



**SPEED MATTERS. FLEXIBILITY MATTERS.
EXECUTION COST MATTERS.**

Market Microstructure: Corn Futures Spreads

Written by Mindy Mallory, Ph.D.

Associate Professor and Clearing Corporation Charitable Foundation Endowed Chair of Food & Agricultural Marketing
Agricultural Economics
Purdue University

& Conner Naughton

318 W Adams St 10th FL | Chicago, IL 60606 | 312-870-1537
www.rcm-x.com | algorithms@rcm-x.com

EXECUTION RISK: CORN MARKET

In markets with a pro-rata matching engine component, liquidity providers have incentive to inflate their posted quantities to receive a larger allocation of passive fills. This is beneficial for traders that need to fill large orders in the spread market, and in low volatility markets helps prevent a single large passive order from claiming the top spot in a FIFO queue and receiving all incoming fills. However, since it results in larger quoted sizes than the true inventory risk appetite of quote providers, some market participants complain about the impression of “vanishing liquidity” this can create.

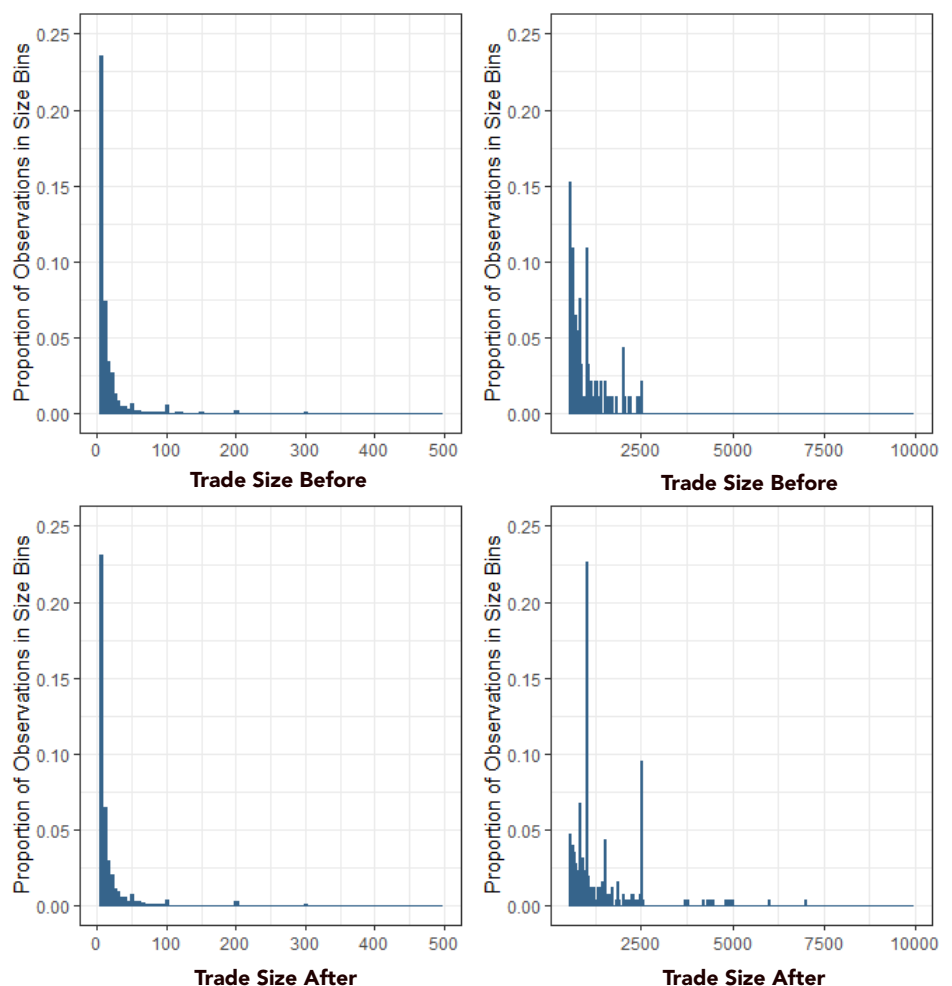
Prior to July 29, 2018 the maximum order quantity allowed for corn calendar spread futures was 2,500 contracts; if a participant needed to buy 5,000 contracts of the spread they would need to submit two orders. Since an order of the maximum possible size might signal additional order flow in the very short term to liquidity providers, liquidity providers will cancel their bids and offers and wait for more information or post at less aggressive prices. For a trader willing to cross the spread for immediacy, having to split their order can result in increased execution costs if their first trade(s) cause the price to move against them as liquidity providers react to their large orders.

The CME Group increased the maximum trade size in the corn spread market to 10,000 contracts in a pilot program on June 29, 2018 in response to these concerns. In this article, we explore the price and size reactions to large orders in the corn December 2018-March 2019 spread market from May 1, 2018 to September 30, 2018. We then conclude the article with a

discussion of how execution risk was affected by increasing the maximum trade size to 10,000.

Figure 1 shows the distribution of trade size before and after the change. Note that the X axis has been broken and trade sizes above 500 are displayed in the right panels to allow what would have been imperceptible in the right tail to be shown. While there is clearly some trading at sizes larger than 2500 it does not account for a very large proportion of total trades. We do see a noticeable increase in the 1000 lot and 2500 lot trade sizes.

Figure 1: ZCZ8-ZCH9 Trade sizes Before & After July 29, 2018



Impact on Trade Sizes and Posted Quantities at the Best Bid and Ask Prices

Figure 2 shows the distributions of the sum of the bid and ask quantities posted before and after the policy change. There does not seem to be an increase in risk aversion reflected in the inflated posted quantities by liquidity providers; posted sizes were actually higher after the increase in the maximum trade size. However, that may have been due to the policy change, or it may have simply been due to the fact that the December-March spread was in a more active trading period after the policy change than before.

Figure 2: ZCZ8-ZCH9 Book Size Before & After July 29, 2018

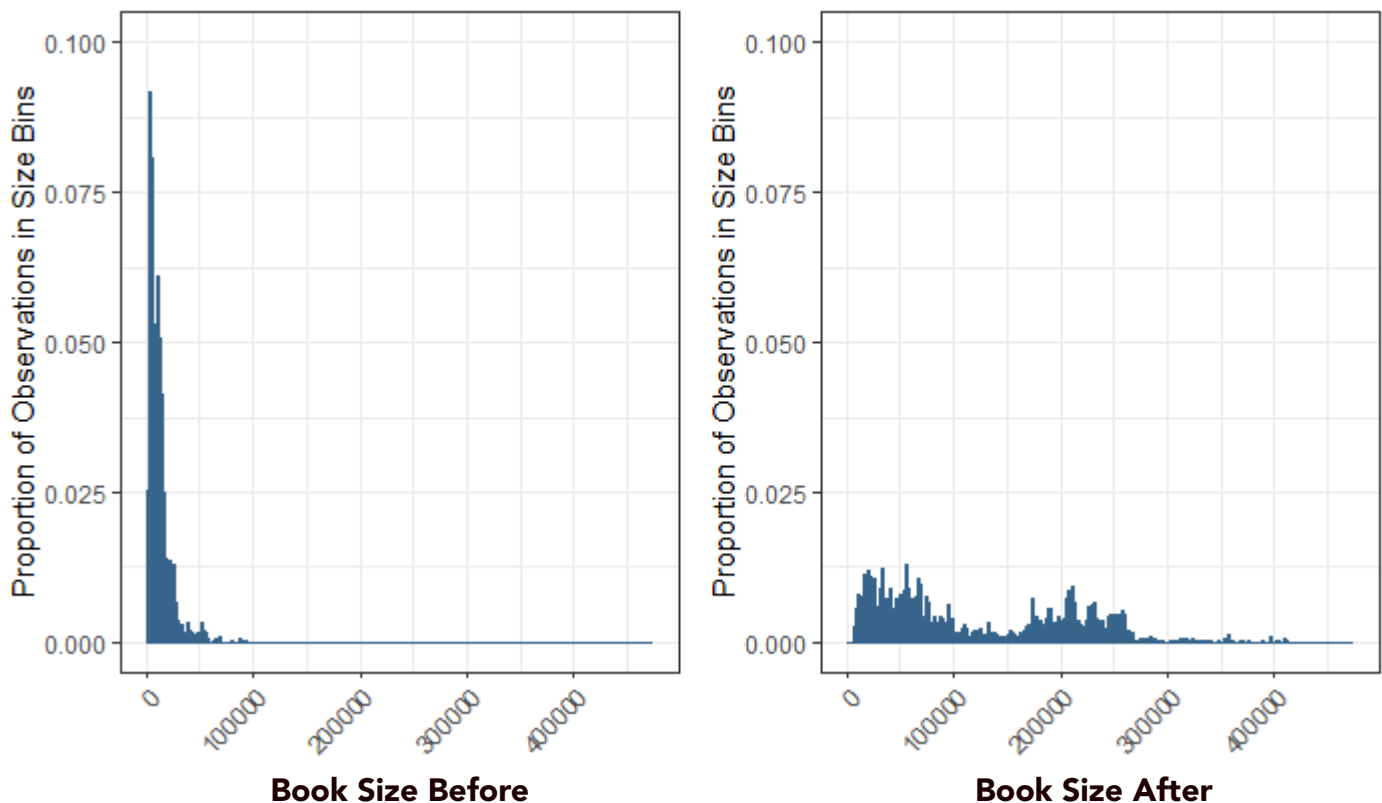


Table 1: Summary of Trade Sizes in Various Size Bins, Before July 29, 2018

Trade Size Bins	Number of Trades	Proportion of Trades	Proportion of Trades that Clear Price Level
0 to 10	22621	0.84	0.01
11 to 20	2002	0.07	0.02
21 to 30	757	0.03	0.03
31 to 40	285	0.01	0.06
41 to 50	268	0.01	0.04
51 to 100	511	0.02	0.10
101 to 500	409	0.02	0.21
501 to 1000	60	0.00	0.42
1001 to 2500	32	0.00	0.50

Table 2: Summary of Trade Sizes in Various Size Bins, After July 29, 2018

Trade Size Bins	Number of Trades	Proportion of Trades	Proportion of Trades that Clear Price Level
0 to 10	41214	0.84	0.00
11 to 20	3214	0.07	0.01
21 to 30	1167	0.02	0.01
31 to 40	612	0.01	0.03
41 to 50	542	0.01	0.02
51 to 100	1099	0.02	0.04
101 to 500	998	0.02	0.08
501 to 1000	156	0.00	0.12
1001 to 2500	83	0.00	0.24
2501 to 5000	11	0.00	0.45
5001 to 10000	2	0.00	0.00

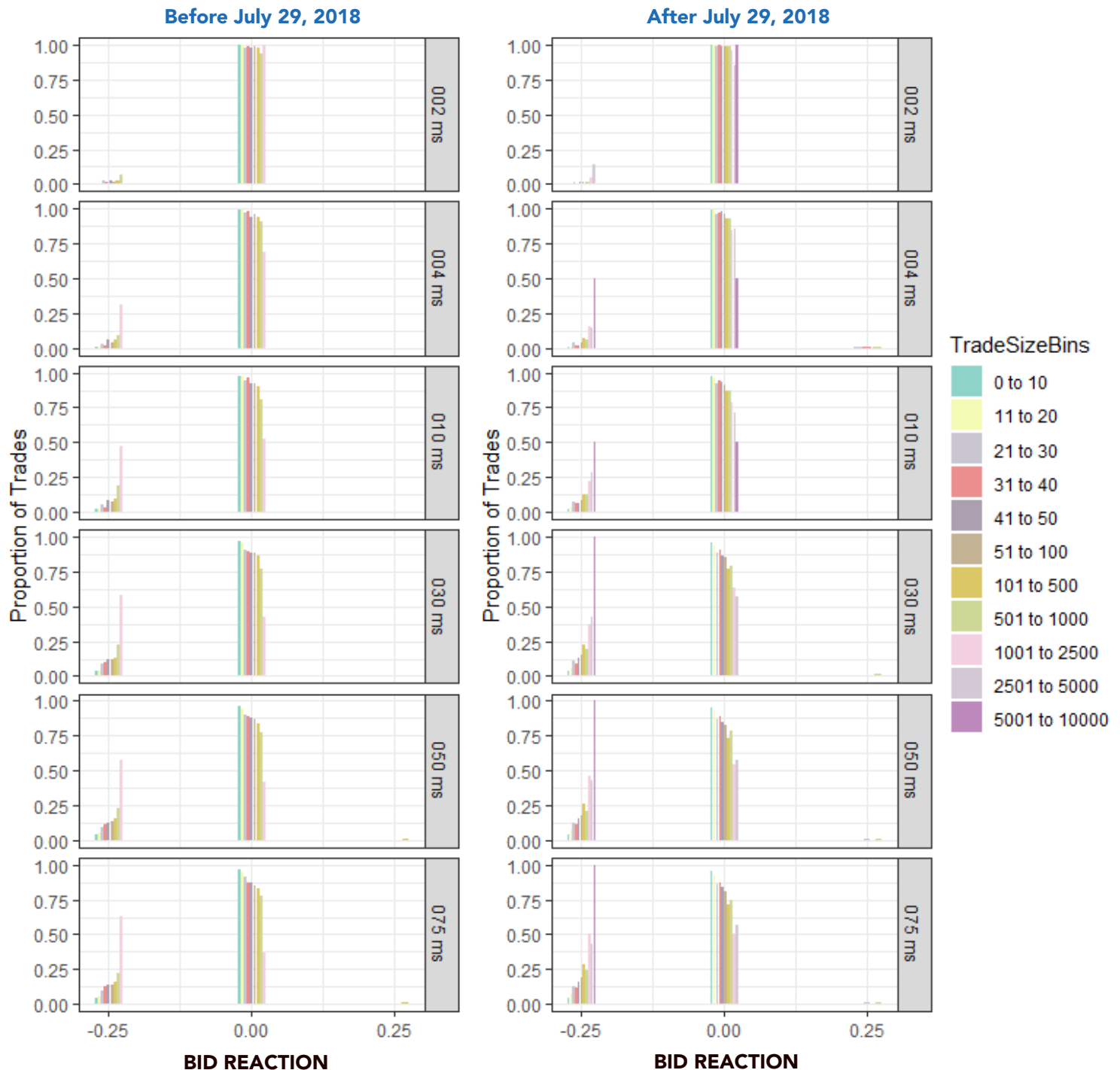
Tables 1 and 2 bin trades (seen on next page) on size and show the number of trades per bin, the proportion of total trades in each size bin, and the proportion of trades in a bin that exhausted all resting liquidity on the inside quote. The tables show that although the increased maximum trade size did bring some activity to the larger end of the size distribution, it was not large enough to meaningfully impact the distribution of trade sizes. However, the proportion of trades that completely take out the price level decreased within each bin after the change in maximum order quantity, although it remains relatively high for the larger size bins. This result is not surprising given the increase in posted liquidity shown in Figure 1.

Price Reactions

Figure 3 on page 5 shows the reaction of price when an aggressive sell order arrives and Figure 4 the mirror case for buy orders. Before and after July 29, 2018 are shown in side-by-side columns, and panels organized into rows show the distribution of trade price reactions 2-75 milliseconds after a trade. Trade size is indicated by color. The bars of the charts represent the proportion of trades of that bin size with the corresponding reaction in bid price. We only observed bid reactions of 0, -1/4 cents, or 1/4 cents (one "tick" up or down).

Note that a very large trade will cause many traders to nearly simultaneously react in the form of canceling, replacing, or submitting new orders to the market. This burst of activity can slow down the exchange matching engine and networking capabilities, adding to the amount of time that it takes to receive data on reaction in prices from these large trades. By examining market data until 75 milliseconds since the large trade has passed, we hope to observe all immediate market effects despite any latency introduced to the market data.

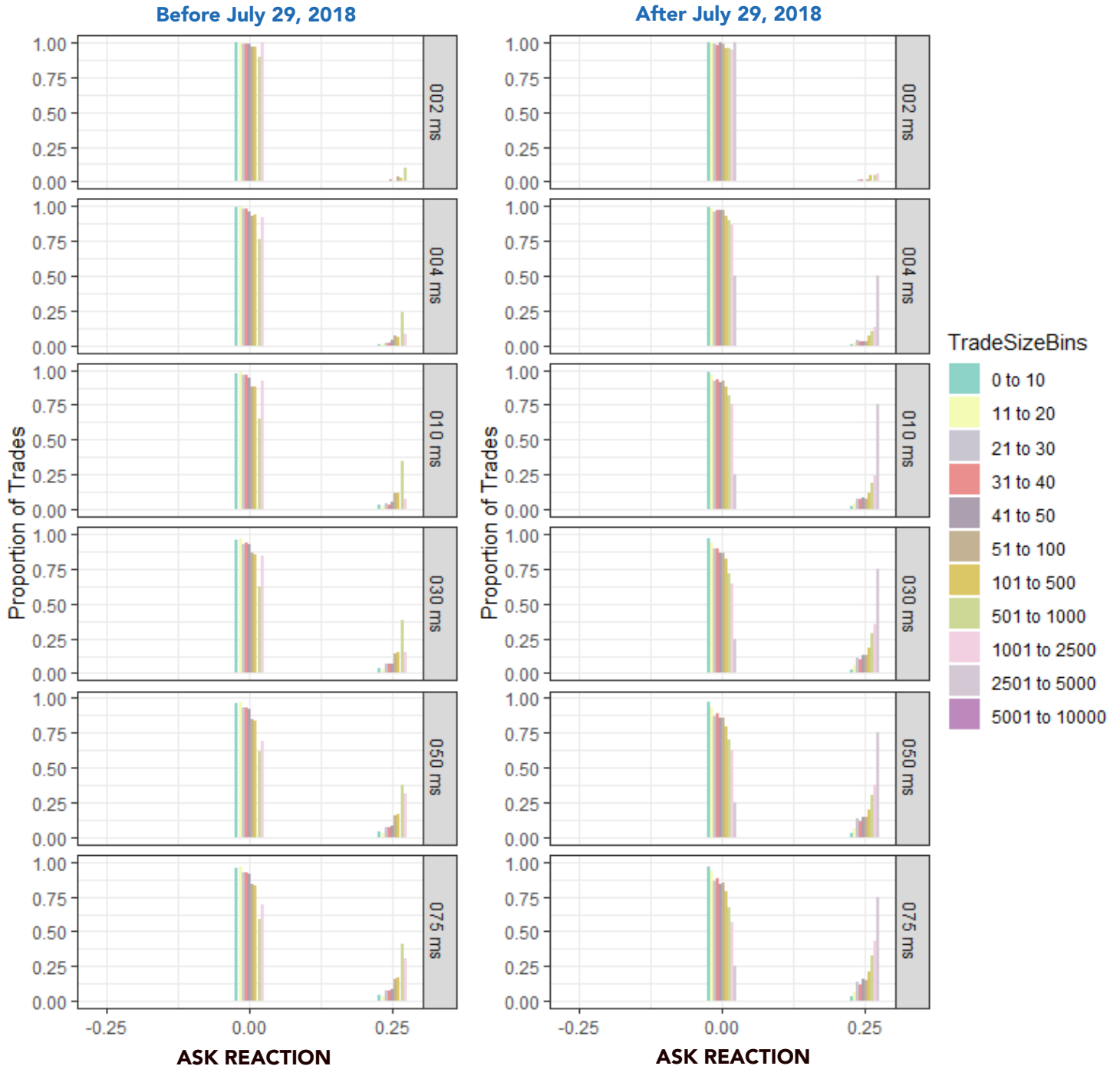
Figure 3: Reaction of Bid Price after Aggressive Sell Order



In the pre-change column there is a small proportion of trades in any size bin except the largest which lead to a decrease in the bid price. Even 75 milliseconds after an execution, less than 25% of all but the largest trades are followed by a negative bid price reaction. However, in the post-change column, there is evidence of a larger proportion of trades resulting in a one tick decrease in bid price. For the bin with the largest sized trades, there is a reaction in the bid price 2 milliseconds

after an aggressive trade is executed in nearly 15% of trades of that size. Trades of this size elicit a sizable reaction in the bid price, as the bottom right panel shows that all trades of this size result in a one tick bid price decrease. The fact that the price reaction becomes more likely as time passes indicates that the decrease in price is not due to the trade wiping out all orders at that price level, but presumably other traders canceling posted quantity or submitting their own sell orders as they are able to incorporate this information into their trading systems at their respective speeds. It is also notable that impact rates for the 2501-5000 bin are similar to those of 1001-2500 bin.

Figure 4: Reaction of Ask Price after Aggressive Buy Order

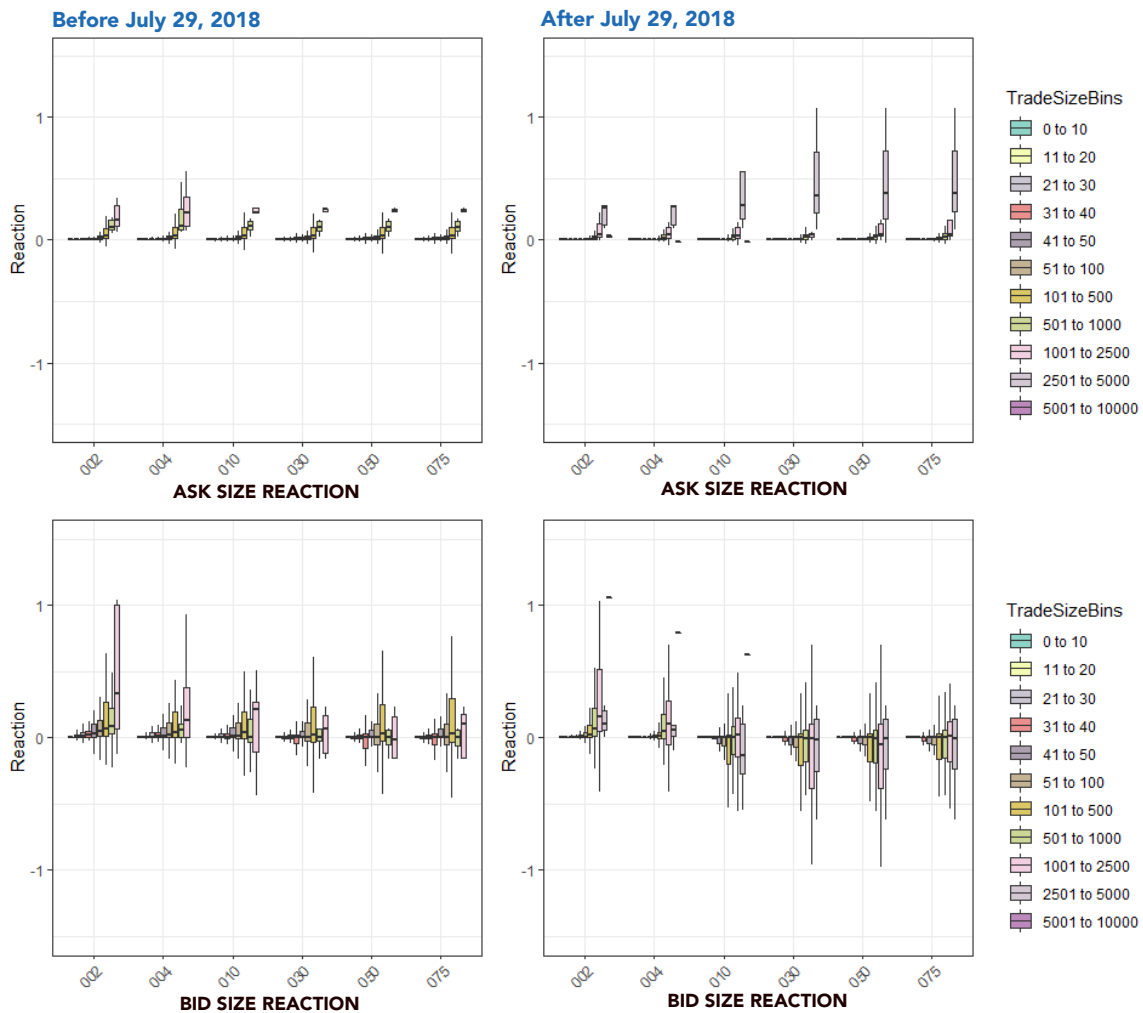


We can further explore these effects by looking at similar plots for the ask price when an aggressive buy trade enters the market, as seen in Figure 4. The plots again show the proportion of trades for each trade size bin which result in no change, a one tick increase, or a one tick decrease to the ask price. Similar to the bid price reactions before the maximum trade size increase, only a small proportion of the largest trade sizes elicit a reaction in the ask price. After the maximum trade size increased, the larger trades are more likely to result in the ask increasing, and the effect is most pronounced in the largest trade bin sizes and after the market has had time to process this new information contained in the large trade.

Size Reactions

Next, we consider what happens to bid and ask liquidity when trades of various sizes arrive in the market. In Figure 5, we show boxplots of the proportional change in size after a trade arrives. We consider the same trade size bins that we did in the price reaction plots, and we show the size reactions after several time points in the interval from 2 to 75 milliseconds after the trade. The following example describes the methodology this analysis used: suppose there are 1,100 contracts offered at the ask and an aggressive buy order for 100 arrives; then, after 50 milliseconds, 500 contracts are offered at the same price.

Figure 5: Reaction of Quote Sizes After Aggressive Buy Order



Note: Conditional on no price reaction, the proportional reaction to quoted size. E.g., a doubling of quoted size would yield Reaction = 1 in this calculation. Size of trade is excluded from this calculation. Outliers not displayed.

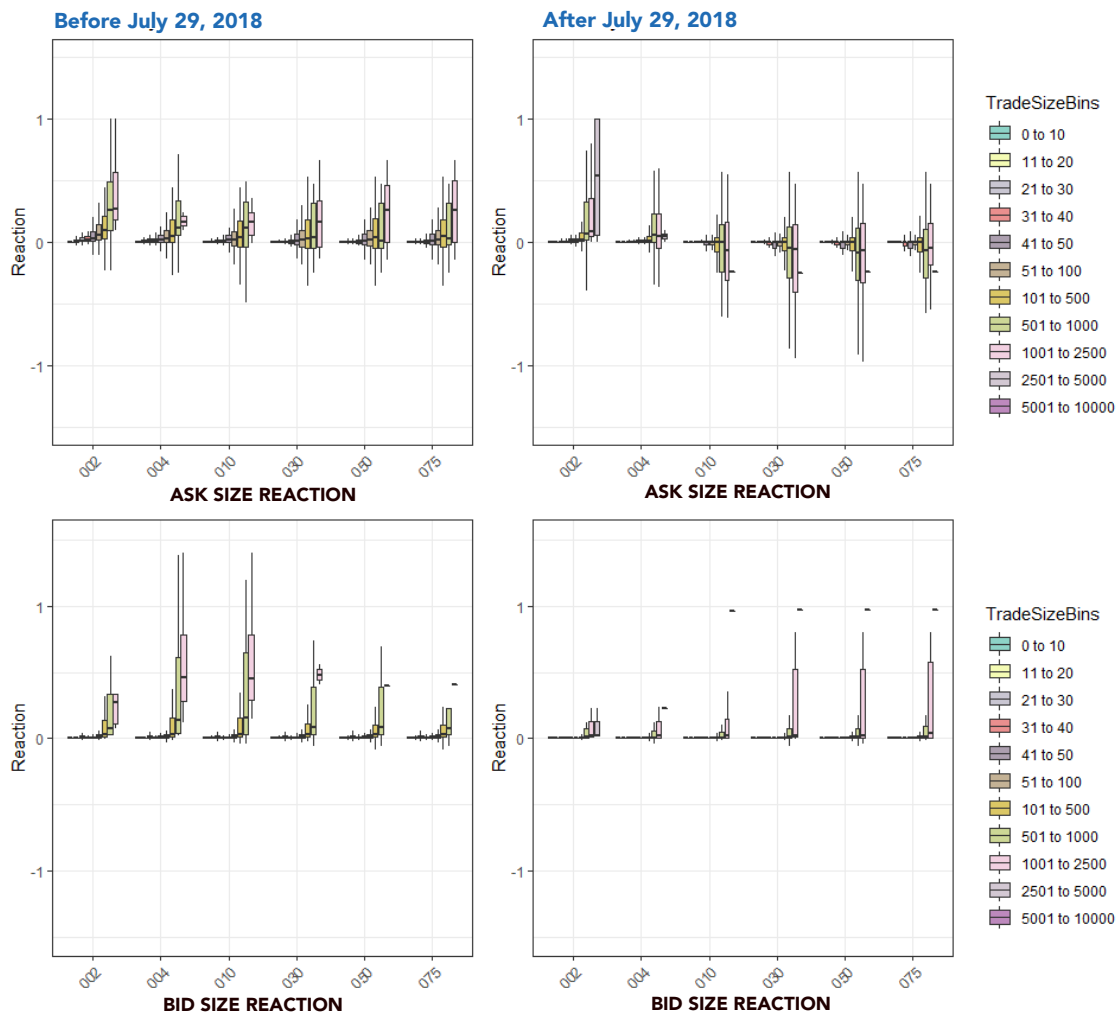
We calculate the proportional change in size as $(500 - 1,100 + 100)/1,100 = -0.46$. When calculating the proportional size changes, we remove the effect of the trade necessarily eliminating the liquidity it trades against. In this manner, the reactions in posted liquidity measured are only from subsequent market actions.

We only calculate the proportional reaction in liquidity for trades that do not fully eliminate all liquidity at a price level. In either case, there would have been a 100 percent reduction in size offered at the original price. There are a small number of outliers not shown on the plot, since very large proportional increases can occur

if a trade prints against a very thin price level, but posted liquidity subsequently increases. Only observations greater than 1.5 times the interquartile range are not shown.

In Figure 5 we see the proportional size reactions of quotes after an aggressive buy order arrives. Conditional on the best ask price remaining the same, we see very little reaction in offered sizes for trades of size less than 500 contracts. For larger trades, we see a build-up in size offered at that price, especially in the bid size offered. When the price proves resilient to a large order, liquidity providers increase their offered size to get a larger share of any additional order flow that may arrive. Comparing before the max trade size increase

Figure 6: Reaction of Quote Sizes After Aggressive Sell Order



Note: Conditional on no price reaction, figure shows the proportional reaction to quoted size. E.g., a doubling of quoted size would yield Reaction = 1 in this calculation. Size of trade is excluded from this calculation. Outliers not displayed.

and after, we see the same pattern but with a stronger effect after the max trade size is increased to 10,000 contracts. The reaction of BID size after an aggressive buy order is a bit more nuanced. Before trade size larger than 2500 was allowed BID size would also often build up momentarily, especially in the larger trade size bins. After trade size up to 10,000 was allowed we see a more variable and downward pressure in the size available at the BID. Which is suggestive that traders are canceling standing orders on the BID immediately following large aggressive BUY orders.

Figure 6 shows the size reactions of bid size offered after an aggressive sell order arrives. It exhibits similar patterns to those found in Figure 5; we see a build-up in liquidity on the BID side after a large sell order. The pattern of ask size reaction to a large sell mirrors the bid size reaction from figure 5.

Impact of Max Trade Size Increase on Execution Risk

The net impact of increasing the max trade size on execution risk for liquidity demanders is mixed. First, aggressive orders in the largest trade sized bins seem to cause resting limit orders at the best bid and ask to be cancelled at higher rates than before. We see that from Figures 3 and 4 that show a larger proportion of trades

of the largest sizes are moving the inside quote. However, the proportion of trades that eliminate the best price level is smaller after the increase in the maximum trade size (Tables 1 and 2). This is good for liquidity demanders since they can get a larger order executed before price effects are realized (as compared to having to submit two 2,500 lot orders where the second order executes at a worst price). However, for trades arriving concurrently or just after large orders, they will experience an increase in execution at a worse price level, in the case of market orders, or an increase in not getting filled in the case of aggressive limit orders.

However, if the price level withstands an aggressive order, our results show that size offered tends to increase, especially on the size of the spread the aggressive order was trading in to (e.g., increase in ask size when the price holds after an aggressive buy order).

Overall, given the small number of executions in the highest size bin, the similar impact profile of 2501-5000 bin to the prior cap, and the lack of a decrease in quoted sizes, this market structure change appears to have improved order placement convenience for large traders without having material adverse effects on market liquidity. Indeed, subsequent to monitoring pilot program, CME announced a decision on December 17, 2018 to make the change permanent.



Disclaimer

The information contained in this report is intended for informational purposes only. While the information and statistics given are believed to be complete and accurate, we cannot guarantee their completeness or accuracy. As past performance does not guarantee future results, these results may have no bearing on, and may not be indicative of, any individual returns realized through participation in this or any other service offered by RCM-X. The risk of loss in trading commodity futures can be substantial.

This general summary of futures execution algorithms that RCM and its affiliates may develop and offer from time-to-time is for information purposes only. The descriptions in this document are not a guarantee that any particular order type, strategy, service, or product will be available for your use, nor are the descriptions a guarantee that any order type, strategy, service, or product will perform in accordance with such descriptions or help you to achieve particular results. RCM makes no representation, warranty or guarantee, expressed or implied, concerning this document or its contents. The information in this document is subject to change at any time, and RCM has no duty to provide you with notice of such changes. In addition, RCM will not be responsible or liable for any losses, whether direct, indirect, or consequential, including loss of profits, damages, costs, claims or expenses, relating to or arising from your reliance upon any part of this document.

This document is not intended to constitute advertising or advice of any kind, and it should not be viewed as an offer or a solicitation to buy or sell securities, or any other financial instrument. It does not take into account the particular investment objectives, financial situation or needs of individual clients. Moreover, this document does not constitute an offer or agreement, or a solicitation of an offer or agreement, to enter into any particular relationship with RCM. Before determining to use any order type, strategy, service or product offered by RCM, you should consult with your independent advisors to review and consider any associated risks and consequences.

RCM-X is a registered DBA of RCM Risk Advisors LLC.

The authors of this research report were provided guidance and feedback by RCM-X. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of RCM-X or its affiliates.



318 W Adams St 10th FL
Chicago, IL 60606
312-870-1537

www.rcm-x.com
algorithms@rcm-x.com