



CODA BLOCK EXECUTION QUALITY REPORT

Contents

- Overview
- Executive Summary
- Metric Definitions
- Methodology
- Results and Conclusions
- Appendix – Comprehensive Data Tables

OVERVIEW

“Initiating auctions on CODA Block could be a valuable tool for trading institutional size with little downside and potentially large benefits. Auctions which result in trades are beneficial to the initiator, particularly when attempting to trade substantial quantities relative to the displayed market.” – David Weisberger, Head of Equities, ViableMkts

Among the findings of this report’s analysis of CODA Block’s first 12 months of market data (October 2017 to September 2018):

- 97% of all executions took place at or better than the NBBO despite a share-weighted fill quantity of 441% of the NBBO order size.
- CODA Block delivers strong hit rates and unique liquidity
 - 10% of all initiated auctions resulted in a trade.
 - 11% of all small-cap auctions resulted in trades.
 - 12% of all mid-cap auctions resulted in trades.
- CODA Block auctions result in minimal leakage and impact
 - On average, CODA Block post-auction mark-outs 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.

Data is consistent throughout the year.

EXECUTIVE SUMMARY

This is the first full-year report of execution quality for CODA Block Auctions, designed by ViableMkts. For the 12 months starting October 1, 2017 and ending September 30, 2018, 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 analysing a full year of data from CODA Block auction initiations and trades. The analysis separates out auctions that were initiated without and with trades that resulted 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. Data provided by technology staff of PDQ Enterprises (parent company of CODA Markets) and analysis done under the supervision of ViableMkts.

Based upon the analysis, we have concluded that, based on statistically significant data, 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 5728% of the displayed size at the NBBO for the last year, the move in the mid 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 seems 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 12% of the spread after 60 seconds, on average, for auctions where the initiator was not completely filled. These results were quite consistent throughout the year, 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 find latent liquidity should strongly consider using CODA block as a tool for finding 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 a share weighted fill quantity over the past year of 441% 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 resulted in fills occurred when the price of the stock moved towards the auction initiator by 22% 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 (9% of the spread at 30 seconds and 10% 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 more compelling. Trades occurred despite only a 12% of the spread move towards the initiator during the auction for small cap and 23% 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 12% 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. These statistics represent the overall numbers, but it is also worth noting that they have been quite consistent on a quarterly basis as well.

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 Viable Mkts, analysed anonymized auction initiating orders and auctions where executions resulted from 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, 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.

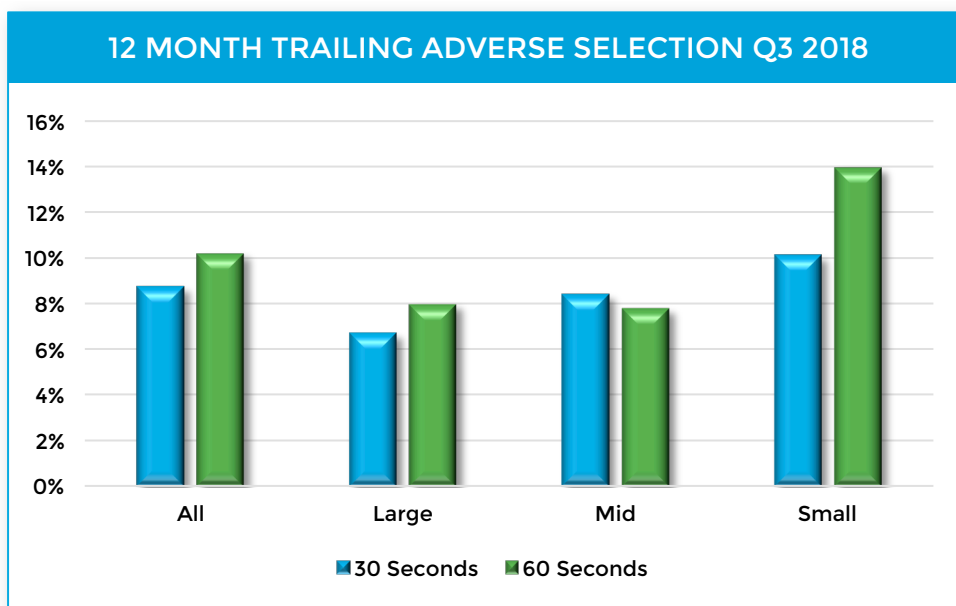
Information Leakage

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.

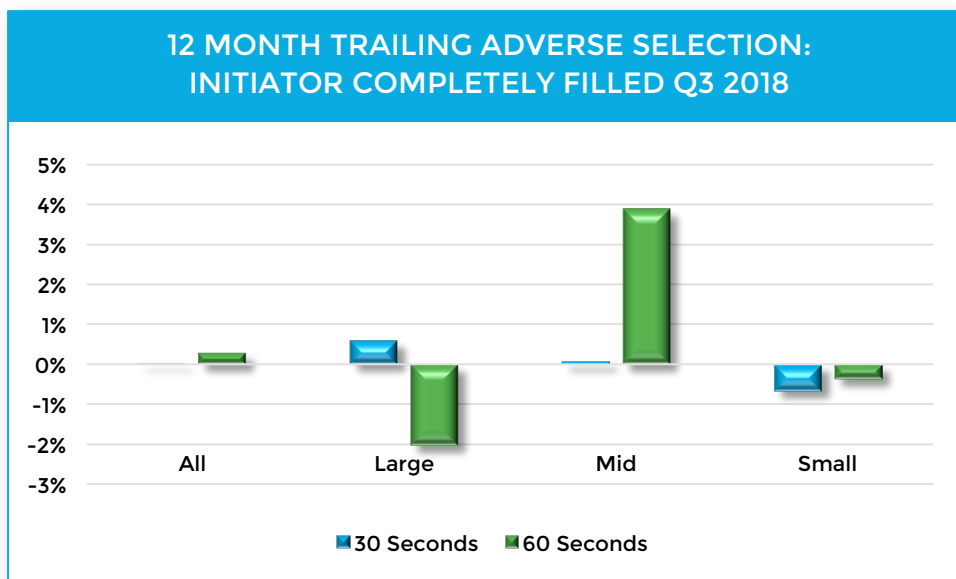
RESULTS & CONCLUSIONS

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.

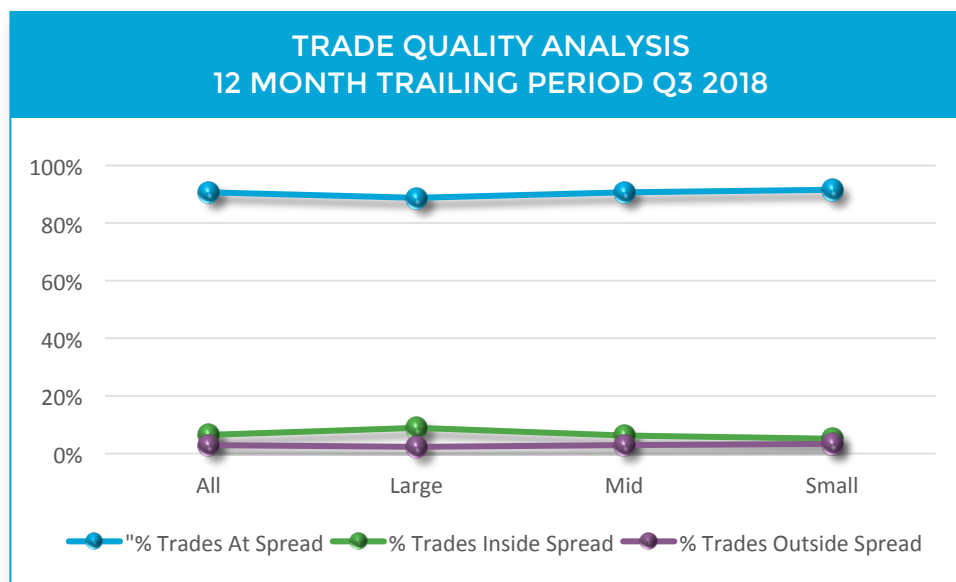


In addition, in the first quarter of 2018, we also analyzed adverse selection for trades where the auction initiator was completely filled. This was added, to ensure that cases where the order was completely filled was due to finding latent liquidity, rather than due to adverse selection. (Which would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



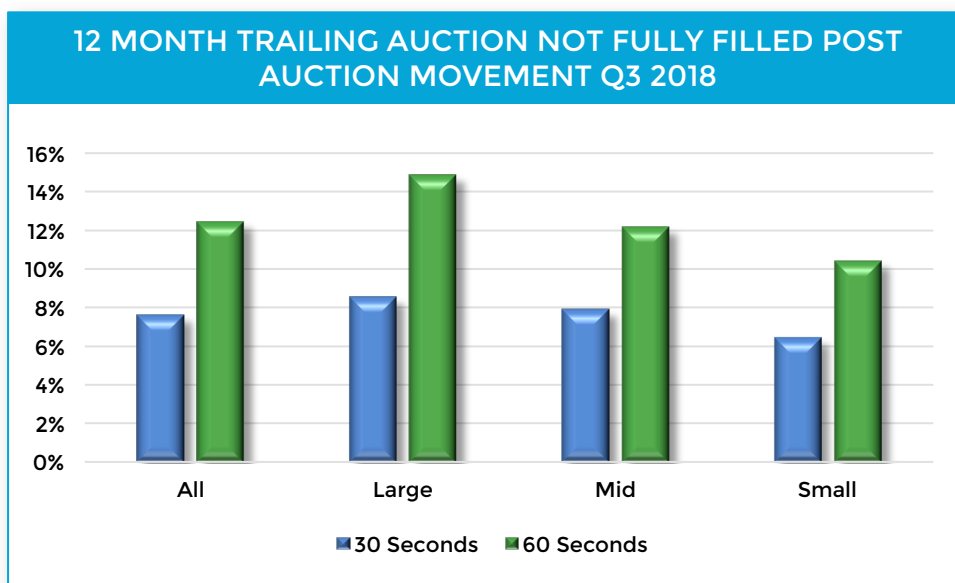
Trade Quality Analysis

For the previous 12 months in aggregate, 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.

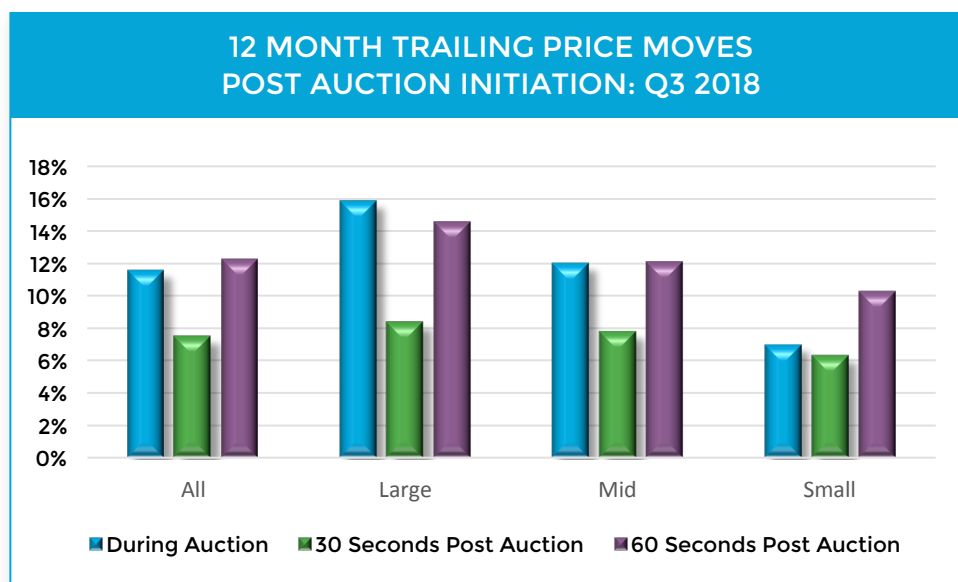


Information Leakage Analysis

For the past 12 months, we see no evidence of significant information leakage from initiated auctions. While 75% of the auctions did attract responses in the latest quarter, the movement after the auction, when auction initiators were not fully filled, was only 12% of the spread during the auction, 8% of the spread at 30 seconds after the auction and 12% of the spread at 60 seconds after the auction.



For all auctions, the movement from the time that an auction was initiated to the auction ended was 12% of the spread, with an additional 7% of the spread after 30 seconds and 12% of the spread after 60 seconds. Thus, despite the average auction initiator in the past 12 months seeking to trade 5728% of the displayed size available at the NBBO, the average move from auction initiation to 90 seconds later was only 31% 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 12-Month Data Table (Q4 2017 - Q3 2018)
2. CODA Block Auction Fully Filled & Non-Fully Filled Initiator Data Table
3. CODA Block Auction Order & Trade Size Requirements

| 1. | | 10/1/2017 - 9/30/2018 | | | |
|---------------------------|---------------------------------------|-----------------------|--------|-------|-------|
| | | All | Large | Mid | Small |
| All Auctions | Auctions per day | 398 | 128 | 136 | 134 |
| | Pct with response | 75% | 80% | 77% | 70% |
| | Pct with trade | 10% | 6% | 12% | 11% |
| | Pct of trades with 3+ participants | 23% | 36% | 20% | 20% |
| | Pct of trades initiator filled 100% | 18% | 37% | 13% | 15% |
| | Pct of auctions initiator filled 100% | 1.8% | 1.8% | 1.8% | 1.8% |
| | Symbols per day | 92 | 29 | 33 | 31 |
| | % of symbols traded per day | 30% | 21% | 35% | 35% |
| | Symbols per period | 2463 | 585 | 933 | 1206 |
| | % symbols traded per period | 45% | 43% | 49% | 41% |
| | Avg trade size | 6,503 | 13,494 | 5,730 | 3,958 |
| | Ratio to NBBO size (share weighted) | 441% | 459% | 449% | 396% |
| | Initiation size ratio to NBBO | 5728% | 5430% | 6266% | 5415% |
| | Avg initiated spread width (bps) | 14.4 | 5.0 | 10.1 | 27.8 |
| | 60s before | 0% | 3% | -1% | -1% |
| | 30s before | -2% | -2% | -2% | -2% |
| | During auction | 12% | 16% | 12% | 7% |
| | 30s after | 7% | 8% | 8% | 6% |
| | 60s after | 12% | 15% | 12% | 10% |
| Only Auctions with Trades | Initiation size ratio to NBBO | 1997% | 1871% | 2139% | 1870% |
| | Avg traded spread width (bps) | 16.9 | 6.9 | 12.3 | 27.0 |
| | 60s before | 4% | 9% | 3% | 4% |
| | 30s before | 3% | 8% | 2% | 2% |
| | During auction | -22% | -41% | -23% | -12% |
| | 30s after | 9% | 7% | 8% | 10% |
| | 60s after | 10% | 8% | 8% | 14% |
| | Pct trades priced at spread | 91% | 89% | 91% | 92% |
| | Pct trades priced inside spread | 6% | 9% | 6% | 5% |
| | Pct trades priced outside spread | 3% | 2% | 3% | 3% |

| 2. | | 10/1/2017 - 9/30/2018 - Initiator Fully Filled | | | | 10/1/2017 - 9/30/2018 - Initiator Not Fully Filled | | | |
|---------------------------|---------------------------------------|--|--------|--------|--------|--|--------|-------|-------|
| | | All | Large | Mid | Small | All | Large | Mid | Small |
| | Auctions per day | 8 | 3 | 2 | 3 | 391 | 126 | 133 | 131 |
| | Pct with response | 100% | 100% | 100% | 100% | 75% | 79% | 76% | 70% |
| | Pct with trade | 100% | 100% | 100% | 100% | 8% | 4% | 11% | 10% |
| | Pct of trades with 3+ participants | 50% | 53% | 51% | 46% | 17% | 26% | 15% | 16% |
| | Pct of trades initiator filled 100% | 100% | 100% | 100% | 100% | 0% | 0% | 0% | 0% |
| | Pct of auctions initiator filled 100% | 100.0% | 100.0% | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| | Symbols per day | 8 | 3 | 3 | 3 | 91 | 29 | 32 | 30 |
| | % of symbols traded per day | 100% | 100% | 100% | 100% | 25% | 14% | 32% | 31% |
| | Symbols per period | 406 | 131 | 131 | 172 | 2462 | 584 | 932 | 1205 |
| | % symbols traded per period | 100% | 100% | 100% | 100% | 44% | 40% | 48% | 40% |
| | Avg trade size | 14,656 | 18,169 | 16,625 | 8,723 | 4,665 | 10,760 | 4,109 | 3,087 |
| | Ratio to NBBO size (share weighted) | 533% | 526% | 558% | 508% | 471% | 527% | 240% | 204% |
| All Auctions | | | | | | | | | |
| | Initiation size ratio to NBBO | 533% | 526% | 558% | 508% | 5807% | 5526% | 6348% | 5466% |
| | Avg initiated spread width (bps) | 15.8 | 7.6 | 15.4 | 25.5 | 14.4 | 4.9 | 10.0 | 27.9 |
| | 60s before | 6% | 16% | -1% | 1% | 0% | 3% | -1% | -1% |
| | 30s before | 5% | 9% | 4% | 3% | -2% | -2% | -2% | -3% |
| | During auction | -26% | -43% | -18% | -13% | 12% | 17% | 12% | 7% |
| | 30s after | 0% | 1% | 0% | -1% | 8% | 9% | 8% | 6% |
| | 60s after | 0% | -2% | 4% | 0% | 12% | 15% | 12% | 10% |
| Only Auctions with Trades | | | | | | | | | |
| | Initiation size ratio to NBBO | 533% | 526% | 558% | 508% | 2260% | 2451% | 2368% | 2021% |
| | Avg traded spread width (bps) | 15.8 | 7.6 | 15.4 | 25.5 | 17.2 | 6.5 | 11.8 | 27.3 |
| | 60s before | 6% | 16% | -1% | 1% | 4% | 5% | 3% | 5% |
| | 30s before | 5% | 9% | 4% | 3% | 2% | 7% | 2% | 2% |
| | During auction | -26% | -43% | -18% | -13% | -21% | -39% | -24% | -12% |
| | 30s after | 0% | 1% | 0% | -1% | 11% | 10% | 10% | 12% |
| | 60s after | 0% | -2% | 4% | 0% | 12% | 14% | 8% | 17% |
| | | | | | | | | | |
| | Pct trades priced at spread | 85% | 87% | 84% | 84% | 92% | 90% | 92% | 93% |
| | Pct trades priced inside spread | 14% | 12% | 16% | 15% | 5% | 7% | 5% | 3% |
| | Pct trades priced outside spread | 1% | 1% | 1% | 1% | 3% | 3% | 3% | 4% |

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 |

Appendix supplied by CODA Markets©

Report & Analysis prepared by:
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.

viablemkt.com