



CODA BLOCK EXECUTION QUALITY REPORT

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KEY FINDINGS

“Traders should strongly consider using CODA Block as a tool for finding latent liquidity.” – David Weisberger, Head of Equities

Among the findings of this report’s analysis of 2Q 2018 market data from CODA Block:

CODA Block delivers strong hit rates and unique liquidity.

- 10% of all initiated auctions resulted in a trade.
 - Small-cap auctions resulted in trades 11% of the time
 - Mid-cap auctions resulted in trades 15% of the time
- Average auction trade size was 4X larger than the Displayed Size
 - 24% of all CODA Block trades involved 3 or more participants

CODA Block auctions result in minimum leakage and impact

- On average, CODA Block post-auction markouts moved:
 - Only 7% of the Spread at 30 seconds (post auction)
 - Only 12% of the Spread at 60 seconds (post auction)
 - Average spread width for CODA Block trades was 11.5 bps
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EXECUTIVE SUMMARY

This is the second quarterly report of execution quality for CODA Block Auctions produced by ViableMkts. In this quarter, the metrics for both market impact and information leakage can be judged benign, showing that initiating auctions on the CODA Block platform could be a valuable tool for trading institutional size with little downside and potentially large benefits.

This report was constructed by analyzing the second quarter data from CODA Block auction initiations and trades. This period included over 27,500 auctions initiated in over 1,450 unique symbols. The analysis separates out auctions that were initiated with and without resulting trades; measuring both the execution quality of trades as well as the movement of the National Best Bid and Offer (NBBO) before, during and after the auction.

Based upon the analysis of statistically significant data, ViableMkts has concluded that initiating auctions does not create significant information leakage and that auctions which result in trades are beneficial to the initiator, particularly when attempting to trade substantial quantities relative to the displayed market. This is based on the following highlights of the findings:

Auction Initiation

At all three market capitalization groups, we find evidence that initiating an auction on CODA Block results in minimal information leakage. Despite an average order size roughly 4,809% of the displayed size at the NBBO for the last quarter, the move in the midpoint of the NBBO for all initiated auctions was only 7% of the bid offer spread at 30 seconds later and 12% 60 seconds later. Considering that these small movements take place despite the likelihood of some clients trading outside of CODA Block, particularly when they are not completely filled, it is reasonable to conclude that initiating an auction does not leak the direction or size of the order to the market. It is particularly compelling that the market moved only 11% of the spread after 60 seconds, on average, for auctions where the initiator was not completely filled. This was despite the initiator attempting to trade 4,809% of the displayed liquidity. These

results are almost identical to the statistical analysis of the first quarter, which confirms the hypothesis that those responding to the auction are unable to discern that a larger order lurked behind. The implication is that traders trying to fill large-sized orders should strongly consider using CODA block as a tool for finding latent liquidity.

Auction Trades

At all three market capitalization groups, we find evidence that auctions which result in trades on CODA Block provide valuable liquidity at a reasonable price. Despite an average fill quantity in the second quarter of 411% of the NBBO order size, 97% of all executions took place at or better than the NBBO. In addition, despite the fact that, on average, auctions were filled when the price of the stock moved towards the auction initiator by 26% of the spread during the auction (lower if the initiator was buying and higher if selling), after the auction, the stocks moved in favour of the trade slightly (7% of the spread at 30 seconds and 8% at 60 seconds). Were there to be a move against the initiator after purchasing or selling, that would have been indicative of adverse selection, but that was not the case. It is also worth noting that the data for small and mid cap stocks was even more compelling. Trades occurred despite only a 19% of the spread move towards the initiator during the auction for small cap and 25% move for mid cap and the post auction move was positive. In addition, small cap stock auctions resulted in trades 11% of the time, while mid cap auctions resulted in trades 15% of the time.

Conclusion

The data shows that using CODA Block generally did not create adverse market moves when initiating an auction, and, when successful, the liquidity found by the process was both incrementally valuable and did not suffer post trade adverse selection on average. The statistics analysed have been quite consistent across market capitalization groups for each of the past 4 quarters of data.

METRIC DEFINITIONS

Market Move

Market move, for the context of this report, is the movement of the midpoint of the NBBO from immediately before the time period specified. For the report, the following Mid Moves were measured:

- Pre-Auction (both 60 seconds and 30 seconds before the auction was initiated to the initiation time)
- During Auction (for the entire duration of the auction from initiation until either trade or cancel messages sent out)
- Post-Auction (both 60 seconds and 30 seconds after the time the auction concluded)

Spread Metrics

The Bid Offer Spread, for the purpose of this paper, is represented by the NBBO as reported by the SIP, which aggregates the top-of-book from all registered securities exchanges. The metrics calculated include:

- Average spread of all initiated auctions
- Average spread of all auctions that resulted in trades
- Ratio of the order size to the size at the NBBO aggregated across exchanges
- Execution price relative to the spread at the far side (the offer for buy orders and bid for sell orders).

Other Descriptive Metrics

In addition to the foregoing, the following additional descriptive metrics were calculated to provide context for the analysis:

- Auctions per day
- % of auctions with responses
- % of auctions with a trade
- % of trades/auctions where initiator was filled 100%
- Symbols with auctions per day
- Average trade size

METHODOLOGY

CODA Markets, working with ViableMkts, analysed anonymized auction initiating orders and auctions where executions resulted from the CODA Block platform. Based on all the metrics defined above.

Auctions were analyzed in total and within market capitalization groups of Large, Mid and Small. Auctions were categorized as all auctions, auctions with trades, and within the auctions with trades, in the last quarter we analyzed auctions where the initiator was completely filled vs those with partial fills.

We looked at the market moves in each of the time periods and stock categories for patterns that would indicate adverse selection or information leakage.

Adverse Selection

For the purpose of this report, we defined adverse selection as situations where the market moved against orders which resulted in executions from the perspective of the auction initiator.

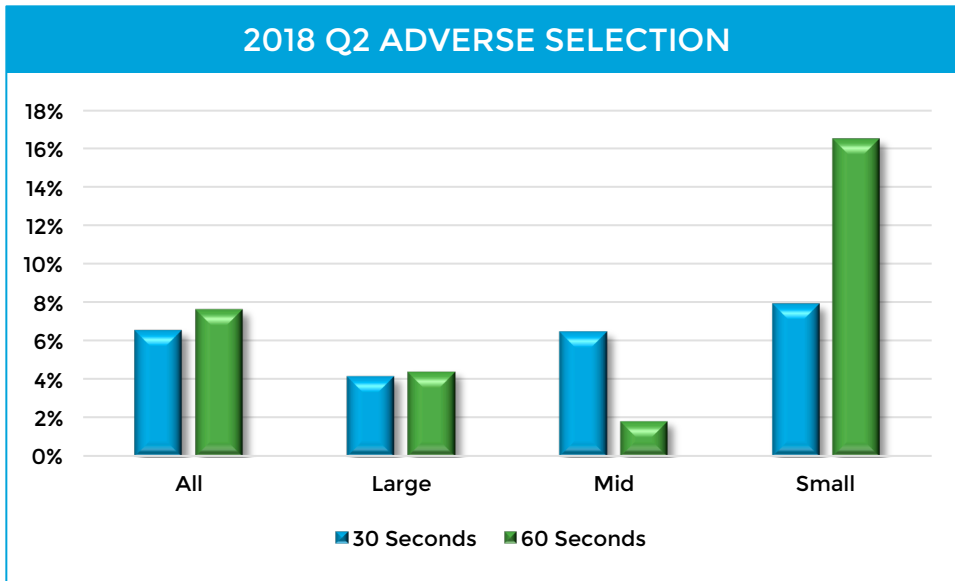
Information Leakage

For the purpose of this report, we defined information leakage as the tendency of the market to move in the direction that the auction initiator was attempting either during or after the auction. This metric needs to be analyzed, however, in the context that the auction initiator could (and often is) trade on multiple venues after the auction, particularly if it fails to execute their orders.

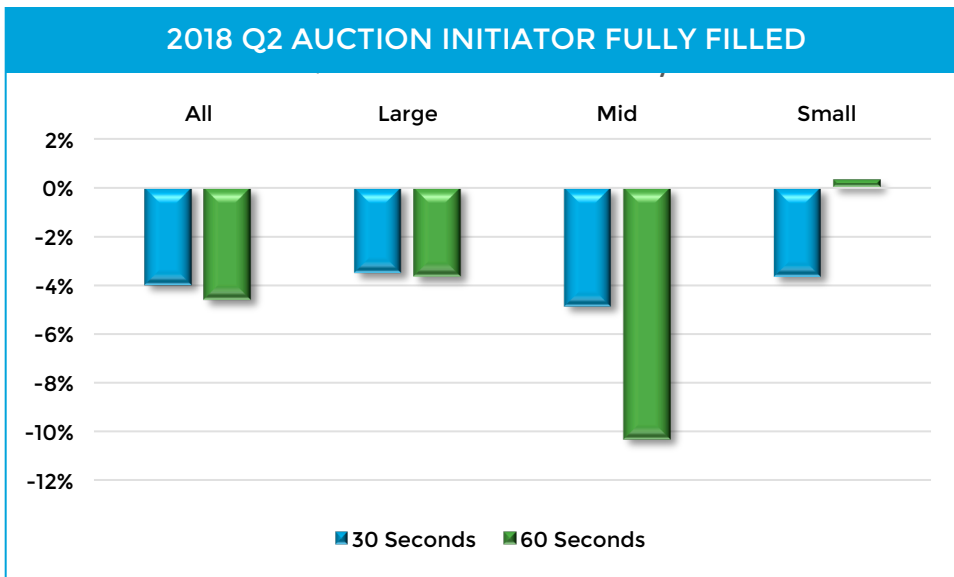
RESULTS & CONCLUSIONS

Adverse Selection Analysis

In the second quarter, across large, mid and small cap stocks, the data shows little to no adverse selection for trades from initiated auctions. Overall and in most cases, the data shows that the market moved positively when fills were received by CODA Block initiators and the adverse moves that occurred were small.

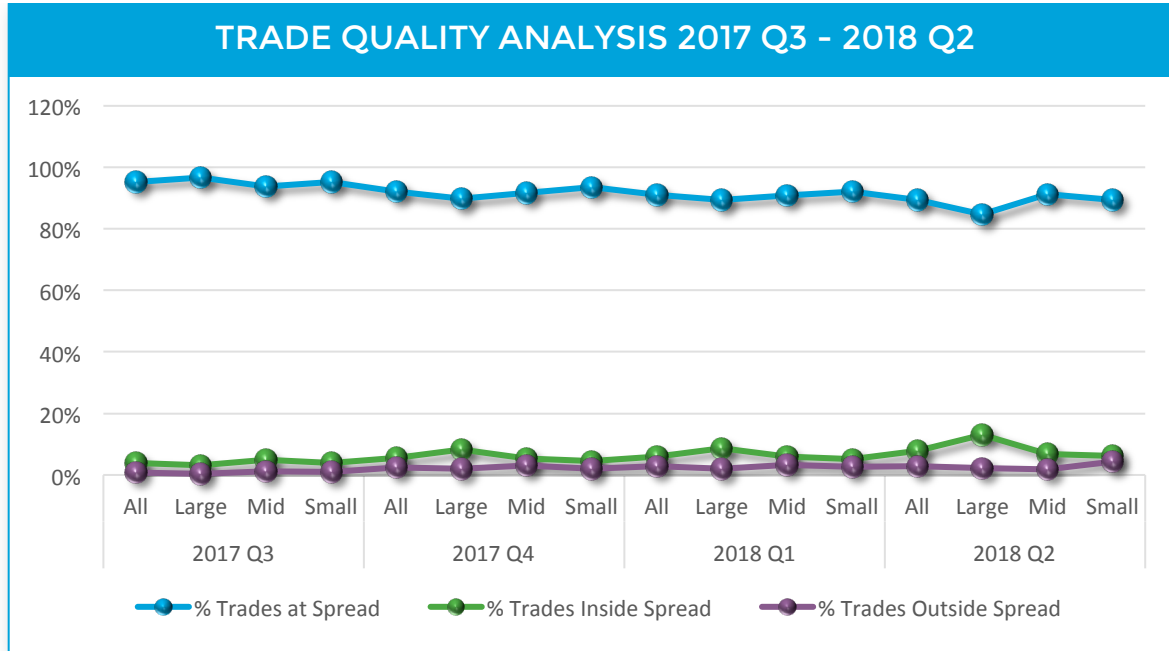


We also analyzed adverse selection for trades where the auction initiator was completely filled. This was added, to ensure that cases where the order was completely filled was due to finding latent liquidity, rather than due to adverse selection. (Which would be described as buying in a falling market or selling in a rising one) The data, however, does not show significant adverse selection in this case, showing only 1% overall and only showing any material adverse move in large cap stocks. (Although, a “21% of spread” adverse move is not very material.)



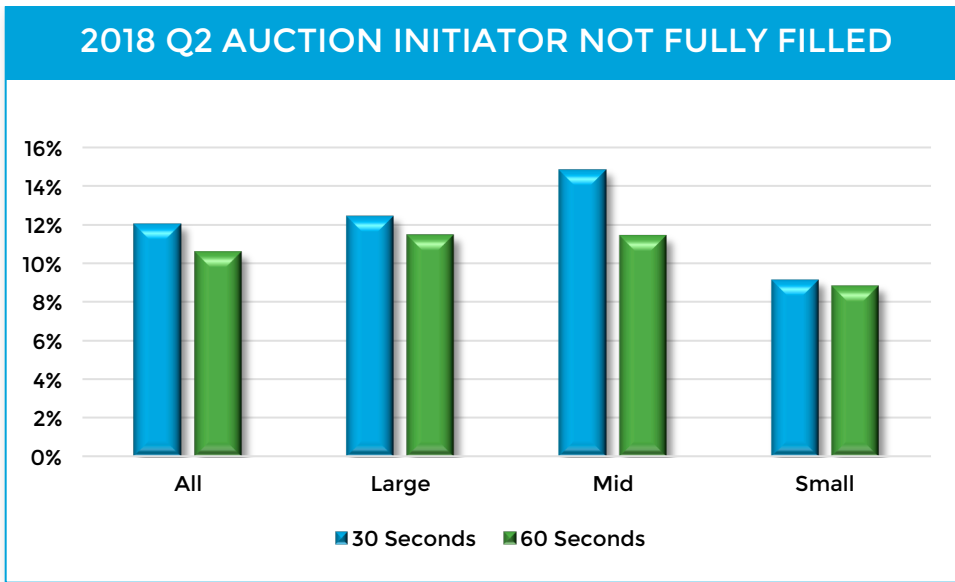
Trade Quality Analysis

In all this quarter, as with the 3 quarters analyzed in our last review, the trades executed, despite being for much larger than the quantity displayed at the NBBO, were done at or better than the NBBO more than 97% of the time. Most trades were executed at the spread, but there were some trades inside the spread with a very small amount outside of the spread as depicted below.

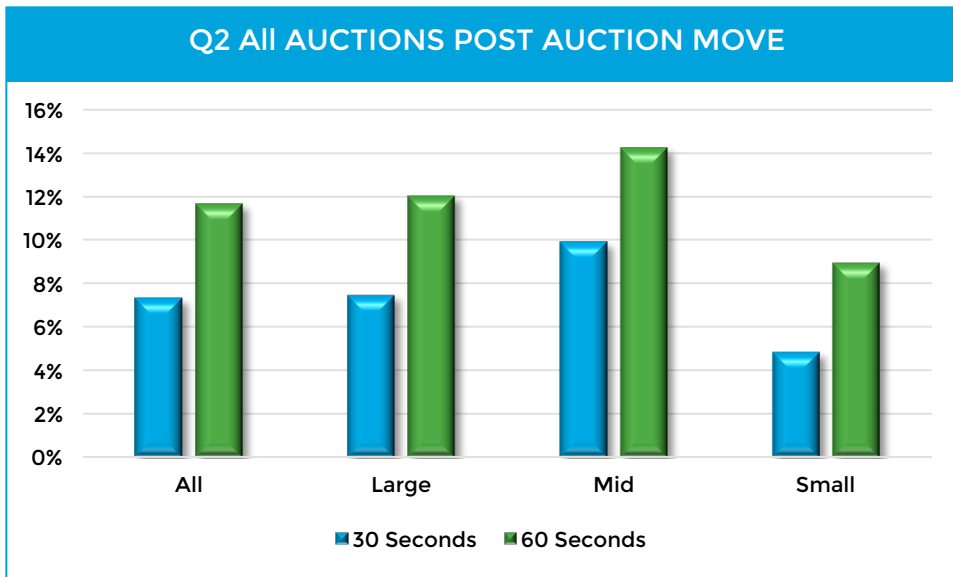


Information Leakage Analysis

In this quarter, we see no evidence of significant information leakage from initiated auctions. While 79% of the auctions did attract responses in the latest quarter, the movement after the auction, when auction initiators were not fully filled, was only 8% of the spread during the auction, 12% of the spread at 30 seconds after the auction and 11% of the spread at 60 seconds after the auction.



For all auctions, the movement from the time that an auction was initiated to the time it ended, was 11% of the spread. 7% of the spread after 30 seconds and 12% of the spread after 60 seconds. Thus, despite the average auction initiator seeking to trade 4,809% of the displayed size available at the NBBO, the average move from auction initiation to 90 seconds later was only 23% of the spread. Considering that it is highly likely that the auction initiator, who is trying to trade over 40 times the available displayed liquidity, would trade elsewhere within the 60 seconds after the auction, this shows that the auction itself does not materially leak information. Had, on the other hand, the responders to the auction been aware of such a large order, we would expect to see much more movement.



APPENDIX

1. CODA Block Auction Quarterly Data Table (Q2 2018 - Q3 2017)
2. CODA Block Auction Fully Filled & Non-Fully Filled Initiator Data Table (Q1 and Q2 2018)
3. CODA Block Auction Order & Trade Size Requirements

1.	2018 Q2				2018 Q1				2017 Q4			
	All	Large	Mid	Small	All	Large	Mid	Small	All	Large	Mid	Small
Auctions per day	430	149	134	148	492	156	173	163	490	154	184	152
Pct with response	79%	83%	79%	75%	80%	84%	80%	76%	77%	81%	80%	70%
Pct with trade	10%	6%	15%	11%	11%	5%	13%	14%	10%	6%	11%	12%
Pct of trades with 3+ participants	24%	36%	21%	22%	22%	31%	20%	21%	21%	39%	16%	17%
Pct of trades initiator filled 100%	22%	42%	16%	18%	19%	36%	15%	16%	15%	33%	8%	13%
Pct of auctions initiator filled 100%	2.3%	2.3%	2.3%	2.3%	2.0%	2.0%	2.0%	2.0%	1.4%	1.4%	1.4%	1.4%
Symbols initiated per day	102	34	35	34	115	34	41	40	108	34	40	35
Pct of symbols traded per day	33%	24%	40%	37%	37%	23%	41%	46%	34%	22%	39%	40%
Symbols initiated per quarter	1455	400	513	595	1,412	362	514	606	1,472	362	576	600
Pct symbols traded per period	40%	35%	44%	40%	44%	37%	45%	46%	44%	39%	50%	43%
Avg trade size	6,905	13,079	6,395	4,117	6,095	11,859	6,131	3,930	6,542	16,075	4,774	3,772
Ratio to NBBO size	411%	548%	306%	368%	403%	462%	380%	372%	469%	330%	759%	352%
Pct trades priced at spread	89%	85%	91%	89%	91%	89%	91%	92%	92%	90%	92%	94%
Pct trades priced inside spread	8%	13%	7%	6%	6%	9%	6%	5%	6%	8%	5%	4%
Pct trades priced outside spread	3%	2%	2%	4%	3%	2%	3%	3%	2%	2%	3%	2%
Initiation size ratio to NBBO	4809%	3839%	4825%	5987%	4115%	3635%	4536%	4131%	5422%	5500%	5447%	5275%
Avg initiated spread width (bps)	11.5	4.4	8.9	21.1	11.2	4.2	8.5	20.7	11.5	4.4	7.1	24.2
60s before	-1%	2%	-2%	-2%	0%	2%	-2%	1%	3%	7%	1%	0%
30s before	-2%	-1%	-2%	-2%	-2%	-2%	-2%	-3%	-1%	-1%	0%	-1%
During auction	11%	12%	14%	6%	8%	13%	9%	3%	11%	16%	9%	8%
30s after	7%	7%	10%	5%	6%	5%	8%	6%	7%	10%	4%	6%
60s after	12%	12%	14%	9%	10%	11%	12%	9%	11%	16%	8%	10%
Initiation size ratio to NBBO	1604%	1528%	1463%	1893%	2106%	1677%	2482%	1732%	1867%	1674%	2054%	1774%
Avg initiated spread width (bps)	14.2	6.3	12.1	21.2	15.3	6.0	11.9	22.1	15.2	7.3	9.5	25.5
60s before	4%	25%	0%	-2%	3%	-10%	5%	7%	6%	12%	2%	6%
30s before	3%	18%	0%	-3%	2%	-7%	3%	3%	4%	10%	2%	4%
During auction	-26%	-41%	-25%	-19%	-26%	-60%	-28%	-12%	-17%	-24%	-21%	-8%
30s after	7%	4%	6%	8%	7%	-2%	9%	8%	11%	19%	6%	13%
60s after	8%	4%	2%	16%	8%	-3%	10%	9%	13%	23%	6%	15%

2.	2018 Q2 - INITIATOR FULLY FILLED				2018 Q2 - INITIATOR NOT FULLY FILLED				
	All	Large	Mid	Small	All	Large	Mid	Small	
Auctions per Day	10	4	3	3	420	145	130	145	
Pct with Response	100%	100%	100%	100%	79%	82%	79%	75%	
Pct with Trade	100%	100%	100%	100%	8%	4%	13%	9%	
Pct of Trades with 3+ Participants	47%	46%	52%	44%	18%	28%	15%	17%	
Pct of Trades with Initiator Filled 100%	100%	100%	100%	100%	0%	0%	0%	0%	
Pct of Auctions with Initiator Filled 100%	100.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	
Symbols initiated per Day	10	4	3	3	100	33	34	33	
Pct of Symbols Traded per Day	100%	100%	100%	100%	26%	15%	35%	31%	
Symbols Initiated per Quarter	223	79	73	79	1455	400	513	595	
Pct Symbols Traded per Period	100%	100%	100%	100%	37%	29%	42%	38%	
Avg Auction Trade Size*	14,137	16,849	16,393	8,315	4,867	10,379	4,486	3,173	
Ratio to NBBO Size	466%	552%	396%	395%	365%	544%	243%	351%	
Pct Trades Priced at Spread	80%	80%	80%	80%	92%	88%	93%	92%	
Pct Trades Priced Inside Spread	19%	19%	19%	19%	5%	9%	5%	3%	
Pct Trades Priced Outside Spread	1%	1%	1%	1%	3%	3%	2%	5%	
All Auctions	Initiation Size Ratio to NBBO	580%	624%	559%	513%	1145%	429%	871%	2110%
	Avg Initiated Spread Width (bps)	13.3	6.6	14.8	20.2	0.0	0.0	0.0	0.0
	60 sec Before Auction Initiation	10%	35%	-8%	-1%	-2%	-2%	-2%	-2%
	30 sec Before Auction Initiation	9%	18%	4%	2%	12%	14%	15%	7%
	During Auction	-24%	-35%	-20%	-15%	8%	8%	10%	5%
	30 sec After Auction Completion	-4%	-3%	-5%	-4%	12%	12%	15%	9%
	60 sec After Auction Completion	-5%	-4%	-10%	0%	11%	11%	11%	9%
Only Auctions with Trades	Initiation Size Ratio to NBBO	580%	624%	559%	513%	1837%	2073%	1614%	2066%
	Avg Initiated Spread Width (bps)	13.3	6.6	14.8	20.2	14.5	6.0	11.6	21.4
	60 sec Before Auction Initiation	10%	35%	-8%	-1%	2%	17%	1%	-2%
	30 sec Before Auction Initiation	9%	18%	4%	2%	1%	18%	0%	-4%
	During Auction	-24%	-35%	-20%	-15%	-26%	-46%	-26%	-19%
	30 sec After Auction Completion	-4%	-3%	-5%	-4%	9%	10%	9%	10%
	60 sec After Auction Completion	-5%	-4%	-10%	0%	11%	10%	4%	20%

3. CODA Block Auction Order & Trade Size Requirements

Description	Criteria	MINIMUM AUCTION ORDER SIZE		MINIMUM AUCTION TRADE SIZE	
		To Initiate	To Participate	Auction Priced at/within NBBO	Auction Priced Outside NBBO
Small Cap	<= \$2 Bln	2,000	1,000	1,000	2,000
Mid Cap	> \$2 Bln <= \$10 Bln	5,000	1,000	1,000	5,000
Large Cap	> \$10 Bln	10,000	1,000	5,000	10,000
High Price Stocks	Priced >= \$100	2,000	1,000	1,000	2,000
Tick Size Pilot*	Test Group 3	See Mkt. Cap	1,000	See Mkt. Cap	5,000

* Above market cap rules apply to Tick Size Pilot Stocks in Test Group 1, Test Group 2

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Report & Analysis prepared by:

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ABOUT ViableMkts

ViableMkts is a strategic advisory firm that provides business analysis, research and guidance to institutions who are focused on successfully adapting to the ever-changing market environment. The firm specializes in financial technology and is comprised of an unparalleled team of proven innovators with an extensive track record of building and delivering financial market solutions. The Principals are former leaders at investment banks, trading platforms, exchanges and technology vendors that cover the gamut of equities, credit, rates, swaps, FX and crypto assets.

ViableMkts helps:

- Sell-side dealers leverage technology to increase inventory velocity, improve sales performance, reduce development time and improve delivery.
- Buy-side asset managers improve access to liquidity, enhance ability to make and distribute prices and maintain trading compliance while reducing transaction costs.
- Platforms accelerate validated learning through vetting product concepts, enhancing product design and refining strategy to improve execution.

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