

October 13, 2016

Brent J. Fields  
Secretary  
US Securities and Exchange Commission  
100 F Street, N.E.  
Washington, D.C. 20549-0609

Re: Chicago Stock Exchange Liquidity Taking Access Delay (Release No. 34-78860; SR-CHX-2016-16)

Dear Mr. Fields:

I appreciate the opportunity to comment on the Chicago Stock Exchange's ("CHX") application to incorporate a "Liquidity Taking Access Delay" ("LTAD") into their exchange design. I am an economics professor at the University of Chicago Booth School of Business who researches market design. I write independently and have no financial relationship with any of the participants in the market structure debate.

I encourage the SEC to approve CHX's application for two reasons. First, as I will explain in detail in what follows, the LTAD meaningfully addresses latency arbitrage. Latency arbitrage is like a tax on liquidity provision; reducing latency arbitrage will enhance liquidity. Second, as expressed in my letter regarding IEX's exchange application,<sup>1</sup> I think it is important for the SEC to allow and even encourage innovation by financial exchanges that attempts to address the negative aspects of high-frequency trading.

For a formal academic explanation of latency arbitrage, and how its root cause is the continuous limit order book market design currently used by all US stock exchanges, please see my 2015 research paper with Peter Cramton and John Shim entitled "The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response," published in the *Quarterly Journal of Economics*.<sup>2</sup> Here is a plain-English example which illustrates the main idea.

Suppose there is a stock that is currently at bid \$9.99 – ask \$10.01. A new piece of public information indicates the value of the stock is meaningfully higher, say \$10.05. Suppose that all market participants see this new public information at exactly the same time, are equally fast, and understand equally well that the value of the stock is now \$10.05. You might guess that, since all market participants see the

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<sup>1</sup> Eric Budish, Comment letter regarding "Investors' Exchange LLC Form 1 Application (Release No. 34-75925; File No. 10-222)" dated February 5, 2016. Available electronically at <https://www.sec.gov/comments/10-222/10222-371.pdf>.

<sup>2</sup> Eric Budish, Peter Cramton and John Shim, "The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response," *Quarterly Journal of Economics*, Vol. 130(4), November 2015, pgs. 1547-1621. Available under Open Access license at: <http://faculty.chicagobooth.edu/eric.budish/research/HFT-FrequentBatchAuctions.pdf>.

information at exactly the same time, are equally fast, and have the same understanding of the new information, that there is no arbitrage opportunity. This guess is wrong.

To see why, consider what happens in an electronic continuous limit order book when such information arrives. Trading firms with orders in the book that are now stale – e.g., asks at \$10.01, and also \$10.02, \$10.03, etc. – send a message to the exchange’s matching engine seeking to cancel their stale quotes, and potentially to replace them with new quotes that reflect the new information. At the exact same time, other trading firms will send a message to the exchange’s matching engine seeking to trade at the stale prices – buy at \$10.01, and also at \$10.02, \$10.03, etc. Because the continuous limit order book processes messages serially, in continuous time, each liquidity provider’s request to cancel their stale quotes would have to reach the exchange before *all* of the stale-quote snipers’ requests to trade at their stale quotes. Even if a liquidity provider is just as fast as the other firms, they still usually lose the race. That is latency arbitrage: arbitrage profits from symmetric public information. Such arbitrages are not supposed to exist in a well-designed market.

The LTAD, known to academic researchers as an “asymmetric delay,”<sup>3</sup> modifies the continuous limit order book to address this built-in latency arbitrage. Specifically, the LTAD addresses latency arbitrage by giving a tiny head start to the cancelation of stale quotes in the race to react to symmetric public information. If a trading firm with quotes in the book and other trading firms see a piece of public information at about the same time, and react with about the same speed, then instead of the firm engaged in liquidity provision usually losing the race to react, and getting sniped, they usually win the race to react aided by the tiny head start. Liquidity providers therefore suffer less latency arbitrage, and, with this tax on liquidity provision reduced, economically will choose to provide more liquidity. What counts economically as “about the same time” and “about the same speed” depends on the magnitude of the tiny head start. CHX is proposing 0.00035 seconds, which, being less than one millisecond, is a *de minimis* amount of time per the SEC’s recent rules interpretation.<sup>4</sup>

Notice, crucially, that if the taker of liquidity knows something that the liquidity provider does not know, the tiny head start makes no difference. A trading firm or investor with asymmetric information can still earn arbitrage profits from this information. It is just symmetric public information, seen and equally well understood by many market participants at essentially the same time, that no longer makes arbitrage profits. That is what is supposed to happen in a well-designed market.

A significant advantage of the LTAD over IEX’s recently approved “speed bump” is that the LTAD addresses latency arbitrage for displayed limit orders. As described in detail in my IEX letter, the IEX speed bump has no effect on latency arbitrage for displayed limit orders, but rather only addresses latency arbitrage for non-displayed pegged orders. This difference is significant because displayed limit orders contribute to price discovery and liquidity, whereas non-displayed pegged orders in a sense free-ride off of prices discovered elsewhere. It is therefore especially important to protect displayed limit orders from latency arbitrage, which the LTAD does.

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<sup>3</sup> For a formal analysis of the continuous limit order book with asymmetric delay, please see Markus Baldauf and Joshua Mollner, “High-Frequency Trading and Market Performance,” 2015 working paper, available at [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2674767](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2674767). See also Section VIII.D of Budish, Cramton and Shim (2015) for additional discussion of the asymmetric delay.

<sup>4</sup> See Commission Interpretation Regarding Automated Quotations Under Regulation NMS. 17 CFR Part 241; Release No. 34-78102; File No. S7-03-16.

The LTAD is not a complete solution to the problems with the continuous limit order book market design. My 2015 research paper discusses some of the limitations of the asymmetric delay, and the important advantages of moving to a discrete-time batch process market design called frequent batch auctions. My IEX letter emphasizes the importance of more comprehensive Reg NMS reform. But the LTAD is a thoughtful and constructive market design idea, which will reduce latency arbitrage and thus enhance liquidity. Chair White, in her June 2014 speech "Enhancing Our Equity Market Structure," emphasized the importance of "trading venues hav[ing] sufficient opportunity and flexibility to innovate successfully with initiatives that seek to deemphasize speed as a key to trading success in order to further serve the interests of investors." The LTAD is exactly such an initiative and I encourage the SEC to approve it.

I will be pleased to be of service to the SEC in these important matters in whatever way is helpful.

Kind regards,

Eric Budish