Implied Matching Functionality In Futures Markets

By James Overdahl

One of the more difficult challenges faced by exchanges is balancing the needs and interests of different segments of the market. One example is the introduction of implied matching functionality, a mechanism that allows exchanges to replicate certain market making functions within their own matching engines. Some market participants have welcomed this innovation while others have questioned its value in liquid markets. In this article, James Overdahl, an economist with NERA Consulting, examines the impact of implied matching functionality on two specific futures contracts. Overdahl, whose research was sponsored by the FIA Principal Traders Group, analyzes the impact using five measures of market quality and finds that in these two instances, market quality improved when the exchanges turned off their implied matching functionalities.

Implied matching functionality refers to the ability of some exchange matching engines to show live bids and offers in one order book by using an algorithm that "leans on," that is, relies on, bids and offers from other related order books. For example, live bids and offers for a calendar spread between a June futures contract and a longer-dated September contract can be constructed, or "implied," from the bids and offers contained in the separate order books for the June contract and the September contract. If this implied spread order is filled, then an execution report will be generated for each counterparty of each leg order that was used in the construction of the spread. Implied matching functionality can be offered at different levels ranging from calendar spreads and inter-commodity spreads to more complex spread strategies that are constructed from individual futures contracts, including butterfly spreads, pack spreads, crack spreads, and crush spreads. The functionality can also be used to generate implied bids and offers for an individual leg for a spread by combining information from the spread order book with resting orders from the order books for one or more individual legs used to construct the spread.

Exchanges offer implied matching functionality to enable liquidity to automatically be exported from one order book to another and to encourage two-sided markets in thinly-traded contracts that have few available bids or offers. This functionality is most commonly employed in "curve products," which are futures products that have contract offerings with many expiration dates and for which contract prices create a forward curve extending out many months into the future. Exchanges contend that implied matching functionality can contribute to price discovery—an important component of market quality—by linking together order books of related products and

bringing the prices of these related products into conformity with their proper economic alignment. Furthermore, exchanges contend that implied matching functionality can promote trading volume, particularly in longer-dated and lightly-traded contracts, by removing concerns about "leg risk," that is, the price slippage resulting from executing transactions for the individual legs required to construct a spread position. Finally, exchanges argue that implied matching functionality can serve as a safeguard against a sudden, aberrant withdrawal of liquidity in an individual order book, even when related contracts continue to actively trade. (Arguments for why exchanges choose to offer implied functionality can be found in an article by John Blank, "Implied Trading in Energy Futures," *Journal of Trading*, Summer 2007, pp. 45-48.)

Exchanges face a business decision as to when to employ implied matching functionality, and these decisions have at times proven to be controversial. The exchange's decision will ultimately involve a determination of whether implied matching functionality will materially contribute to the overall quality of the market hosted by the exchange. Any metric of overall market quality will contain several different elements, and various segments of the trading population hold strong, differing opinions about which elements of market quality should be given the greatest weight. Therefore, differing opinions about market quality measures often lead to differing opinions regarding the appropriate use and timing of implied matching functionality by the exchanges. When deciding whether to utilize implied matching functionality, the exchange must make an independent assessment of the functionality's contribution to overall market quality while also weighing and balancing the competing views of various segments of the trading population.

Experimental Window

In the past year, two exchange decisions, one by the CME Group and one by ICE Futures U.S., have highlighted the differing views of market participants about when implied matching functionality should be employed. On Jan. 31, 2011, the CME turned on implied matching functionality for corn futures after turning off this functionality in August 2010. On Feb. 25, 2011, ICE Futures U.S. turned on implied matching functionality for the sugar 11 futures contract, after turning off this functionality in March 2009.

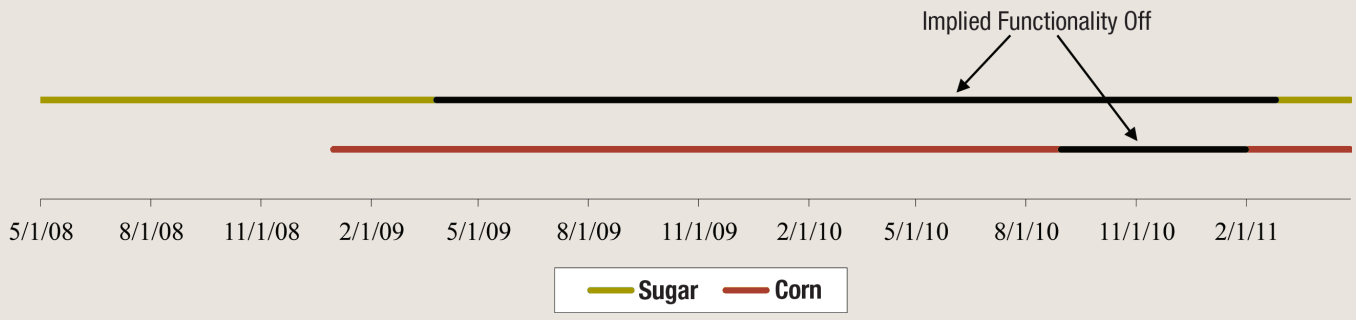
During the periods that implied matching functionality was turned off, the exchanges relied on professional market makers and arbitrageurs to perform the tasks of providing liquidity and linking related order books. These traders often employ automated algorithms, suited for the electronic trading environment, to help them perform the tasks of market making, support spread transactions, and arbitrage between related products and markets.

In floor-based trading, spread trading was supported by traders who specialized in facilitating spread trading. They were known as "spreaders." Electronic market makers and arbitrageurs, by supporting spread transactions (in addition to their other roles), are performing the function of the "spreader" in modern markets.

Some commercial users of the corn and sugar 11 futures contracts have expressed concerns about the reliance on professional computer-based traders and have questioned the marginal contribution to market quality that these professional traders provide over "the implied engine," that is, implied matching functionality. These concerns were expressed in a letter from the World Sugar Committee, an advisory group to ICE Futures U.S. composed of large traders of the sugar 11 futures contract in which they asserted that professional computer-based traders contributed little to the contract. Although the letter was not made public, excerpts were published in the media. See "High-speed trading blamed for sugar rises," *Financial Times*, Feb. 8, 2011.

The decisions by the CME and ICE Futures U.S. to turn off implied matching functionality for lengthy periods before turning it back on provide an experimental window to empirically examine the contribution of this functionality to various measures of market quality. The Futures Industry Association's Principal Traders Group engaged NERA Economic Consulting to examine the data and to prepare this summary report. What we find is that in order books for outright futures contracts, that is, listed futures contracts as opposed to the spreads constructed from these listed contracts, measures of liquidity improved and intra-day volatility declined during the period when implied functionality was turned off. We also find that futures volume increased during this period even after using variables to control for other potential explanations. Finally, we examine the order books for calendar spreads and fail to find a consistent result as to whether market quality measures improved or declined during the periods in which implied functionality was turned off. This non-result, however, is consistent with the argument that turning off implied functionality--and relying on professional market makers and arbitrageurs to support spread trading--does not appear to consistently degrade important measures of market quality for calendar spreads in these two markets.

Exhibit 1 **Implied Functionality Usage Timeline**



Source: NERA Economic Consulting

The power of these results is limited by the fact that the markets studied are only two of many markets that use implied matching functionality and that the periods studied represent only snapshots of the market at two points in time. Therefore, drawing conclusions about the contribution of implied matching functionality in all markets and all time periods is not possible. In addition, we faced data limitations that prevented us from performing more powerful tests. For example, we only had top-of-book data available for the sugar 11 futures contract. In addition, due to data limitations, we did not look at the issue of how matching time is affected by implied functionality, an important issue to many traders. Also, we did not evaluate every argument related to implied matching functionality. In spite of these limitations, our evidence suggests that important measures of market quality did not decline and may actually improve during periods when implied functionality was turned off. This should be welcome news to those, such as some commercial users of corn and sugar, who have expressed concerns about market quality in the absence of implied functionality.

What Do the Data Say?

We look at various market quality measures from the futures markets for corn and sugar 11 and use a linear regression model to compare these measures during the period in which the implied functionality engine was turned on and off. Implied functionality for corn futures was turned off for the CME Globex platform between Aug. 30, 2010 and Jan. 31, 2011. Implied functionality for sugar 11 futures was turned off on the ICE Futures U.S. platform between March 27, 2009 and Feb. 25, 2011. The dataset we used was supplied by DRW Holdings, a firm that provides liquidity in many markets, including markets using implied functionality. A researcher at NERA Economic Consulting performed validation checks on measures that were constructed by DRW from underlying data. Validation checks were not performed on data that could be sourced to well-known providers such as Bloomberg, Globex, and ICE Futures U.S.

To begin, we define five measures of market quality, which are described below.

1) Bid-Ask Spread

The bid-ask spread is the lowest offer price minus the highest bid price. The tighter (lower) the bid-ask spread, the more liquid the market is. The variable is measured from each order book at one-minute intervals throughout the trading day, and then averaged over the day for each contract to produce an average daily bid-ask spread. To ensure the statistics are meaningful, the average bid-ask spread is only calculated for a given contract on a given day when there are more than 100 book updates and more than 30 minutes that include at least one book update.

2) Cost-To-Trade

The cost-to-trade variable captures market depth. The variable captures the difference between the average fill price and the mid-market top-of-book quoted price for an order of a stipulated size, Q. In our analysis, we select Q as a percentage of average daily trading volume so that for most of the time the size of the order exceeds the quantity quoted at the top of the book, but is less than the total available quantity quoted for resting orders that are displayed in the order book. A smaller value for the cost-to-trade variable is consistent with a more liquid market.

3) Book Dispersion

We define book dispersion as a function of the sum of all quantities associated with displayed orders for which the order's quoted price is within 50 cents of the top-of-book quoted mid-price. A higher sum indicates a higher available quantity and less dispersion in the order book. The book dispersion variable is constructed as 1/[1 + available quantity]. A lower book dispersion value is consistent with a deeper and more liquid market.

4) Availability of a Two-Sided Market

One indicator of market quality is how often an order book contains a two-sided market. This variable is constructed as the percentage of the time when there is no resting limit order bid or no resting limit order offer. The smaller the percentage of time without a two-sided market, the more liquid the market is. In our results displayed below, this variable is labelled "No Market Time."

5) Intra-day Microstructure Volatility

We compute the intra-day volatility by one minute interval changes of the top-of-book mid-price. We then calculate the difference between the intra-day volatility and the 20-day realized volatility as "intra-day microstructure volatility." A lower volatility measure indicates less volatility attributable to microstructure noise, which is consistent

Table 1 **Regressions for Corn Futures—Outrights**

Dependent Variable	Contract 1	Contract 2	Contract 3	Contract 4	Contract 5	Contract 6
Bid-Ask Spread	0.13	-0.32***	-0.73***	-0.52***	-1.00***	-0.73***
	[499,96]	[573,106]	[572,106]	[564,106]	[519,104]	[364,101]
Cost-to-Trade	-0.26**	-0.29***	-1.17***	-0.60***	-1.20***	-0.74***
	[498,96]	[572,106]	[572,106]	[563,106]	[508,104]	[359,101]
Book Dispersion	-0.78***	-1.13***	-1.66***	-1.01***	-1.34***	-0.87***
	[499,96]	[573,106]	[572,106]	[564,106]	[519,104]	[364,101]
No Market Time	0.21	-0.14	-1.19***	-1.04***	-0.94***	-0.82***
	[499,96]	[573,106]	[572,106]	[562,106]	[511,104]	[361,101]
Excess Volatility	-0.85***	-0.41***	-0.46***	-0.53***	-0.95***	-0.48***
	[492,96]	[566,106]	[564,106]	[552,106]	[503,104]	[349,101]

Source: NERA Economic Consulting

with better market quality. In our results displayed below, this variable is labelled "Excess Volatility."

Regression Results for CME Corn Futures

For the corn futures contracts traded on Globex, we examine the impact of turning off implied functionality on our measures of market quality for both the outright futures order book and for the spread order book. Intra-day Globex book data from Jan. 2, 2009 to April 21, 2011, a period that spans the time during which implied functionality was turned off, were used. We use data from the Globex day session when most trading volume occurs unless indicated otherwise. Observations from the Globex night session were used in addition to data from the day session in the construction of the variable measuring the availability of a two-sided market, "No Market Time."

The timeline in Exhibit 1 shows the window during which implied matching functionality was turned off in relation to the total period we examine. For corn futures, the period we examine is represented by the yellow line, where the black line represents the period during which implied functionality was turned off. The timeline also shows, with a blue line, the period we examine for the sugar 11 futures market where the black line represents the period during which implied functionality was turned off at ICE Futures U.S.

For the outright order book, we construct data series on a rolling basis for the first 6 futures contracts in the March, May, July, September, December cycle. All contracts are assumed to roll to the next nearby contract ten days before contract expiration to avoid the effects on the market related to the delivery period. We use a dummy variable to indicate whether implied functionality was on, in which case the variable was assigned a value zero, or off, in which case the variable took on a value of one. A significant negative coefficient for the dummy variable is consistent with an improvement in market quality measures during the period in which implied functionality is turned off. A significant positive coefficient for the dummy variable is consistent with a decline in market quality measures during the period in which implied functionality was turned off. The regression model also contains variables to control for other factors that are likely related to market quality, such as overall market volatility and seasonality.

Table 2 summarizes the regression results. We report a standardized regression coefficient for the dummy variable representing the period for which implied functionality was turned off. The coefficients are standardized in order to improve comparability across contracts. This is done by dividing the coefficient by the standard deviation of the relevant dependant variable. Due to our definition of market quality measures, a negative coefficient indicates in improvement in these measures. The superscripts *, **, *** indicate that the P-value of the coefficient is less than 10%, 5% and 1%, respectively. A lower P-value indicates stronger confidence that the result was not produced by chance. The two numbers in the parenthesis are the total number of observations, and the number of observations from the period where implied functionality was turned off. The regressions are reported for the nearby contract (regression 1), the next nearby contract (regression 2), out to the 6th nearby contract, where the contract series conforms to the roll specification discussed above.

Table 2 Regressions for Corn Futures—Spreads

Dependent Variable	Contract 1	Contract 2	Contract 3	Contract 4	Contract 5	Contract 6
Bid-Ask Spread	0.21*	-0.03	0.37***	1.29***	0.49***	-0.11
	[491,96]	[563,106]	[563,106]	[558,106]	[526,104]	[348,101]
Cost-to-Trade	0.26**	1.23***	0.84***	3.00***	0.14	-0.54***
	[491,96]	[531,105]	[465,62]	[431,2]	[409,43]	[253,98]
Book Dispersion	0.31***	-0.10	0.40***	1.12***	0.54***	-0.04
	[491,96]	[563,106]	[563,106]	[558,106]	[526,104]	[348,101]
No Market Time	0.08	-0.06	-0.11	-0.04	0.07	-0.28*
	[491,96]	[563,106]	[563,106]	[558,106]	[503,104]	[283,99]
Excess Volatility	-0.26*	0.30**	0.18	0.77***	0.33**	0.05
	[483,96]	[553,106]	[553,106]	[548,106]	[509,104]	[324,101]

Source: NERA Economic Consulting

Table 3 Regressions for Sugar Futures—Outright

Dependent Variable	Contract 1	Contract 2	Contract 3	Contract 4	Contract 5	Contract 6
Bid-Ask Spread	-1.03***	-1.26***	-1.65***	-1.61***	-1.35***	-2.33***
	[568,341]	[648,398]	[547,395]	[452,365]	[321,289]	[192,184]
Excess Volatility	-0.20**	-0.52***	-0.77***	-0.20	0.09	-0.90**
	[566,340]	[645,397]	[545,394]	[449,364]	[318,288]	[188,183]

Source: NERA Economic Consulting

The coefficient levels are difficult to interpret intuitively, however the signs have a clear meaning. A negative sign indicates better market quality measure when implied matching functionality is turned off. That is, a negative sign means that bid-ask spreads are lower, cost-to-trade is lower, book dispersion is lower, the percentage of time there is no two-sided market is lower, and intraday microstructure volatility is lower. The statistical significance indicator describes the degree of confidence we have in the result. This result holds generally across all contracts and across all measures.

We examined the impact of turning off implied functionality for the direct order book for calendar spreads. All the calendar spreads are constructed between adjacent futures contracts. This means we look at the flowing calendar spreads: March-May, May-July, July-September, September-December, and December-March. The summary results of the regressions are displayed in Table 3.

These results are mixed and difficult to interpret. Although the regressions have a high degree of explanatory power, we do not obtain consistent results on the impact of turning off implied functionality. Some coefficients are negative and significant, some are positive and significant, and some are not significant at all. This is true across all market quality measures in each regression. It is possible that because of the highly non-stationary nature of the calendar spreads, a linear regression model is not appropriate for capturing and analyzing the variation related to use of implied functionality.

Regression Results for ICE Sugar 11 Futures

We apply a regression analysis similar to the corn analysis for the Sugar 11 futures contract traded on ICE Futures U.S. Due to the limitation of the available data, we compute only two of the above market quality measures, the average bid-ask spread and the intra-day volatility measure, using data from the order book for outright futures contracts. The summary regression results for the period in which implied functionality was turned off are shown in Table 3.

The signs for each coefficient are consistent with improvements in market quality measures during the period in which implied functionality was turned off. The average bid-ask spread is lower and intraday microstructure volatility is lower. The coefficients are generally significant with a p-value of one percent or lower. As with the corn regressions, other variables were included in the regressions to control for overall market volatility and seasonality.

We also performed a regression analysis of how market quality for the calendar spread order book was affected during the period in which implied functionality was turned off. A summary of these results are shown in Table 4.

Table 4 Regressions for Sugar Futures—Spreads

Dependent Variable	Contract 1	Contract 2	Contract 3	Contract 4
Bid-Ask Spread	-0.63***	-0.17*	0.14	0.00
	[586,360]	[666,418]	[537,412]	[453,383]
Excess Volatility	0.08	0.03	0.32***	0.18
	[584,359]	[662,416]	[522,410]	[445,380]

Source: NERA Economic Consulting

Table 5 Impact on Volume

Description	CME Corn	ICE Sugar
Implied Turned Off: Volume Coef. w/ 1 Std. Error	43758 ± 6639	19240 ±2552
Volume Coefficient P-Value	7.8E-11	1.3E-13
Average Volume During Implied Off Period	288,830	111,985
Percentage Volume Decrease if Implied On	14.8%	17.2%
Total Variation Explained by Model (R-squared)	75%	68%

Source: NERA Economic Consulting

As with the results from the corn regressions on calendar spreads, these results are difficult to interpret. The signs vary from positive to negative, and the significance is not consistent across the analysis. The most powerful statement we can make from these results is that it appears that turning off implied functionality did not result in higher average bid-ask spread or higher intraday microstructure volatility.

Implied Functionality and Futures Volume

A final set of regressions analyzed the impact of the decision to turn off implied functionality on futures volume. This analysis shows that turning off implied functionality produced a positive and significant impact on futures volume. Moreover, this impact could not be explained by other market variables such as volume in related markets, the daily price range, calendar spread prices, market volatility, and seasonality. Table 5 summarizes the impact of turning off implied functionality for CME corn and ICE sugar.

Conclusion

The decisions by the CME and ICE Futures U.S. to turn off implied matching functionality for lengthy periods provided an experimental window to empirically examine the contribution of this functionality to various measures of market quality. Such an examination shows that for outright futures contracts measures of market quality improved during the period when implied functionality was turned off. We also find that futures volume, an important measure of market health, increased during this period even after using variables to control for other potential explanations. Finally, an examination of the order books for calendar spreads fails to yield a meaningful result as to whether market quality improved or declined for these order books. This non-result, however, is consistent with the argument that turning off implied functionality—and relying on professional market makers and arbitrageurs to support spread trading—does not appear to degrade market quality for calendar spreads in these two markets.

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