What Does Best Execution Look Like?

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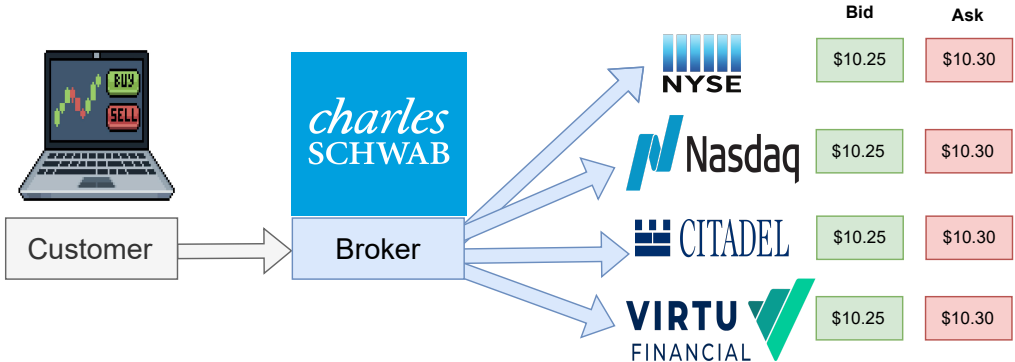
Broker's Routing: Overview



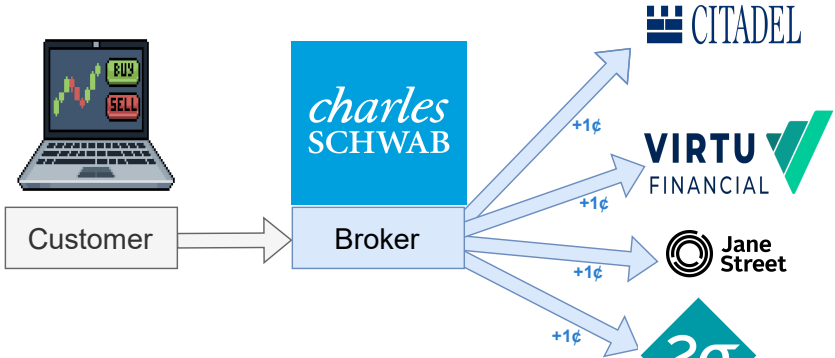
Retail trades can be more desirable than anonymous order flow:

-Lower adverse selection. Easley and O'Hara (1996).

-Lower correlation. Baldauf, Mollner, Yueshen (2023).

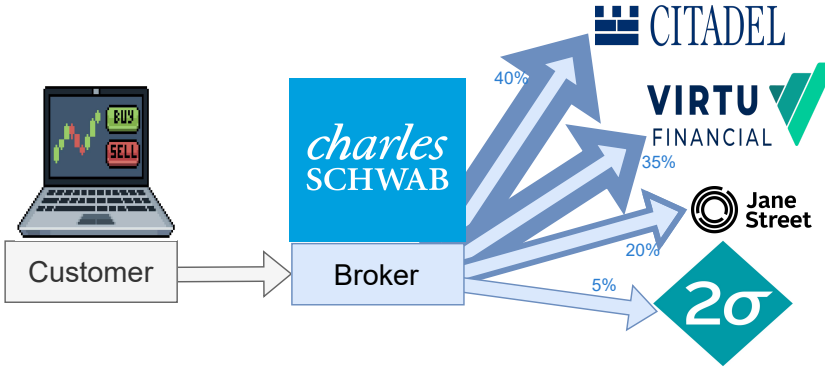
Wholesalers offer combination of **PFOF** and **price improvement** to obtain retail orders

Broker's Routing: PFOF



Brokers set a uniform PFOF rate across all wholesalers. Level playing field.

Broker's Routing: Competition



- Brokers route more to wholesalers who offer better average prices.
- Wholesalers compete for order flow based on average prices.

Findings

- **Brokers Measure and Respond to Wholesaler Performance**
  - Evaluate based on effective-over-quoted spreads
  - Better wholesalers obtain more order flow
- **Wholesalers Respond to Broker Measures**
  - When a broker changes focus, wholesalers respond immediately
  - Wholesalers offer more price improvement in volatile markets
  - Wholesalers change behavior around month-end
- **Broker Choices Impact Competitive Landscape**
  - Large vs. Small stocks - wholesaler competition looks quite different
  - Choices a broker makes can impact competition

Related Literature

- Topbas and Ye (2023): FINRA ATS Data
- Battalio and Jennings (2023): Price improvement from wholesaler data
- Dhyrberg, Shkilko, Werner (2023): SEC 605 data - market centers offering better prices obtain more order flow - aggregate, no small trades
- Huang, Jorion, Lee, Schwarz (2023): Own trades - six brokers, small trades

Our contributions:

- Proprietary data from three brokers: observe exact broker-wholesaler relationship
- Document how each of our brokers obtains best-execution:
  - What do they measure, how do they adjust flow, etc

Plan

1. Brokers Respond to Wholesalers
   - Broker Focus Points
   - Routing-Performance Relationship
   - Market Conditions and Wholesaler Performance
2. Wholesaler Respond to Brokers
3. Competitive Landscape

Data Overview

Three Retail Brokers. Collectively $> 50\%$ of retail equity market:

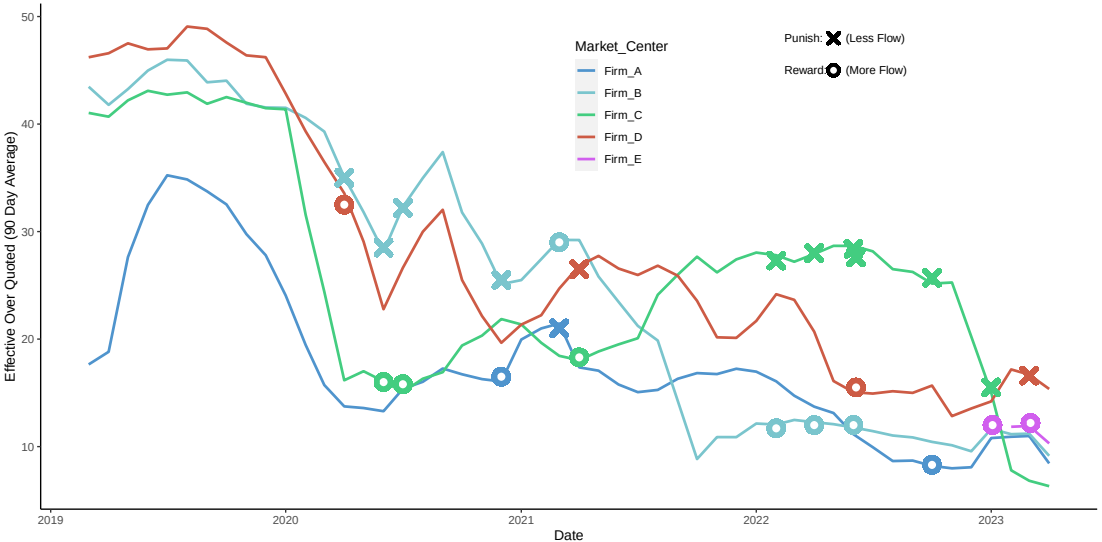
	Broker A	Broker B	Broker C
History:	30 Days	90 Days	90 Days
Symbol: (Size):	Each Symbol 5 Size Categories	Four Security Bins 3 Size Categories	One Bin
Decisions:	Daily (Rolling)	Monthly	Monthly

Performance Variables

- Effective Over Quoted Spread (EFQ)
  - EFQ is effective over quoted spread
  - Effective spread: how much the market maker charges on orders
  - Quoted spread: benchmark of how much the exchange would charge on orders
  - EFQ of 100% - charging the exchange bid-ask spread
  - EFQ of 0% - filling every order at the mid-quote

- Order Share:
  - Brokers allocate some portion of orders to each market maker
  - Use about 5 wholesalers
  - Unequal distribution — two firms at 30 - 40%, two firms at 5-10%

Broker B - Nasdaq 100 Orders



Performance Regression

- How does a wholesaler's EFQ impact their monthly order share?
- Consider EFQ and EFQ Rank
  - EFQ - lower is better
  - EFQ rank - ordinal ranking of wholesalers

Performance Regression

	Dependent variable: OrderShare					
	Broker A Data		Broker B Data		Broker C Data	
	(1)	(2)	(3)	(4)	(5)	(6)
Prior EFQ	-1.230^{***}		-0.958^{***}			
	(0.129)		(0.286)			
Prior EFQ Rank		-8.882^{***}		-5.553^{***}		
		(0.754)		(1.898)		
Prior Score					-3.015^{***}	
					(0.646)	
Prior Score Rank						-7.294^{***}
						(0.653)
Observations	129,526	129,526	786	786	170	170
R^2	0.316	0.339	0.248	0.253	0.613	0.766
Note:						*p<0.1; **p<0.05; ***p<0.01

Importance of Broker Focus

- Broker A routes based on 30 days of history and specific size categories:
- How sensitive are broker's routing decisions?
  - Consider multiple time horizons
  - Consider multiple order size histories

Broker Focus - Time Horizon

	Dependent variable:			
	OrderShare			
	(1)	(2)	(3)	(4)
Prior 5 Days EFQ	−0.469***			
	(0.006)			
Prior 10 Days EFQ		−0.635***		
		(0.006)		
Prior 30 Days EFQ			−0.835***	
			(0.007)	
Prior 45 Days EFQ				−0.469***
				(0.006)
Observations	129,526	129,526	129,526	129,526
R^2	0.051	0.072	**0.093**	0.051
Note:				*p<0.1; **p<0.05; ***p<0.01

- Broker A routes based on 30 days of prior history
- R^2 peaks at 30 days history, the history window length that Broker A uses in practice

Broker Focus - Order Size

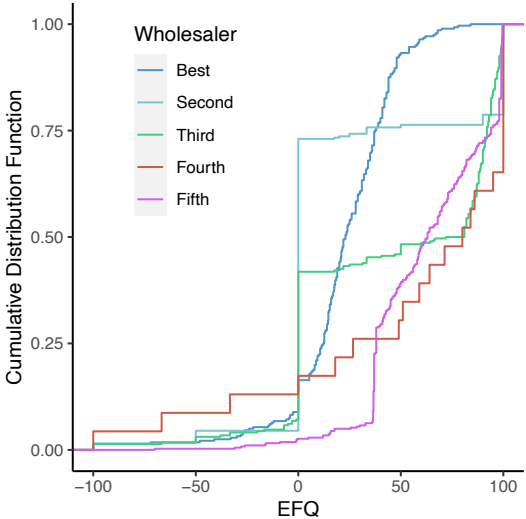
	Dependent variable:		
	OrderShare For Trades Size 3		
	(1)	(2)	(3)
Prior EFQ - Size 1	-0.518^{***}		
	(0.031)		
Prior EFQ - Size 3		-0.975^{***}	
		(0.024)	
Prior EFQ - Size 5			0.003
			(0.002)
Observations	11,420	11,420	11,420
R^2	0.024	**0.125**	0.0002

- Consider 3 Sizes:
  - Size 1 - $<$ 100 shares
  - Size 3 - 500 to 2,000 shares
  - Size 5 - Over 5,000 shares
- R^2 for Size 3 order routing is highest for size 3 EFQ

Understanding Broker Behavior

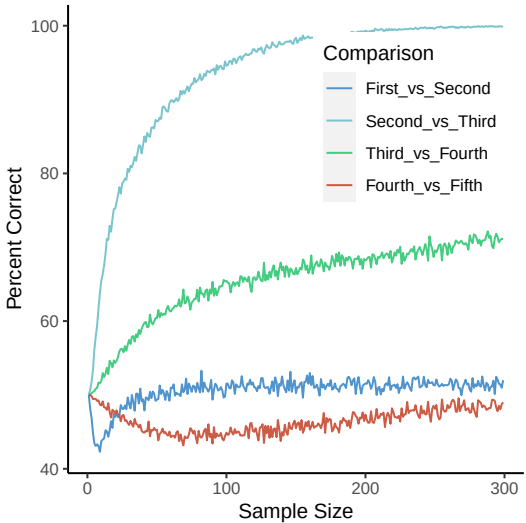
- Suppose one had an incomplete view of a broker's history:
  - Could an average retail customer understand their broker's decisions? (No)
  - SEC Rule 605 updates - Brokers will start providing much more data to customers

Individual Orders: Broker A Data



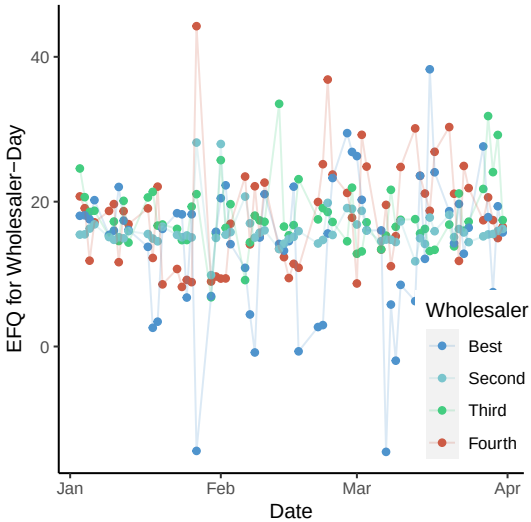
- Distribution of all Odd-Lot Trades in JP Morgan on March 13, 2023
- How large of a sample of trades would be needed to distinguish wholesaler performance?
- Experiment: draw a random sample of trades, calculate wholesaler rankings

Individual Orders: Broker A Data



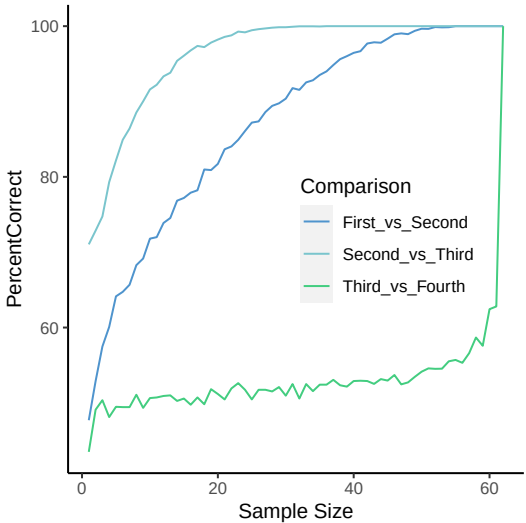
- Very easy to tell the top two wholesalers from the rest.
- Very hard to distinguish some individuals:
  - First-vs-Second, Fourth-vs-Fifth no better than chance

Days in the Month: Broker B Data



- Broker B routes based on 90-day average
- Plot individual day-level wholesaler performance
- How many days of data does one need to accurately guess 90-day average?

Days in the Month: Broker B Data



- Easy to distinguish first-vs-second
- Extremely hard to distinguish third-vs-fourth

Plan

1. Brokers Respond to Wholesaler Performance
   - Broker Focus Points
   - Observability of wholesaler performance
2. Wholesalers Respond to Broker Objectives
   - What happens when a broker changes focus?
   - End of month evaluation?
   - Different market conditions?
3. Competitive Landscape

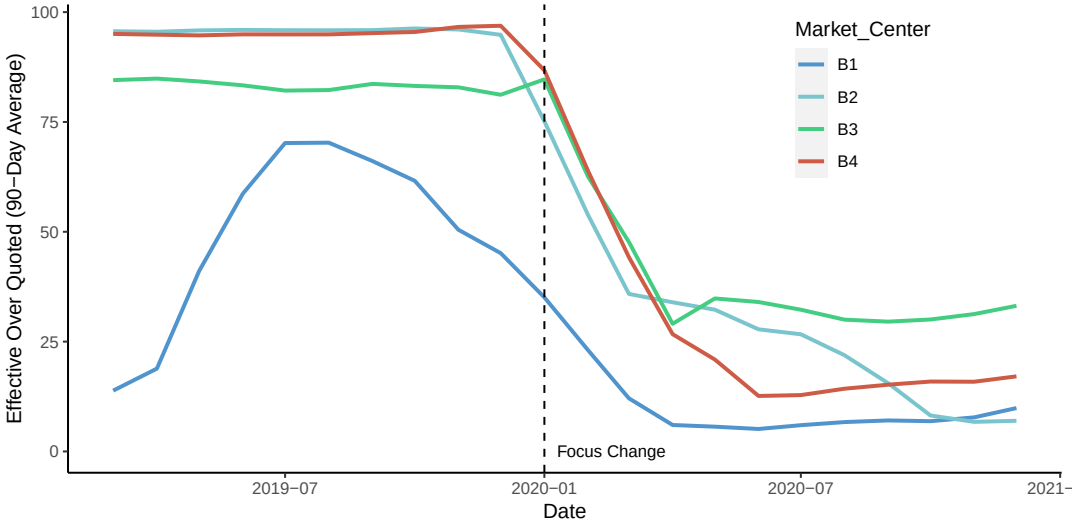
Focus Change

- If brokers changes focus, how do wholesalers respond?

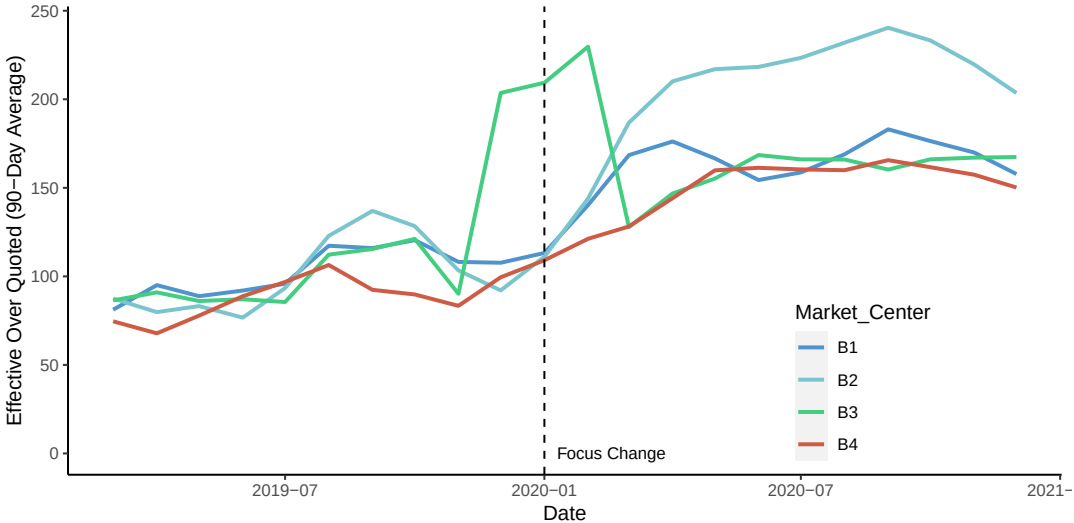
- Broker B: implemented a focus change on January 1, 2020.
  - Consider all aspects of performance.
  - 2019: special focus on orders from 100-1,999 shares
  - 2020: special focus on orders from 1-1,999 shares

- Wholesalers immediately respond.
  - Consistent with competitive, monitored performance

Orders 1-99 Shares



Very Large Orders (2000+ shares)



Focus Change Regression

	Dependent variable:: EFQ			
	Odd Lot		Large Orders	
	(1)	(2)	(3)	(4)
OddLot		44.685**		
		(7.731)		
LargeOrder				66.695***
				(4.483)
FocusChange	−61.821***	−17.085***	68.992***	−16.847***
	(8.034)	(1.641)	(11.205)	(1.591)
OddLot∗FocusChange		−44.790***		
		(6.642)		
LargeOrder∗FocusChange				85.549***
				(10.749)
Observations	820	1,650	820	1,650
R^2	0.841	0.809	0.544	0.886
Note:				*p<0.1; **p<0.05; ***p<0.01

Market Conditions

- Wholesaler are evaluated on long-run historical averages
  - Do they care about market volatility?

$$EFQ = \alpha_0 + \alpha_1 IntradayVolatility + \epsilon$$

- How does wholesaler performance change with market conditions?
  - Competitive pressure - increase performance when they can

	Dependent variable:		
	EFQ (%)	Effective Spread (BPS)	Public Quoted Spread (BPS)
	(1)	(2)	(3)
Trade Volume	1.449**	−3.092	9.581**
	(0.722)	(2.840)	(3.937)
Variance Ratio 1 Minute	−4.001***	52.127***	68.921***
	(0.673)	(2.646)	(3.669)
Intraday Vol	**-0.581*****	**10.364*****	**40.469*****
	(0.152)	(0.599)	(0.831)
Depth	−0.820**	0.728	2.457
	(0.325)	(1.279)	(1.774)
Log Return	−0.882	12.709**	46.892***
	(1.435)	(5.639)	(7.820)
Observations	64,906	64,906	64,906
R^2	0.126	0.604	0.557
Note:		*p<0.1; **p<0.05; ***p<0.01	

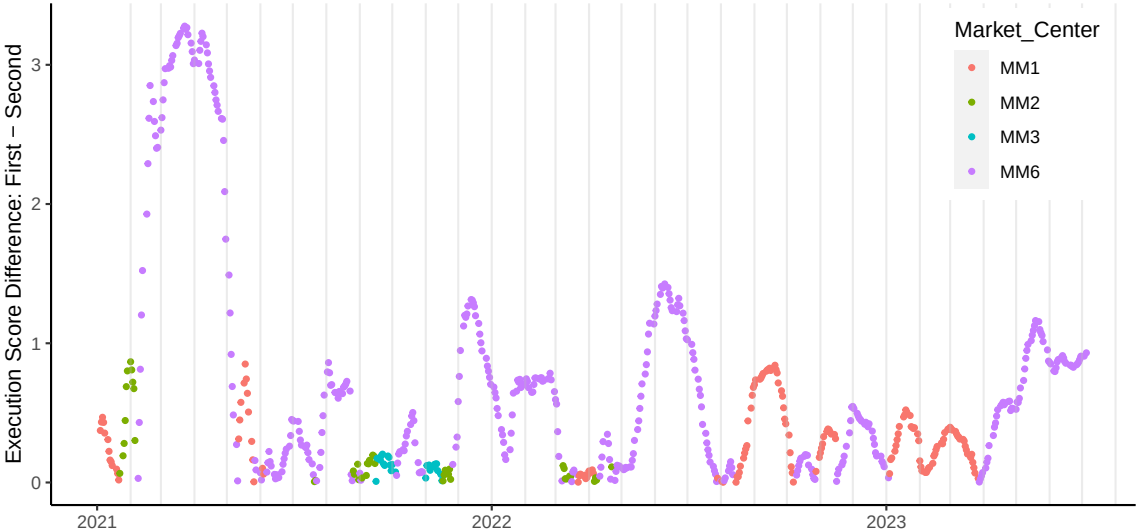
- In volatile markets:
  - Effective spreads increase
  - Quoted spreads increase more
  - EFQ ratios decrease
- Wholesalers improve EFQ on volatile days
- Suggests competitive pressure to improve when they can improve

Wholesaler Dynamics

- Two of our brokers evaluate wholesalers right around the end of the month
- Next month's allocation depends on the 90-day-average right at the end of the month
- End-of-race effect: wholesalers may try to
  - catch a competitor
  - decide to give up

End-Of-Month Race

End-Of-Month Race



Plan

1. Brokers Evaluate Wholesalers

2. Wholesaler Respond to Broker Focuses

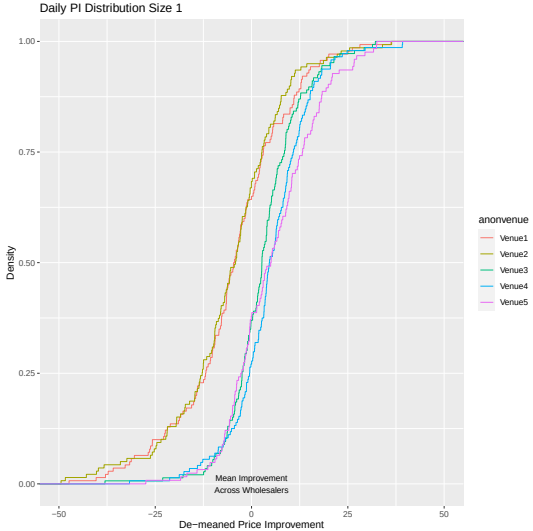
3. Competitive Landscape
   - Different Races in Large vs Small Differences
   - Wholesaler Entry

Order Type Distribution

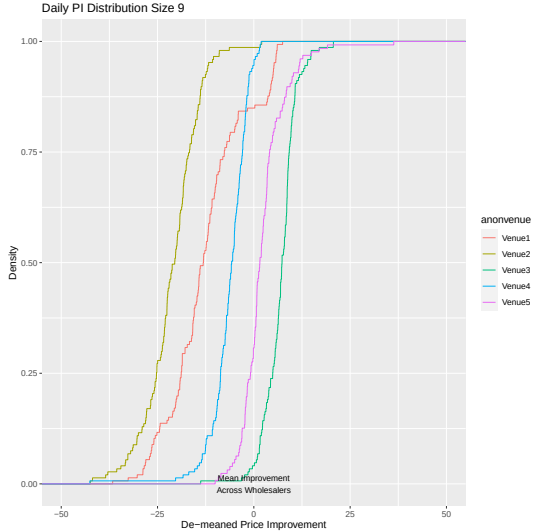
- Broker A routes selectively:
  - Each symbol is on its own. AAPL is routed based on AAPL history, not MSFT history
  - Five independent order size categories
  - Routing a 50 share AAPL order? Look at 1-99 share AAPL performance
  - Routing a 3,000 share AAPL order? Look at 2-5,000 share AAPL pefromance
- Are certain types of orders more or less competitive?
  - Consider distribution of wholesaler performance across stocks and across order sizes

Stock Liquidity

Illiquid Symbols

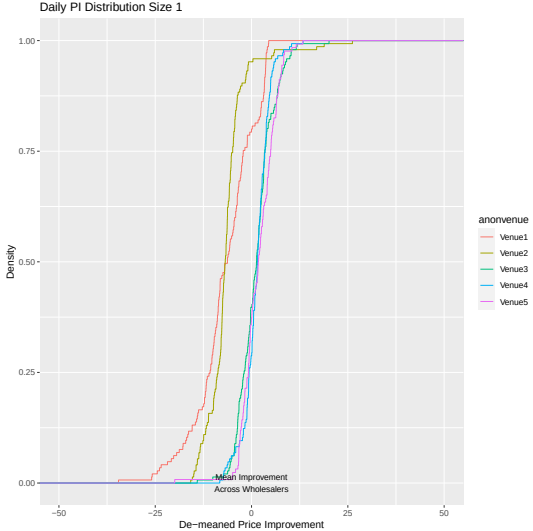


Liquid Symbols

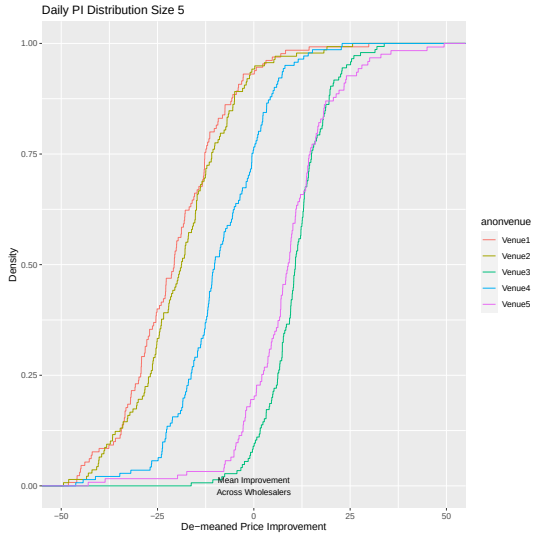


Order Size

Small Orders



Large Orders



Race Example

Bundling is a complicated choice:

- Simple problem: transfers from one stock to another
- Hard problem: some stocks have a close race, others do not
- Bundling changes the respective lead of competitors

Wholesaler Entry

- Large market maker begins working as a wholesaler with Broker A in December 2021

$$Outcome = \alpha_0 + \alpha_1 Post + \epsilon$$

- Where does wholesaler A5 enter?
  - Endogenous choice - each symbol and order size category is independent.
- How does entry change outcomes:
  - EFQ? Increased competition? Displacement?

Wholesaler Entry: Endogenous Entry

	Dependent variable: A5_PostShare					
	(1)	(2)	(3)	(4)	(5)	(6)
First-To-Second	0.073**					0.001
	(0.033)					(0.057)
First-To-Avg		0.054				0.060
		(0.045)				(0.073)
First Firm Order Share			0.147***			−0.095
			(0.030)			(0.120)
HHI				17.102***		9.990
				(2.809)		(13.297)
Effective-Over-Quoted Spread					0.053	0.148**
					(0.036)	(0.062)
Observations	1,461	1,461	1,586	1,586	1,586	1,461
R^2	0.444	0.442	0.396	0.403	0.384	0.447

Note: *p<0.1; **p<0.05; ***p<0.01

Wholesaler Entry: Outcomes Including Entrant

	Dependent variable:				
	First-To-Second	First-To-Avg	First Firm Order Share	HHI	Effective Over Quoted Spread
	(1)	(2)	(3)	(4)	(5)
Post	0.674	-2.977^{***}	9.617^{***}	-0.070^{***}	-7.109^{***}
	(0.586)	(0.432)	(1.188)	(0.006)	(0.478)
Observations	3,157	3,157	2,106	3,467	3,467
R^2	0.293	0.205	0.441	0.421	0.560

- EFQ, HHI, First-to-Average decrease - increased competition
- Current system was not perfectly competitive if wholesaler could enter?

Wholesaler Entry: Outcomes Excluding Entrant

	Dependent variable:				
	First-To-Second	First-To-Avg	First Firm Order Share	HHI	Effective Over Quoted Spread
	(1)	(2)	(3)	(4)	(5)
Post	-1.367^{**}	-2.021^{***}	0.159	0.112^{***}	-6.020^{***}
	(0.589)	(0.405)	(0.599)	(0.013)	(0.499)
Observations	3,133	3,133	3,467	2,100	3,467
R^2	0.262	0.233	0.384	0.470	0.555

- Table - results without Wholesaler A5
- Changes are smaller - wholesaler A5 might be subsidizing liquidity
- HHI goes up - suggests displacement

Findings

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  - Evaluate based on effective-over-quoted spreads
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