CODA BLOCK EXECUTION QUALITY REPORT

Contents

EXECUTIVE SUMMARY

This is the first quarterly report by ViableMkts of execution quality for CODA Block auctions. CODA Block is a US equity ATS which operates an on-demand, institutional auction trading facility. In this report, 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 or no downside and potentially large benefits.

This report was constructed by analyzing 9 months of CODA Block auction initiations, orders and trades - a period which included over 96,000 auctions initiated in over 2,000 symbols, and over 53,000,000 shares traded in nearly 1,000 symbols. The analysis separates out auctions that were initiated with and without resulting trades, and measures 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.

This analysis report was prepared by ViableMkts based on data provided by CODA Markets, Inc.

Based upon the analysis of statistically significant data, ViableMkts has concluded that initiating auctions does not create significant information leakage and, furthermore, 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 4,115% of the displayed size at the NBBO for the last quarter (with CODA Block ticker-only alerts sent to qualified subscribers), the move in the midpoint of the NBBO for all initiated auctions was only 6% of the bid-offer spread at 30 seconds later and 10% 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 and 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 4,180% of the displayed liquidity.

This 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 first quarter of 403% 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 favor 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 cap stocks was even more compelling. Trades occurred despite only a 12% of the spread move towards the initiator during the auction, and the post-auction move was slightly more positive. In addition, small cap stock auctions resulted in trades 14% of the time, which was a higher success rate than for larger cap stocks.

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 incrementally valuable and did not suffer post-trade adverse selection on average. The statistics analyzed have been quite consistent across market capitalization groups for each of the past 3 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

ViableMkts analyzed anonymized auction data, namely initiating orders, responding orders, and resulting auction execution or non-execution data on the CODA Block platform based on all the metrics defined above.

For each quarter, auctions were analyzed in total and within market capitalization groups of Large (>$10 bln+), Mid ($2 bln-$10 bln) and Small (< $2 bln). Auctions were categorized as all auctions and auctions with trades. Within the auctions with trades, in the last quarter, ViableMkts analyzed auctions where the initiator was completely filled vs those with partial fills.

ViableMkts 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.

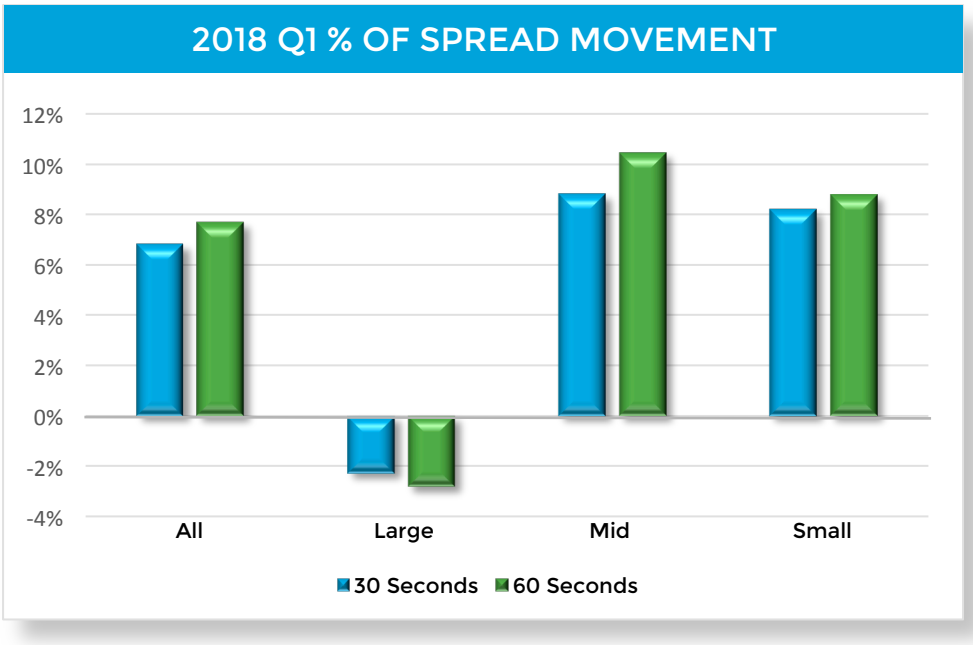
Information Leakage

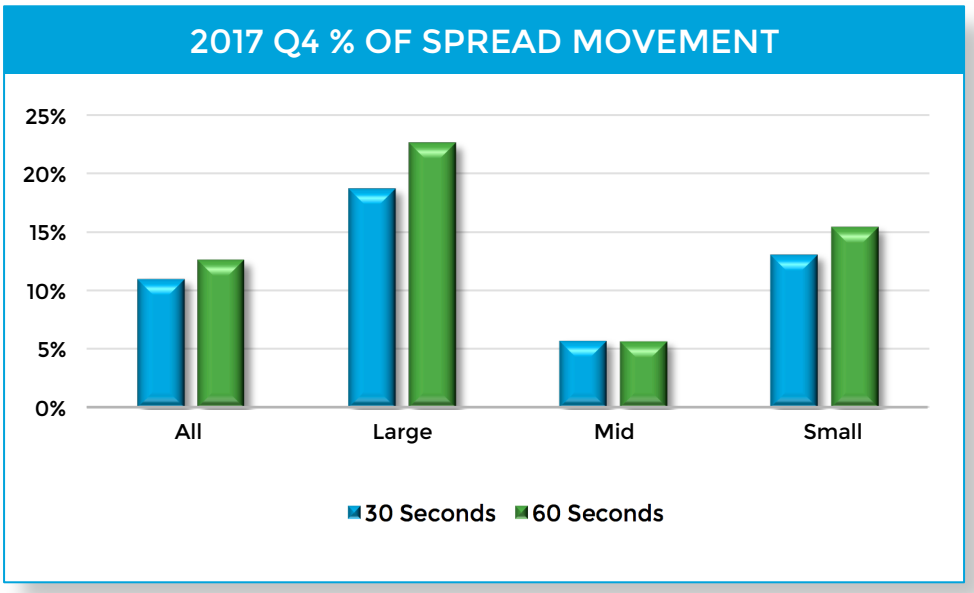
For the purpose of this report, we defined information leakage as the tendency of the market to move in the direction that the auction initiator was attempting to trade either during or after the auction. This metric needs to be analyzed, however, in the context that the auction initiator could (and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

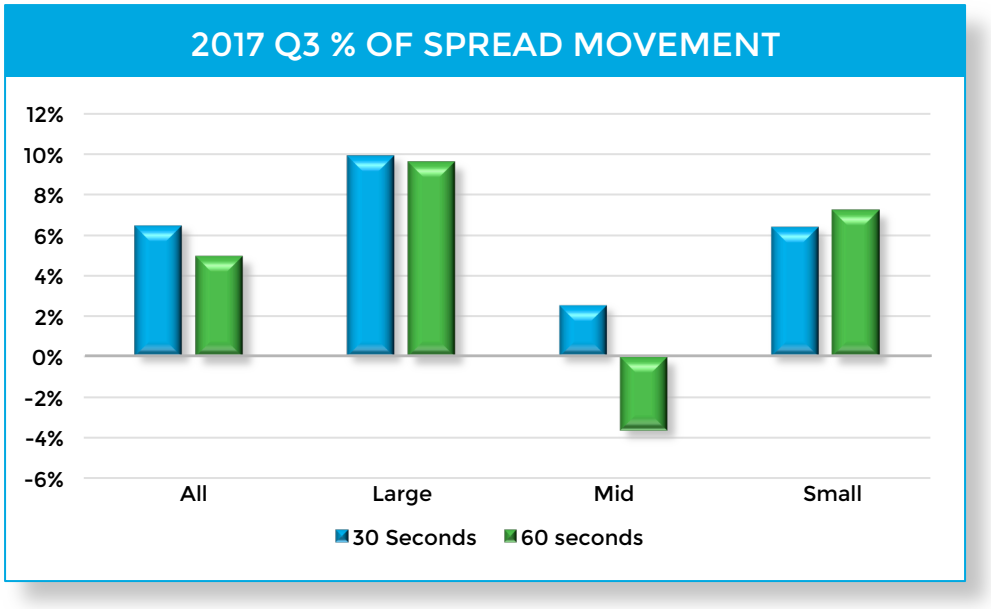
RESULTS & CONCLUSIONS

Adverse Selection Analysis

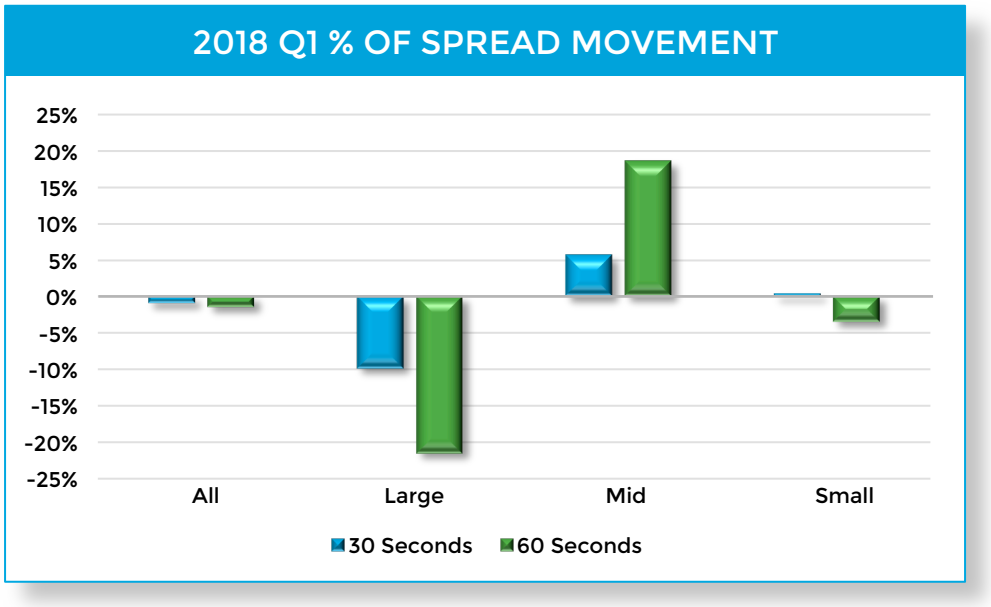
In all three quarters analyzed - and across large, mid and small cap stocks - the data shows little to no adverse selection for trades from initiated auctions. Overall and in most cases, the data shows that the market moved positively when fills were received by CODA Block initiators, and the adverse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


2018 Q1 % OF SPREAD MOVEMENT
12%
10%
8%
6%
4%
2%
0%
-2%
-4%
All
Large
Mid
Small
30 Seconds
60 Seconds


2017 Q4 % OF SPREAD MOVEMENT
25%
20%
15%
10%
5%
0%
All
Large
Mid
Small
30 Seconds
60 Seconds

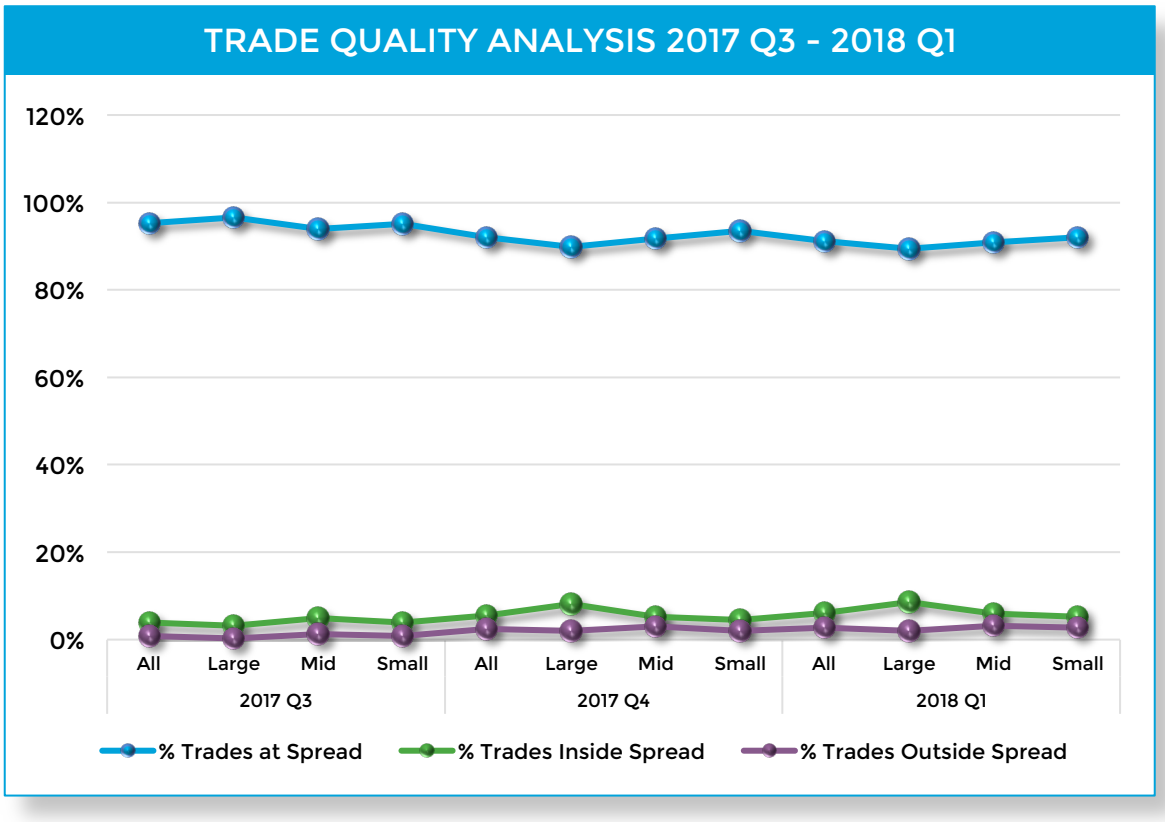


In addition, in the first quarter of 2018, we also analyzed adverse selection for trades where the auction initiator was completely filled. This was added to ensure that cases where the order was completely filled were due to finding latent liquidity, rather than due to adverse selection. (Which would 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, at 21% of spread, an adverse move is not very material)



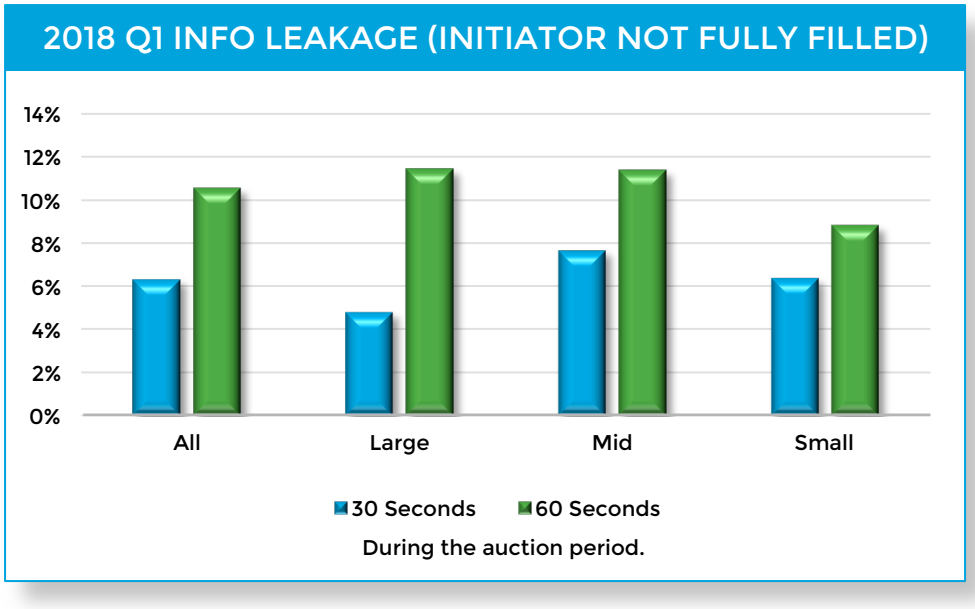
Trade Quality Analysis

In all three quarters analyzed, the trades executed, despite being for much larger than the quantity displayed at the NBBO, were done at or better than the NBBO 97% of the time or greater. 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.

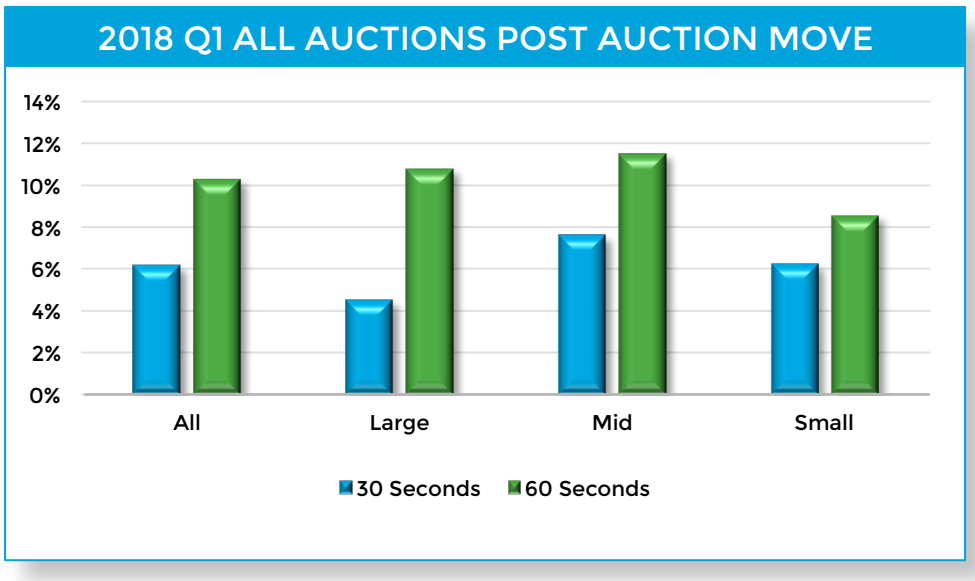


Information Leakage Analysis

In all three quarters analyzed, we see no evidence of significant information leakage from initiated auctions. While 80% of the auctions did attract responses in the latest quarter, the movement after the auction, when auction initiators were not fully filled, was only 9% of the spread during the auction, 6% 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 when the auction ended was 8% of the spread, with an additional 6% of the spread after 30 seconds and 10% of the spread after 60 seconds. Thus, despite the average auction initiator in the past quarter seeking to trade 4, 115% of the displayed size available at the NBBO (with CODA Block's ticker-only alert sent to qualified subscribers), the average move from auction initiation to 90 seconds later was only 18% 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 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 (Q1 2018 – Q3 2017)
2. CODA Block Auction Fully Filled & Non-Fully Filled Initiator Data Table (Q1 2018)
3. CODA Block Auction Order & Trade Size Requirements

1.

		2018 Q1				2017 Q4				2017 Q3			
		All	Large	Mid	Small	All	Large	Mid	Small	All	Large	Mid	Small
	Auctions per Day	492	156	173	163	490	154	184	152	497	149	191	157
	Pct with Response	80%	84%	80%	76%	77%	81%	80%	70%	72%	74%	74%	69%
	Pct with Trade	11%	5%	13%	14%	10%	6%	11%	12%	4%	4%	3%	5%
	Pct of Trades with 3+ Participants	22%	31%	20%	21%	21%	39%	16%	17%	41%	47%	41%	35%
	Pct of Trades with Initiator Filled 100%	19%	36%	15%	16%	15%	33%	8%	13%	28%	43%	19%	22%
	Pct of Auctions with Initiatior Filled 100%	2.0%	1.9%	2.0%	2.2%	1.4%	1.9%	0.9%	1.5%	1.0%	1.8%	0.5%	1.0%
	Symbols Initiated per Day	115	34	41	40	108	34	40	35	95	29	36	30
	Pct of Symbols Traded per Day	37%	23%	41%	46%	34%	22%	39%	40%	17%	18%	12%	22%
	Symbols Initiated per Quarter	1,412	362	514	606	1,472	362	576	600	1,202	309	479	463
	Pct Symbols Traded per Period	44%	37%	45%	46%	44%	39%	50%	43%	26%	28%	22%	29%
	Avg Auction Trade Size*	6,095	11,859	6,131	3,930	6,542	16,075	4,774	3,772	9,912	15,946	9,539	5,125
	Ratio to NBBO Size	403%	462%	380%	372%	469%	330%	759%	352%	374%	246%	615%	387%
	Pct Trades Priced at Spread	91%	89%	91%	92%	92%	90%	92%	94%	95%	97%	94%	95%
	Pct Trades Priced Inside Spread	6%	9%	6%	5%	6%	8%	5%	4%	4%	3%	5%	4%
	Pct Trades Priced Outside Spread	3%	2%	3%	3%	2%	2%	3%	2%	1%	0%	1%	1%
All Auctions	Initiation Size Ratio to NBBO	4115%	3635%	4536%	4131%	5422%	5500%	5447%	5275%	5158%	4905%	6144%	3955%
All Auctions	Avg Initiated Spread Width (bps)	11.2	4.2	8.5	20.7	11.5	4.4	7.1	24.2	10.4	4.1	7.1	20.6
All Auctions	60 sec Before Auction Initiation	0%	2%	-2%	1%	3%	7%	1%	0%	2%	7%	1%	-1%
All Auctions	30 sec Before Auction Initiation	-2%	-2%	-2%	-3%	-1%	-1%	0%	-1%	0%	4%	-1%	-1%
All Auctions	During Auction	8%	13%	9%	3%	11%	16%	9%	8%	12%	20%	10%	7%
All Auctions	30 sec After Auction Completion	6%	5%	8%	6%	7%	10%	4%	6%	6%	9%	5%	5%
All Auctions	60 sec After Auction Completion	10%	11%	12%	9%	11%	16%	8%	10%	11%	17%	9%	8%
Only Auctions with Trades	Initiation Size Ratio to NBBO	2106%	1677%	2482%	1732%	1867%	1674%	2054%	1774%	1000%	812%	947%	1390%
Only Auctions with Trades	Avg Initiated Spread Width (bps)	15.3	6.0	11.9	22.1	15.2	7.3	9.5	25.5	15.1	7.3	10.4	25.0
Only Auctions with Trades	60 sec Before Auction Initiation	3%	-10%	5%	7%	6%	12%	2%	6%	-2%	-1%	-2%	-3%
Only Auctions with Trades	30 sec Before Auctopm Initiation	2%	-7%	3%	3%	4%	10%	2%	4%	1%	4%	5%	-5%
Only Auctions with Trades	During Auction	-26%	-60%	-28%	-12%	-17%	-24%	-21%	-8%	-19%	-29%	-16%	-13%
Only Auctions with Trades	30 sec After Auction Completion	7%	-2%	9%	8%	11%	19%	6%	13%	6%	10%	3%	6%
Only Auctions with Trades	60 sec After Auction Completion	8%	-3%	10%	9%	13%	23%	6%	15%	5%	10%	-4%	7%

2.		2018 Q1 - INITIATOR FULLY FILLED				2018 Q1 - INITIATOR NOT FULLY FILLED			
		All	Large	Mid	Small	All	Large	Mid	Small
	Auctions per Day	10	3	3	4	482	153	170	159
	Pct with Response	100%	100%	100%	100%	80%	84%	80%	75%
	Pct with Trade	100%	100%	100%	100%	9%	3%	11%	12%
	Pct of Trades with 3+ Participants	49%	48%	51%	49%	16%	21%	15%	16%
	Pct of Trades with Initiator Filled 100%	100%	100%	100%	100%	0%	0%	0%	0%
	Pct of Auctions with Initiatior Filled 100%	100.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%
	Symbols initiated per Day	10	3	3	4	113	33	40	39
	Pct of Symbols Traded per Day	100%	100%	100%	100%	31%	15%	36%	40%
	Symbols Initiated per Quarter	223	73	73	83	1408	361	513	603
	Pct Symbols Traded per Period	100%	100%	100%	100%	42%	33%	43%	45%
	Avg Auction Trade Size*	14,362	17,800	16,999	8,890	4,212	8,478	4,223	3,010
	Ratio to NBBO Size	458%	469%	422%	505%	359%	452%	351%	297%
	Pct Trades Priced at Spread	85%	87%	82%	85%	93%	91%	92%	93%
	Pct Trades Priced Inside Spread	14%	12%	17%	14%	4%	6%	4%	4%
	Pct Trades Priced Outside Spread	1%	1%	1%	1%	3%	3%	4%	3%
All Auctions	Initiation Size Ratio to NBBO	577%	740%	444%	540%	4180%	3693%	4614%	4187%
	Avg Initiated Spread Width (bps)	16.1	7.1	15.9	23.9	11.1	4.1	8.4	20.6
	60 sec Before Auction Initiation	4%	2%	3%	6%	0%	2%	-2%	1%
	30 sec Before Auction Initiation	2%	-1%	6%	2%	-2%	-2%	-3%	-3%
	During Auction	-31%	-59%	-23%	-15%	9%	14%	10%	4%
	30 sec After Auction Completion	-1%	-10%	6%	0%	6%	5%	8%	6%
	60 sec After Auction Completion	-1%	-21%	19%	-3%	11%	11%	11%	9%
Only Auctions with Trades	Initiation Size Ratio to NBBO	577%	740%	444%	540%	2407%	2163%	2785%	1891%
	Avg Initiated Spread Width (bps)	16.1	7.1	15.9	23.9	15.1	5.4	11.2	21.8
	60 sec Before Auction Initiation	4%	2%	3%	6%	3%	-17%	5%	7%
	30 sec Before Auctopm Initiation	2%	-1%	6%	2%	1%	-10%	2%	4%
	During Auction	-31%	-59%	-23%	-15%	-25%	-60%	-29%	-12%
	30 sec After Auction Completion	-1%	-10%	6%	0%	9%	2%	9%	10%
	60 sec After Auction Completion	-1%	-21%	19%	-3%	10%	8%	9%	11%

3. CODA Block Auction Order & Trade Size Requirements

		MINIMUM AUCTION ORDER SIZE		MINIMUM AUCTION TRADE SIZE	
Description	Criteria	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 >/= $300	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					

Appendix supplied by CODA Markets©

David Weisberger
Head of Equities
ViableMkts

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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