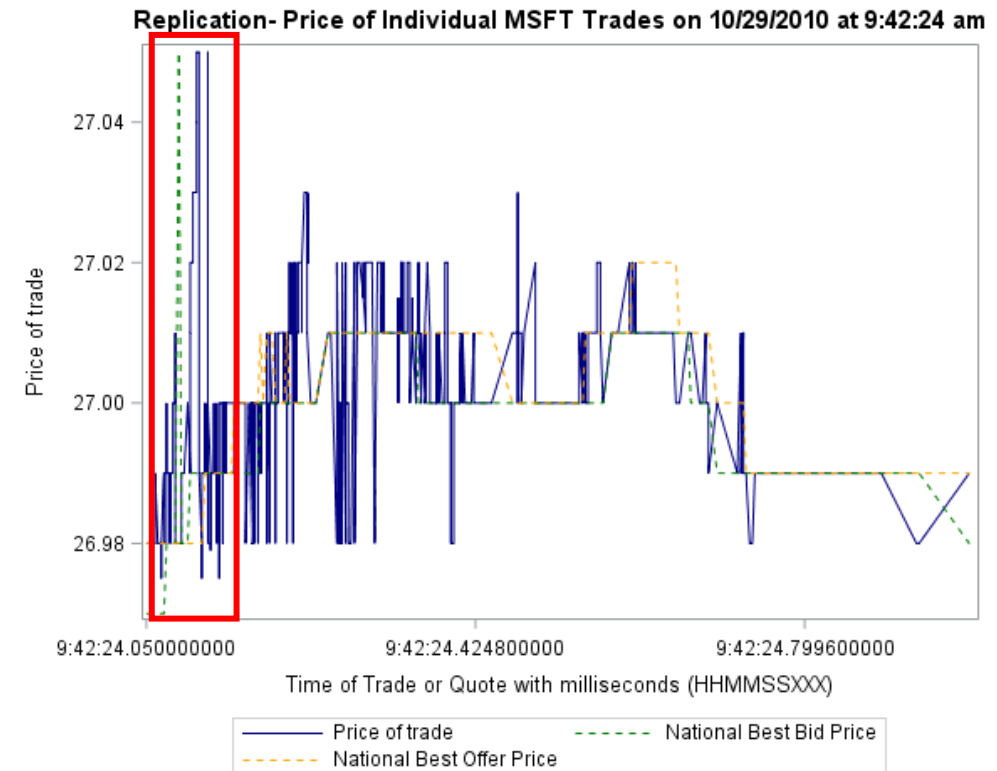| Data	Timestamp Precision	Method Used in Academic Literature	Pct of Outside NBBO Trades (example: MSFT on 20231201)
Early 1990s Monthly TAQ	Second	$t - 5$	74.211%
Late 1990s Monthly TAQ	Second	$t - 3$	67.579%
2000s Monthly TAQ	Second	$t - 1$	50.173%
2003 Daily TAQ	Millisecond	$t - 0.001$	13.220%
2015 Daily TAQ	Microsecond	$t - 0.000001$	6.965%
2016 Daily TAQ - present	Nanosecond	$t - 0.1 \times 10^{-9}$	6.955%

**Great Leap –
Holden and Jacobsen (2014, JF)**

At first glace, more precise timestamp ➡ less trades outside prevailing NBBO

Our Motivation: An Example

Matching trades to the "prevailing" NBBO does not always work

Price of Individual MSFT Trades on 10/29/2010 at 9:42:24am
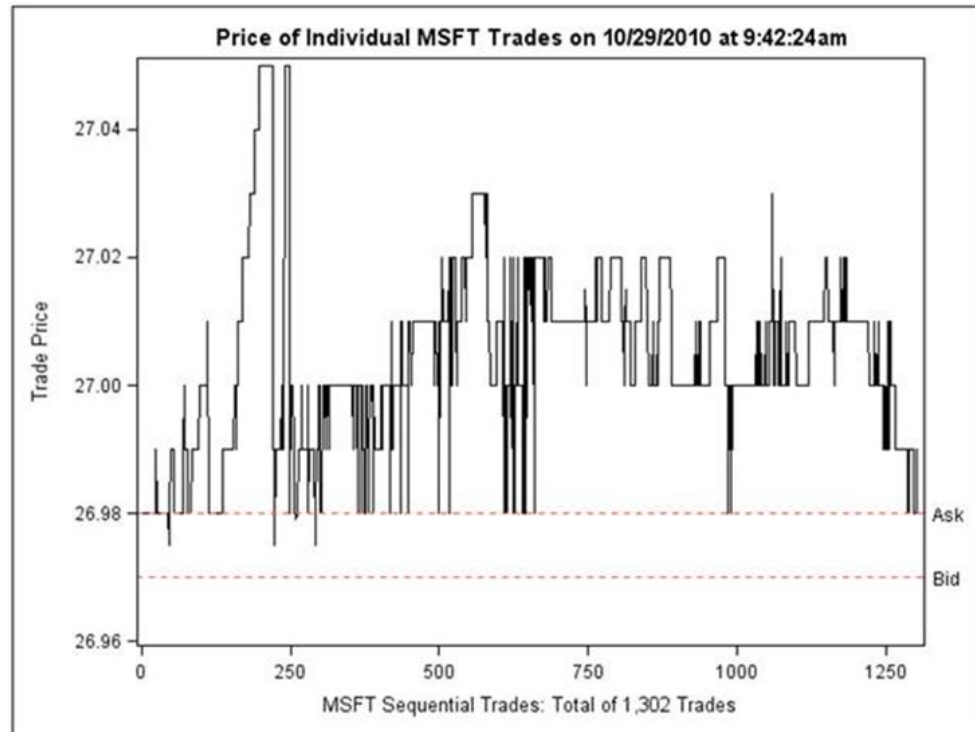
Previous-second: almost all trades are outside the assigned previous second NBBO

Replication- Price of Individual MSFT Trades on 10/29/2010 at 9:42:24 am

Why is the trade late?

What do we still miss here?

Previous-millisecond: it's better! 55% trades are inside the matched previous millisecond NBBO

The Research Question

What is the **BEST** approach to match trades to quotes in the era of fast trading?

Does adjusting trade and quotes for message latency improve trade classification accuracy?

Three New Facts on Today's (U.S.) Market Structure

Fact I. Direct Feed has replaced SIP Feed as Primary

- Exchanges and market players have switched to use Direct Feed as primary

- Direct feed is faster (next slide); HFTs have Direct Feed sent wirelessly using expensive weatherproof laser-beam technologies

- TAQ is the SIP feed. Direct Feed is not available to academics

Market Center	Primary Source	Secondary Source
Cboe BZX Exchange, Inc.	Direct Feed	SIP Data Feed
Cboe BYX Exchange, Inc.	Direct Feed	SIP Data Feed
Cboe EDGA Exchange, Inc.	Direct Feed	SIP Data Feed
Cboe EDGX Exchange, Inc.	Direct Feed	SIP Data Feed
Investors' Exchange, LLC	SIP Data Feed	n/a
NASDAQ BX, Inc.	Direct Feed	SIP Data Feed
NASDAQ PHLX LLC	Direct Feed	SIP Data Feed
NASDAQ Stock Market LLC	Direct Feed	SIP Data Feed
NYSE Arca, Inc.	Direct Feed	SIP Data Feed
NYSE American LLC	Direct Feed	SIP Data Feed
NYSE Chicago, Inc.	Direct Feed	SIP Data Feed
NYSE National, Inc.	Direct Feed	SIP Data Feed

Direct Feed vs SIP Feed

Latency Observable in TAQ

Latency Unobservable in TAQ

Exchange A

Quote Originating Exchange | Trade Executing Exchange

1. Quote originating exchange receives a new limit order. The quote is superior to the exchange's current Relative BBO record.

The exchange's matching engine enters this quote into its book

The quote originating exchange sends the quote message to SIP at "Quote@Exchange Time"

(**SIP Feed**)

7. Market order is routed to the quote originating exchange to be executed at the best price (Reg NMS)

(**SIP Feed**)

4. An NBBO update message is sent to all participant exchanges

(**SIP Feed**)

SIP

2. SIP receives quote originating exchange's new quote and starts processing for (1) NBBO (2) LULD;

3. SIP completes processing the quote at "Quote@SIP Time"; SIP broadcasts the updated NBB/NBO to all participant exchanges

Exchange B

5. (**SIP Feed**) Trade Originating Exchange receives the new NBBO and enters its book

6. The trade originating exchange matching engine considers a market order to be routed away

Trade Originating Exchange

Direct Feed vs SIP Feed

Exchange A

1. Quote originating exchange receives a new limit order. The quote is superior to the exchange's current Relative BBO record. The exchange's matching engine enters this quote into its book

Quote Originating Exchange | Trade Executing Exchange

(**SIP Feed**)

2. (**Direct Feed**) The exchange sends this quote to all exchanges that it is connected to via Direct Feed

4. (**Direct Feed**) Market order is routed to the quote originating exchange to be executed at the best price (Reg NMS)
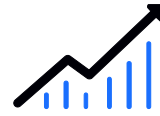
SIP

3. The trade originating exchange matching engine considers a market order to be routed away

Exchange B
Trade Originating Exchange

Direct Feed is much FASTER!!!

Why Care about Latency/Feed Speed? (Practitioner)

Comment letters for the SEC's 2020 Roundtable on Market Data and Market Access

*"The fundamental problem with today's market data infrastructure is that the SIPs no longer provide enough market data at **sufficient speeds** for today's marketplace. This causes many firms to have no other choice but to rely on exchanges' proprietary feeds to meet best execution obligations and remain competitive when routing customers' orders."* – Ellen Greene, SIFMA

*"Proprietary feeds usually have **lower latency** than SIP-provided Core Data because they are transmitted using the **fastest technologies** and because, unlike the information in the SIPs, information in the feeds **does not have to first be consolidated** with other information administered by one of the three NMS plans."*

– Rich Steiner, RBC Capital Markets

Fact II. Exchanges' Matching Engines and SIP(s) Are Co-located
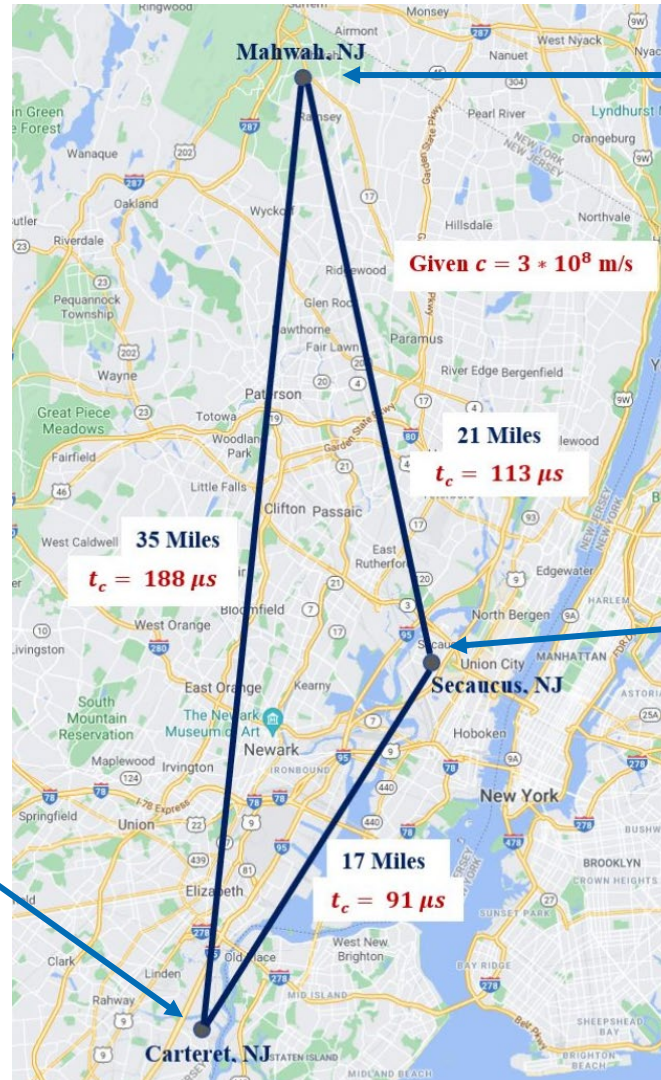
Mahwah, NJ:

CTA SIP (Tape A & Tape B Securities);

Co-located exchanges:

NYSE, NYSE ARCA, NYSE American, NYSE National

Secaucus, NJ:

Co-located exchanges:

Chicago Stock Exchange (CHX), CBOE EDGA & EDGX, CBOE BYX & BZX

Nearby exchanges:

The Investors' Exchange (IEX) at Weehawken, NJ

Carteret, NJ:

UTP SIP (Tape C Securities);

Co-located exchanges:

NASDAQ, NASDAQ OMX

Given $c = 3 * 10^8$ m/s

21 Miles
$t_c = 113\ \mu s$

35 Miles
$t_c = 188\ \mu s$

17 Miles
$t_c = 91\ \mu s$

Exchange and SIP Physical Locations

Exchange ID (TAQ)	Exchange Name (TAQ)	Data Center Address	City	State	Zip	Co-located?
A	NYSE American, LLC (NYSE American)	1700 MacArthur Blvd	Mahwah	NJ	07430	CTA Server
B	NASDAQ OMX BX, Inc. (NASDAQ OMX BX)	1400 Federal Blvd	Carteret	NJ	07008	UTP Server (NY11)
C	NYSE National, Inc (NYSE National)	1700 MacArthur Blvd	Mahwah	NJ	07430	CTA Server
D	FINRA Alternative Display Facility (ADF)		Carteret & Mahwah	NJ	07008 & 07430	TRF Server (CTA or UTP)
I	International Securities Exchange, LLC (ISE)	1400 Federal Blvd	Carteret	NJ	07008	UTP Server (NY11)
J	Cboe EDGA Exchange (Cboe EDGA)	800 Secaucus Rd	Secaucus	NJ	07094	CBOE (NY5)
K	Cboe EDGX Exchange (Cboe EDGX)	800 Secaucus Rd	Secaucus	NJ	07094	CBOE (NY5)
M	Chicago Stock Exchange, Inc. (CHX)	755 Secaucus Rd	Secaucus	NJ	07094	CH3 and NY4
N	New York Stock Exchange, LLC (NYSE)	1700 MacArthur Blvd	Mahwah	NJ	07430	CTA Server
P	NYSE Arca, Inc. (NYSE Arca)	1700 MacArthur Blvd	Mahwah	NJ	07430	CTA Server
S	Consolidated Tape System (CTS)	1700 MacArthur Blvd	Mahwah	NJ	07430	CTA Server
T	NASDAQ Stock Market, LLC (in Tape A, B securities) (NASDAQ)	1400 Federal Blvd	Carteret	NJ	07008	UTP Server (NY11)
Q	NASDAQ Stock Exchange, LLC (in Tape C securities)	1400 Federal Blvd	Carteret	NJ	07008	UTP Server (NY11)
V	The Investors' Exchange, LLC (IEX)	300 Boulevard E	Weehawken	NJ	07086	SOLO
X	NASDAQ OMX PSX, Inc. (NASDAQ OMX PSX)	1400 Federal Blvd	Carteret	NJ	07008	UTP Server (NY11)
Y	Cboe BYX Exchange, Inc (Cboe BYX)	800 Seacaucus Rd	Secaucus	NJ	07094	CBOE (NY5)
Z	Cboe BZX Exchange, Inc (Cboe BZX)	800 Seacaucus Rd	Secaucus	NJ	07094	CBOE (NY5)

Fact III. Exchange-to-SIP Latency Is Observable in Daily TAQ

Exchange-to-SIP Travel Time

Exchange

SIP

2. SIP receives quote/trade message and process for Consolidated Tape

3. SIP *completes* processing the message at "SIP Time"

1. For a given trade/quote message, "Participant Exchange Time" is when the message *leaves* the exchange

Participant Exchange Time was recently available in Daily TAQ since 2015 August

SIP Time= Participant Exchange Time + Exchange-to-SIP Travel Time + SIP Gateway Latency + SIP Processing Time

SIP Time has been available in TAQ since 1993

Latency = SIP Time – Participant Exchange Time

Quote and Trade Message Latency by Network (20190603)

Exchange Name (TAQ)	Quote Message Median Latency	Trade Message Median Latency	Exchange Data Center City	Co-location With CTA SIP
NYSE National	102 µs	149 µs	Mahwah	Co-located
NYSE	105 µs	154 µs	Mahwah	Co-located
NYSE American	105 µs	159 µs	Mahwah	Co-located
NYSE Arca	111 µs	160 µs	Mahwah	Co-located
Cboe BYX	401 µs	456 µs	Secaucus	Away (NY5)
Cboe BZX	403 µs	464 µs	Secaucus	Away (NY5)
Cboe EDGA	406 µs	468 µs	Secaucus	Away (NY5)
Cboe EDGX	409 µs	472 µs	Secaucus	Away (NY5)
IEX	449 µs	491 µs	Weehawken	Away
NASDAQ BX	537 µs	578 µs	Carteret	Away (UTP)
NASDAQ	540 µs	586 µs	Carteret	Away (UTP)
NASDAQ PSX	540 µs	594 µs	Carteret	Away (UTP)
CHX	10,254 µs	1,065 µs	Secaucus	Away (CH3, NY4)

Exchange Name (TAQ)	Quote Message Median Latency	Trade Message Median Latency	Exchange Data Center City	Co-location With UTP SIP
NYSE National	367 µs	371 µs	Mahwah	Away (NYSE)
NYSE	369 µs	372 µs	Mahwah	Away (NYSE)
NYSE American	372 µs	376 µs	Mahwah	Away (NYSE)
NYSE Arca	373 µs	377 µs	Mahwah	Away (NYSE)
Cboe BYX	193 µs	210 µs	Secaucus	Away (NY5)
Cboe BZX	193 µs	212 µs	Secaucus	Away (NY5)
Cboe EDGA	200 µs	220 µs	Secaucus	Away (NY5)
Cboe EDGX	201 µs	221 µs	Secaucus	Away (NY5)
IEX	216 µs	236 µs	Weehawken	Away
NASDAQ BX	16.67 µs	19.39 µs	Carteret	Co-located
NASDAQ	17.04 µs	21.59 µs	Carteret	Co-located
NASDAQ PSX	18.06 µs	24.05 µs	Carteret	Co-located
CHX	8,025 µs	571 µs	Secaucus	Away (CH3, NY4)

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Why Should We Care about Latency? (Academic)

1. Prior studies omit quote/trade message latency between exchanges and assume the latency is zero

   - Bartlett and McCrary (2019)'s Direct NBBO method

     - Match trades to their prevailing NBBO quotes based on trade/quote's participant exchange time

     - Assumes exchange-to-exchange latency is zero, i.e., order routing is instantaneous

Why Should We Care about Latency? (cont.)

- Using exchanges' Rule 605 data, we find **36.68%** of market orders* at NYSE and ARCA are routed to other exchanges

  - Omitting latency would match trades to quotes **before** the away exchanges perceive them

  - When order routing among exchanges increases, the conventional SIP time method (and the Direct NBBO method) trade classification accuracy declines

2. Adjusting for latency could alter research inference when measuring liquidity

Literature

Matching trades with quotes is the important **first step** for multiple strands of microstructure research

- Order Imbalance

  - Diether, Lee, and Werner (2009a, b), Boehmer, Jones, and Zhang (2008), Chakrabaty, Moulton, and Shkilko (2012), etc.

- Liquidity (effective spread, realized spread, and price impact)

  - Holden and Jacobsen (2014), Comerton-Forde, Hendershott, Jones, Moulton, and Seasholes (2010), Peterson and Sirri (2003), Werner (2003), Bessembinder (2003), Comerton-Forde, Gregoire, and Zhong (2019), etc.

- Informed Trading

  - Poppe, Moos, and Schiereck (2016), Boehmer, Grammig, Theissen (2007), etc.

Questions?

We Propose Two New Trade-to-Quote Matching Methodologies

Direct Feed and Relative BBO (1st Best)

1. Sorting Quotes from "Quote@Exchange Time" for every exchange co-located in the same city to compute the city's best price at "Quote@City Time"
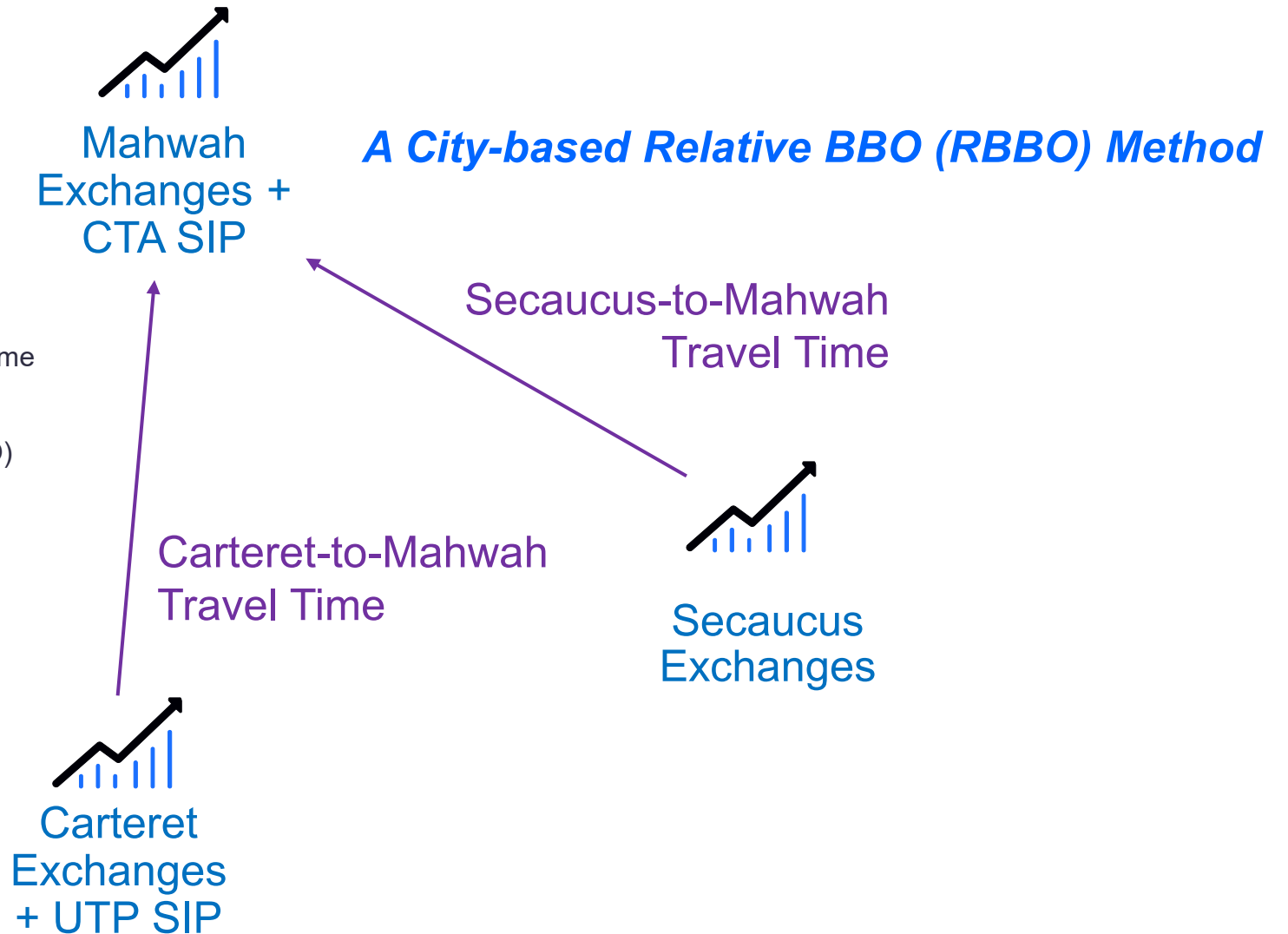
2. Computing travel latency as the time it took for the prevailing quote message to travel from one city to another

Travel Latency=(UTP/CTA) SIP Time – Participant Exchange Time

3. Sorting Quotes from all cities to generate the best price (BBO) at a given city at "Quote@City Laten-adj Time"

4. Matching the Trade at "Trade@City Time " to the prevailing RBBO at "Quote@City Laten-adj Time"

5. Consolidates all trade-to-quote matches across the three cities

A City-based Relative BBO (RBBO) Method

Mahwah Exchanges + CTA SIP

Secaucus-to-Mahwah Travel Time

Secaucus Exchanges

Carteret-to-Mahwah Travel Time

Carteret Exchanges + UTP SIP

SIP Feed and Latency Adjusted Time Method (2nd Best)

Quotes

NBBO@SIP time + NBBO Msg SIP-to-TradeEXExchange Travel Time, *matching to*

Trades

Trade@EXExchange Time

We suggest a **[SIP Feed]** computing-saving solution which takes advantage of knowing the trade took place at Exchange X and bringing the Trade@EXExchange Time ***early*** :

Quotes

NBBO@SIP time, *matching to*

Trades

Trade@EXExchange Time – NBBO Msg TradeEXExchange-to-SIP Travel Time

$\approx$Trade@EXExchange Time – (Trade@SIP Time – Trade@EXExchange Time)

Reference: SIP Feed

Latency Observable in TAQ

Latency Unobservable in TAQ

1. Quote originating exchange receives a new limit order. The quote is superior to the exchange's current Relative BBO record.
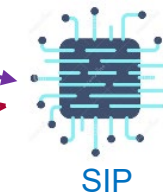The exchange's matching engine enters this quote into its book

Quote Originating Exchange | Trade Executing Exchange

The quote originating exchange sends the quote message to SIP at "Quote@Exchange Time"

(**SIP Feed**)

4. An NBBO update message is sent to all participant exchanges

SIP

(**SIP Feed**)

7. Market order is routed to the quote originating exchange to be executed at the best price (Reg NMS)

(**SIP Feed**)

5. (**SIP Feed**) Trade Originating Exchange receives the new NBBO and enters its book

6. The trade originating exchange matching engine considers a market order to be routed away

Trade Originating Exchange

2. SIP receives quote originating exchange's new quote and starts processing for (1) NBBO (2) LULD;

3. SIP completes processing the quote at "Quote@SIP Time"; SIP broadcasts the updated NBB/NBO to all participant exchanges

Trade Classification Accuracy

- Three Trade Classification Methods w/ and w/o latency adjustment

    1. Lee and Ready (LR, 1991):

    $$Trade\ k = \begin{cases} BUY_k, & if\ P_k > M_{t-1} \\ SELL_k, & if\ P_k < M_{t-1} \\ use\ tick\ test, & all\ else \end{cases}$$

    2. Ellis, Michaely, and O'hara (EMO, 2000)

    $$Trade\ k = \begin{cases} BUY_k, & if\ P_k = NBO_{t-1} \\ SELL_k, & if\ P_k = NBB_{t-1} \\ use\ tick\ test, & all\ else \end{cases}$$

    3. Chakrabarty, Li, Nguyen, and Van Ness (CLNV, 2006)

    $$Trade\ k = \begin{cases} BUY_k, & if\ (NBO_{t-1} - 0.3 * spread) < P_k < NBO_{t-1} \\ SELL_k, & if\ (NBB_{t-1} + 0.3 * spread) > P_k > NBB_{t-1} \\ use\ tick\ test, & all\ else \end{cases}$$

- Trades matched to crossed quotes, or locked quotes, or outside NBBO

Data Source

Dataset 1

Daily TAQ

Dataset 2

NYSE/ARCA Integrated Data Feed (Limit Order Book, LOB, "Direct Feed")

Message-based limit order submission, deletion, execution, and replacements. Submission messages and execution messages are used.

- *Sample period*

[TAQ Sample] 2015 August to 2019 September, 49 months

[LOB Sample] 2017 December to 2019 June, 19 months

- *Trade to Quote Latency Adjustment Methodology:*

[second-best] "Latency Adjusted Time" as main results; **[first-best]** "RBBO" in appendix

We match TAQ regular trades to LOB limit orders* that were executed against market orders*, and infer the TAQ trade position from the counterparty limit order position

How We Match Trades in TAQ and LOB?

By symbol, trade price, trade size, and the exact nanosecond part_time

MsgType	Symbol	SourceTime	OrderID	Price	Volume	TradeID
...						
103	AAPL	10:03:10.804101376	00016044086562791062	189.7000	79	649014
...						
103	AAPL	10:03:10.804101376	00016044086562792313	189.7000	79	649014
...						

Msg 103: LOB order executions

Date	Symbol	SIP Time (Time_m)	Participant Exchange Time (Part_time)	Price	Volume	TradeID
...						
20190329	AAPL	10:03:10.804481417	10:03:10.804101376	189.7	79	2991
...						

Daily TAQ Trades

How We Match Trades in TAQ and LOB?

By symbol, trade price, trade size, and the exact nanosecond part_time

MsgType	Symbol	SourceTime	OrderID	Price	Volume	TradeID
...						
103	AAPL	10:03:10.804101376	0001604408656279<u>1062</u>	189.7000	79	649014
...						
103	AAPL	10:03:10.804101376	0001604408656279<u>2313</u>	189.7000	79	649014
...						

Msg 103: LOB order executions

MsgType	Symbol	SourceTime	OrderID	Price	Volume	Side
...						
100	AAPL	<u>10:03:10.220877312</u>	<u>0001604408656279</u>1062	189.7000	79	<u>B</u>
...						
100	AAPL	<u>10:03:10.799669504</u>	<u>0001604408656279</u>2313	189.7000	79	<u>S</u>
...						

Msg 100: LOB order submissions

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LOB Sample Result – Trade Classification Accuracy

		Lee Ready Accuracy	EMO Accuracy	CLNV Accuracy
SIP Time	[A]	86.75%*** (1,670.89)	87.50%*** (1,909.72)	87.50%*** (1,847.91)
Time with Latency Adjustment [2nd Best]	[B]	92.05%*** (2,208.77)	91.86%*** (2,303.71)	91.93%*** (2,337.61)
Difference	[B-A]	**5.30%*** (125.50)**	**4.46%*** (121.09)**	**4.43%*** (120.64)**
Total Number of Matched TAQ & LOB LO-to-MO Trades (NYSE+ARCA): **654,170,045** Total Number of Trading Days: 395 days (2017/12-2019/06) (t-stat in parenthesis)				

LOB Sample Result – Lee Ready Trade Classification Accuracy
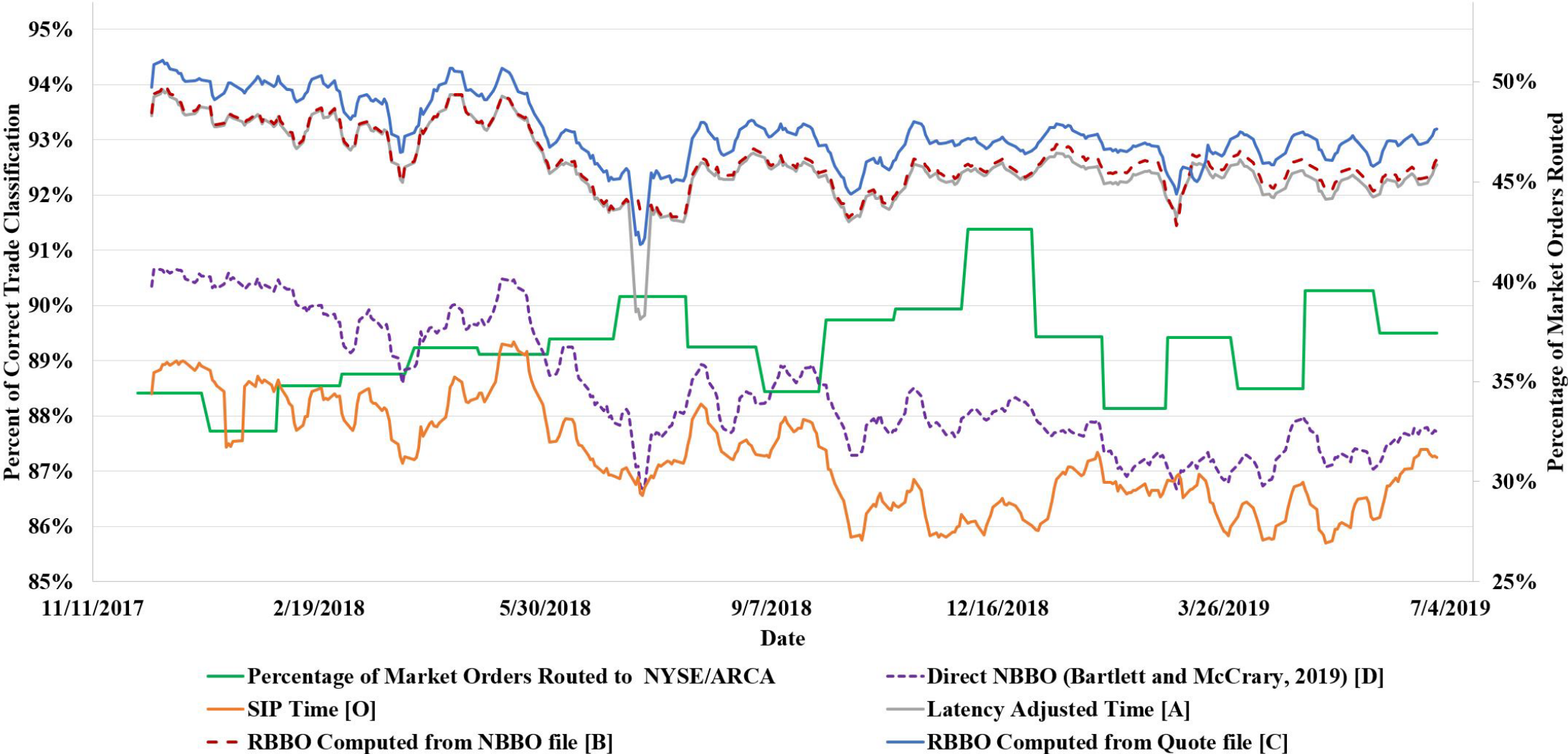
Computation Cost

|		Average Computing Time for One-day's Trades-to-quotes	Lee Ready Trade Classification Accuracy	Accuracy Improvement Compare to (O)	Coding Complexity
SIP latency-adjusted NBBO based on DTAQ NBBO file	[A]	30-40 minutes	92.05%	5.30%***	Add two lines to Holden and Jacobsen (2014)'s SAS code
Approximate exchange-specific RBBO based on DTAQ NBBO file	[B]	2.5 - 3 hours	92.16%	5.41%***	Create a latency reference file and adjust NBBO for 13 exchanges per UTP/CTA
Near-perfect city-specific RBBO based on DTAQ Quote file	[C]	**3 hours**	**92.63%**	**5.88%*****	Generate RBBO file from DTAQ Quote file based on datacenter location
Bartlett and McCrary (2019)'s Direct NBBO Method	[D]	40-50 minutes	87.95%	1.21%***	Match trades to their prevailing NBBO quotes by participant exchange time
Benchmark: Current SIP Time Method	[O]	30-40 minutes	86.75%	-	Holden and Jacobsen (2014)'s SAS code
Total Number of Matched TAQ & LOB LO-to-MO Trades (NYSE+ARCA): **654,170,045** Total Number of Trading Days: 395 days (2017/12-2019/06), (*t*-stat in parenthesis)					

What Causes the Remaining 8% Inaccurate Classifications?

Tick Test Used?
(Locked or crossed spread)

No 98.29% of all trades
- **Incorrect** 8.10% of all trades
  - 1.49% are trade thru exempt (TTE)
    - Reason 2: Legit TTE (about 31.28% of all trades are TTE)
  - 2.50% is $0.01 away to trigger tick test (TT) and will be correct with TT
    - Reason 3: Lee and Ready (1991) has a specific threshold to trigger TT
  - 1.57% are hidden orders executed within 1 second
    - Reason 4: Hidden order executions have priority over regular orders
  - 2.54% unknown (2.20% at NBBO and incorrect; 0.34% inside NBBO and incorrect)
- **Correct** 90.19% of all trades

Yes 1.71% of all trades
- **Incorrect** 0.71% of all trades
  - Reason 1: Tick test could be inaccurate, 1-in-4 tick movement scenarios. Aitken and Frino (1996)
- **Correct** 1% of all trades

TAQ Sample Result – Latency Adjustment and Abnormal Quotes
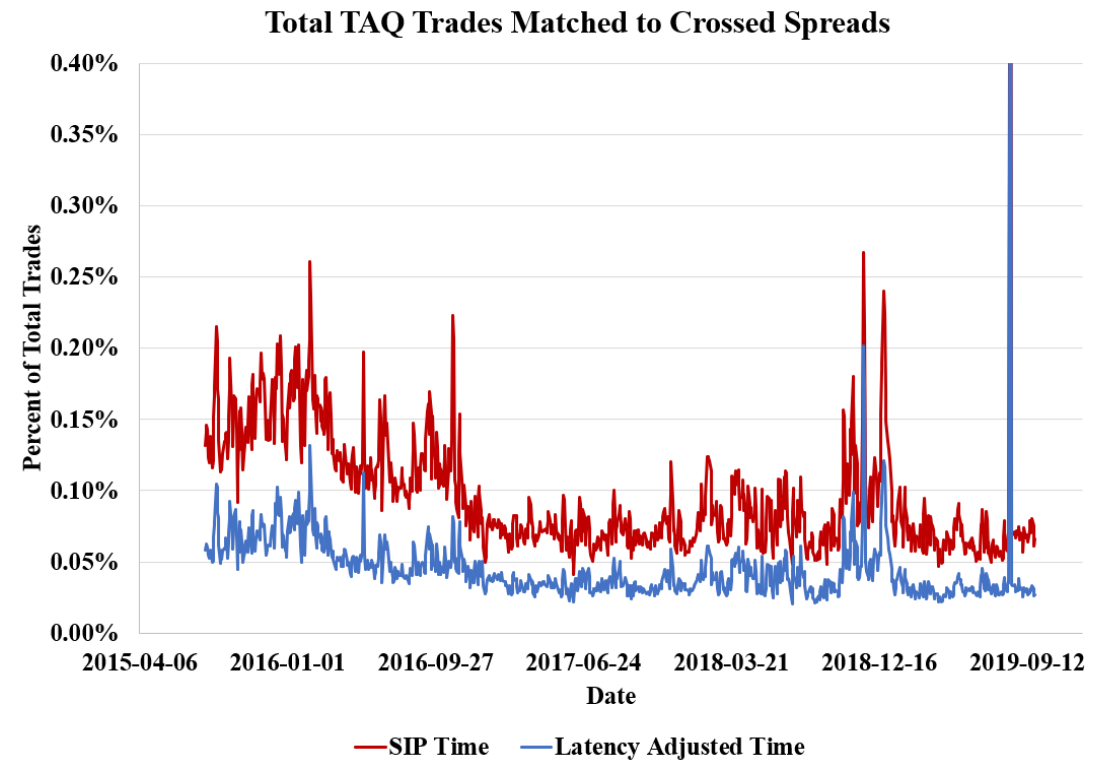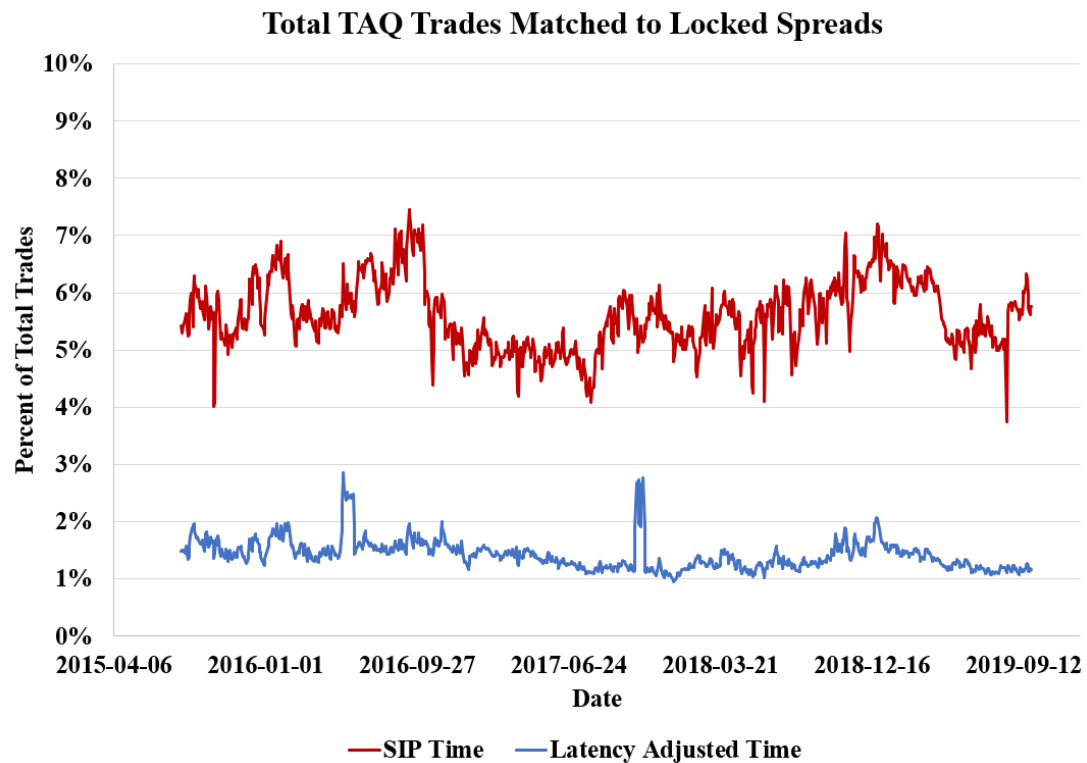
Note: the spike on 8/12/2019 with 1.4% crossed spread is caused by a network component failure at Mahwah which affected the Consolidated Tape System (CTS). On that day, the trade and quote records have gaps during 3:17pm-3:45pm.

# TAQ Sample Result – Latency Adjustment and Abnormal Quotes

**Total TAQ Trades Matched to Abnormal Spreads**
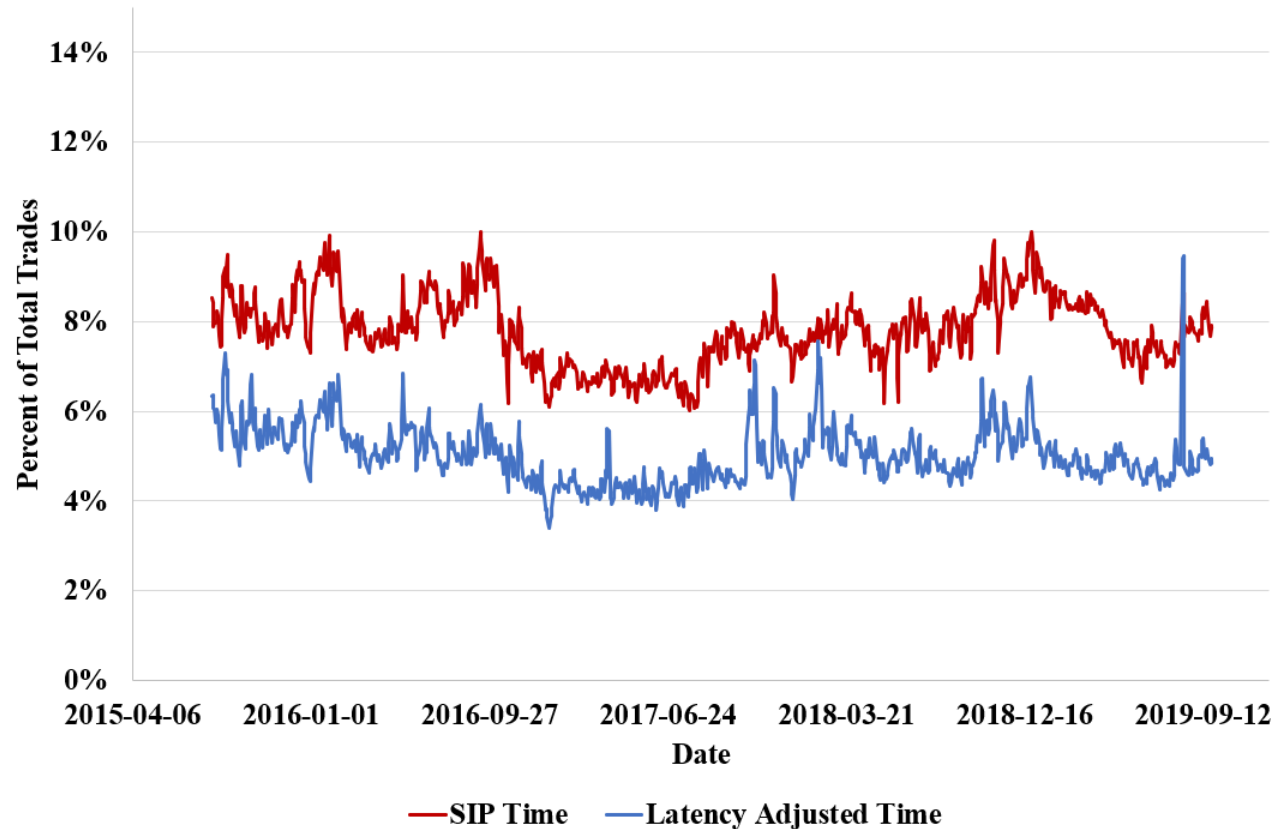
Percentage of trades matched to locked, crossed, or outside NBBO quotes drop from 7.79% to 5.02% with -2.77%***

Why Adjusting for Latency is Important?

We use [2020 NYSE Pillar migration](#) (with significant reduction in latency) as an exogenous shock, and we show that failure to adjust for latency could result in false positive research inferences
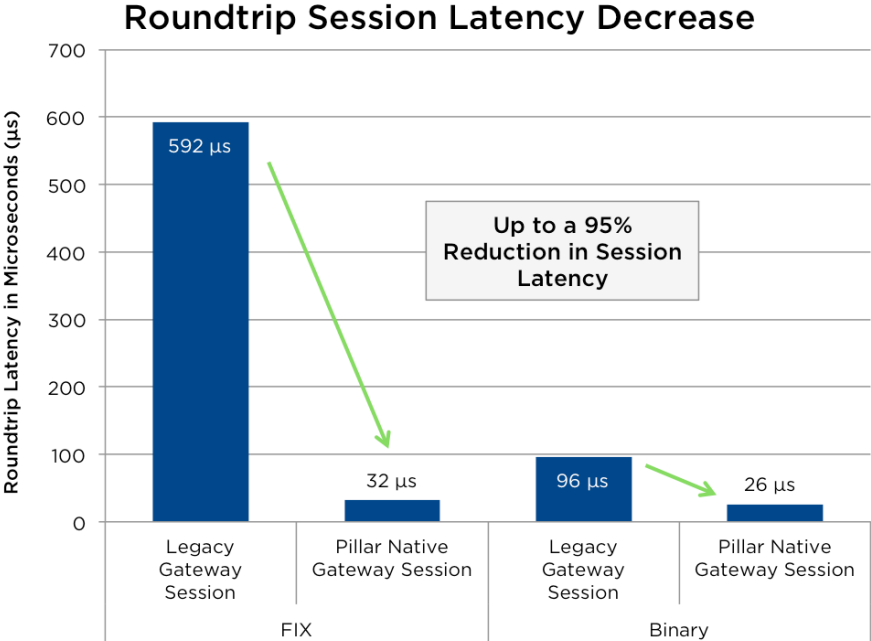
NYSE
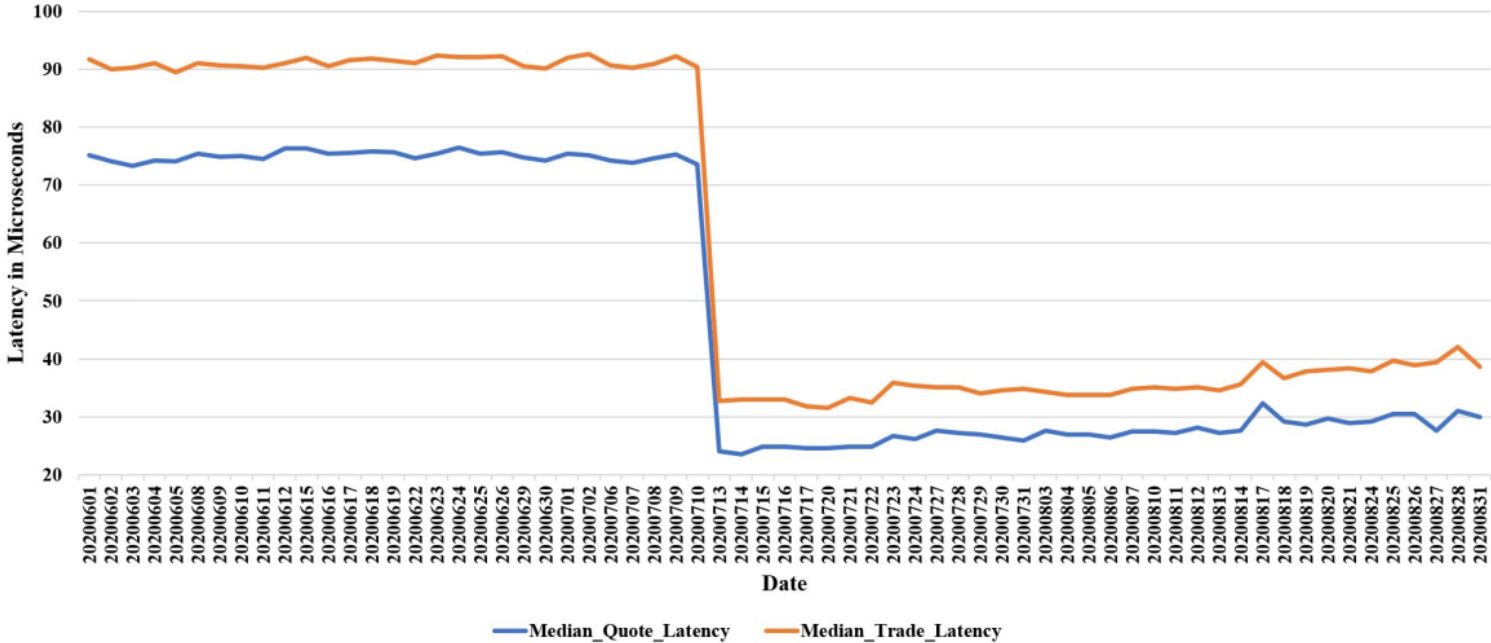
In TAQ (as observed)

Why Adjusting for Latency is Important? (cont.)

We use 2020 NYSE Pillar migration (with significant reduction in latency) as an exogenous shock, and we show that failure to adjust for latency could result in false positive research inferences

| | | Panel B NYSE Trades Only | | |
		Percent Effective Spread (%)	Percent Realized Spread (%)	Percent Price Impact (%)
SIP Time				
Before NYSE Pillar Migration	[A]	0.2233	0.0599	0.1633
After NYSE Pillar Migration	[B]	0.2232	0.0457	0.1774
Difference	[B-A]	-0.0001	-0.0142**	0.0141**
		(-0.03)	(-2.02)	(2.07)
Latency Adjusted Time				
Before NYSE Pillar Migration	[C]	0.2634	0.0100	0.2534
After NYSE Pillar Migration	[D]	0.2622	0.0092	0.2529
Difference	[D-C]	-0.0013	-0.0009	-0.0004
		(-0.41)	(-0.12)	(-0.06)

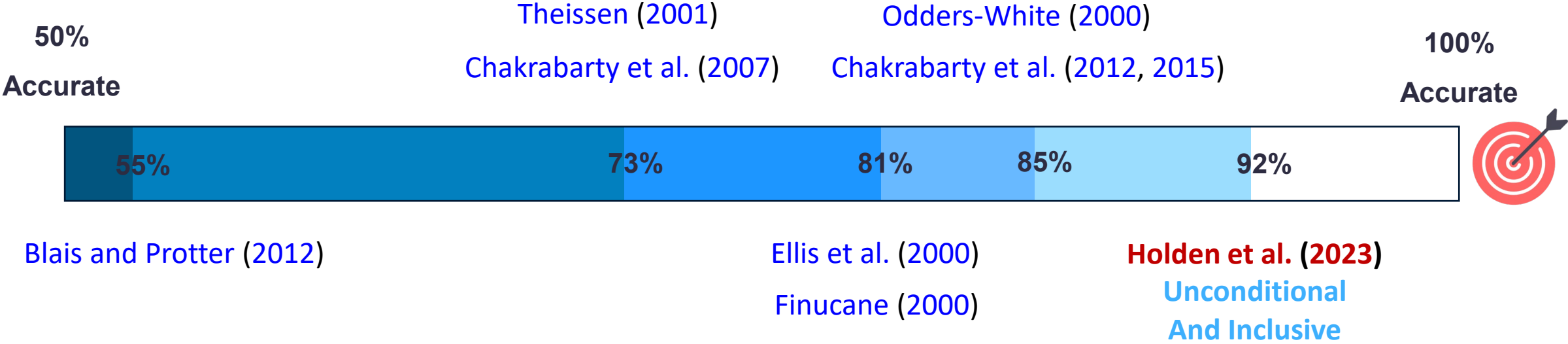*t*-statistics in parentheses, ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.10

Conclusion

- For TAQ trade classification research with samples after 2015 August, one should adjust for message latency

- With latency adjustment, Lee Ready classification accuracy increases from 86% to 92%; Adjusting for latency could alter research inferences when measuring liquidity

- Adjusting for latency is easy
  - Add two lines to Holden and Jacobsen (2014) SAS code:

    Trade ctm file: latency=time_m-part_time; * create a latency variable;

                          time_m=part_time-latency; * replace SIP time with latency adjustment;

  - WRDS will provide the RBBO files

The Contribution

Lee Ready Trade Signing Accuracy

Theissen (2001)

Odders-White (2000)

Chakrabarty et al. (2007)

Chakrabarty et al. (2012, 2015)

50%
Accurate

100%
Accurate

55%   73%   81%   85%   92%

Blais and Protter (2012)

Ellis et al. (2000)

Holden et al. (2023)

Finucane (2000)

**Unconditional
And Inclusive**

Latency Concerns For Policymakers

- The new NMS & the CT Plan L.L.C.

U.S. SECURITIES AND EXCHANGE COMMISSION

Notice Rule

Notice of Filing of a National Market System Plan
Regarding Consolidated Equity Market Data

Joint Industry Plans, National Market System Plans (NMS)

Public Comments

Submit a Comment on 4-757

View Received Comments

Details

Public Comments Due
30 days after publication in the *Federal Register*

File Number
4-757

Rule Type
Notice

Release Number
34-99403

SEC Issue Date
Jan. 19, 2024

1. Where is the new CT plan SIP (co-)located?

2. What delivery methods (wireless/wired) and plan pricing for the CT plan?

3. Is the CT plan SIP feed latency comparable with the exchange proprietary direct feed?

Questions?

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Thank You!