

# Robocops: Regulating High Frequency Trading After the Flash Crash of 2010

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## I. INTRODUCTION

In February 2011, the television game show *Jeopardy!* aired a three-day contest between Ken Jennings and Brad Rutter, two of the show's all-time grand champions, and Watson, an IBM supercomputer that understands questions posed in natural language.<sup>1</sup> At the end of the three-day competition, Watson handily defeated the two grand champs with a final tally of \$77,147 to Jennings' \$24,000 and Rutter's \$21,600.<sup>2</sup>

The IBM researchers who designed and built Watson admitted that the machine benefitted from what they called the "buzzer factor."<sup>3</sup> Though Jennings and Rutter were skilled in anticipating the light indicator that signals when it is possible to "buzz in" to give a response, Watson could hit the buzzer

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<sup>1</sup> See John Markoff, *Computer Wins on 'Jeopardy!': Trivial, It's Not*, N.Y. TIMES, Feb. 17, 2011, at A1.

<sup>2</sup> *Id.* at A23.

<sup>3</sup> *Id.*

in as little as ten milliseconds.<sup>4</sup> Thus, Watson's advantage was not that it was smarter than Jennings or Rutter, but that it could process the clues and buzz in faster than either of the human contestants.<sup>5</sup>

Jennings, famous for setting a *Jeopardy!* record of seventy-four consecutive wins, jocularly acknowledged in his final written response of the contest, "I, for one, welcome our new computer overlords."<sup>6</sup> The response may have been lighthearted and funny, but it was also perceptive and farsighted. Jennings himself stated, "It's not about the results; this is about being part of the future."<sup>7</sup> Shortly after the episodes aired, bloggers posed questions regarding implications of Watson's potential uses.<sup>8</sup>

Even before IBM used complex algorithms to create Watson,<sup>9</sup> Wall Street has used algorithmic supercomputers for trading on financial markets.<sup>10</sup> This trading method, better known as "algorithmic trading," and more specifically its subset "high frequency trading" (HFT), accounts for 60–70% of daily trades on today's U.S. financial exchanges, where as recently as 2005 it accounted for just a fifth of daily trading.<sup>11</sup> As of this writing, HFT has not been officially defined

<sup>4</sup> *Id.* Watson beat the human players to the buzzer in 24 out of 30 Double Jeopardy questions on the competition's last day. *Id.*

<sup>5</sup> Watson by no means was correct in every response it gave—sometimes painfully incorrect. On the second day's Final Jeopardy question, the clue for the category "U.S. Cities" was: "Its largest airport is named for a WWII hero; its second largest for a WWII battle." The correct response was "What is Chicago?" but Watson wrote "What is Toronto?????" *Jeopardy!: The IBM Challenge: Day 2* (Sony Pictures, Inc. Feb. 15, 2011).

<sup>6</sup> Markoff, *supra* note 1, at A1. Jennings borrowed the quip from *The Simpsons: Deep Space Homer* (Fox television broadcast Feb. 24, 1994).

<sup>7</sup> Markoff, *supra* note 1, at A23.

<sup>8</sup> See, e.g., Douglas A. Berman, *How Might IBM's "Watson" Do as a Sentencing [sic] Judge (or a Law Clerk)?*, SENT'G L. & POL'Y (Feb. 18, 2011, 3:33 PM), [http://sentencing.typepad.com/sentencing\\_law\\_and\\_policy/2011/02/how-might-ibms-watson-do-as-a-sentencing-judge-or-a-law-clerk.html](http://sentencing.typepad.com/sentencing_law_and_policy/2011/02/how-might-ibms-watson-do-as-a-sentencing-judge-or-a-law-clerk.html) (discussing Watson's implications in the legal and medical fields); *Quant: Will IBM Get into HFT High Frequency Trading?*, QUANTLABS.NET (Feb. 23, 2011, 1:40 PM), <http://quantlabs.net/labs/articles/high-frequency-trading/723-quant-will-ibm-get-into-hft-high-frequency-trading>.

<sup>9</sup> The names and photos of the IBM algorithms team who built Watson can be found at <http://www-03.ibm.com/innovation/us/watson/research-team/algorithms.html>.

<sup>10</sup> See generally Michael J. McGowan, Note, *The Rise of Computerized High Frequency Trading: Use and Controversy*, 9 DUKE L. & TECH. REV. 16 (2010).

<sup>11</sup> It is difficult to pinpoint an exact percentage. However, by most estimates HFT accounts for a significantly large percentage of daily volume on the equity exchanges. For a more recent estimation, see Andrew G. Haldane, Exec. Dir., Fin. Stability and member of the interim Fin. Policy Comm., Bank of Eng., Speech Given at the International Economic Association Sixteenth World Congress (July 8, 2011), *available at* <http://www.bankofengland.co.uk/publications/Documents/speeches/2011/speech509.pdf>; see also IRENE ALDRIDGE, HIGH-FREQUENCY TRADING: A PRACTICAL GUIDE TO ALGORITHMIC STRATEGIES AND TRADING SYSTEMS 1 (2010); Charles Duhigg, *Stock Traders Find Speed Pays*, in *Milliseconds*, N.Y. TIMES, July 24, 2009, at A1; Dave Fry, *High-Frequency Trading Still Controls the Tape: Dave's Daily*, THE STREET (Oct. 21, 2011, 7:03 PM), <http://www.thestreet.com/story/11285083/1/high-frequency-trading-still-controls-the-tape->

by U.S. regulators.<sup>12</sup> However, certain features are indicative of its strategies: very high order amounts; rapid order cancellation; a flat position at the end of the trading day; extracting very low margins per trade; and trading at ultra-fast speeds.<sup>13</sup>

Like IBM's Watson, speed is the key advantage of HFT. A decade ago, the average trade execution time on the New York Stock Exchange (NYSE) was twenty seconds; today, it is approximately one second.<sup>14</sup> One reason for this dramatic drop in the average is that some HFT platforms can execute a trade faster than the blink of an eye—trading speeds have increased from milliseconds to microseconds (millionths of a second).<sup>15</sup> The dramatic speed at which HFT operates allows huge trading volume over short periods: one startling analogy is that if supermarkets ran HFT programs, the average household could complete its shopping for a lifetime in less than a second.<sup>16</sup>

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daves-daily.html. For additional discussion regarding the wide range of estimates for HFT activity level, see Large Trader Reporting, 76 Fed. Reg. 46,960, 49,961 n.8 (Aug. 3, 2011) (to be codified at 17 C.F.R. pts. 240 and 249).

<sup>12</sup> See Press Release, U.S. Commodity Futures Trading Comm'n, Commodity Futures Trading Commission Votes to Establish a New Subcommittee of the Technology Advisory Committee (TAC) to focus on High Frequency Trading (Feb. 9, 2012), available at <http://www.cftc.gov/PressRoom/PressReleases/pr6178-12>. In May 2012, the TAC proposed a draft definition for HFT:

High frequency trading is a form of automated trading that employs:

- (a) algorithms for decision making, order initiation, generation, routing, or execution, for each individual transaction without human direction;
- (b) low-latency technology that is designed to minimize response times, including proximity and co-location services;
- (c) high speed connections to markets for order entry; and
- (d) high message rates (orders, quotes or cancellations).

U.S. Commodity Futures Trading Comm'n, Presentation by the CFTC Technical Advisory Committee, Sub-Committee on Automated and High Frequency Trading—Working Group 1 at 3 (June 20, 2012), available at <http://www.cftc.gov/ucm/groups/public/@newsroom/documents/file/wg1presentation062012.pdf>.

<sup>13</sup> PETER GOMBER ET AL., DEUTSCHE BÖRSE GROUP, HIGH-FREQUENCY TRADING 15 (2011), [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1858626](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1858626).

<sup>14</sup> Haldane, *supra* note 11, at 4. This Note implicitly focuses on high frequency equities trading; however, HFT is used in a variety of financial markets, such as commodities and foreign exchange. See, e.g., BANK FOR INT'L SETTLEMENTS, MKTS. COMM., HIGH-FREQUENCY TRADING IN THE FOREIGN EXCHANGE MARKET 5 (2011), available at <http://www.bis.org/publ/mktc05.pdf> Javier Blas, *Commodity Market's Algorithmic Challenge*, FIN. TIMES (Mar. 26, 2012, 10:42 AM), available at <http://www.ft.com/intl/cms/s/0/79722992-750f-11e1-90d1-00144feab49a.html#axzz20cMC1szk>.

<sup>15</sup> Haldane, *supra* note 11, at 5.

<sup>16</sup> *Id.*

Critics believe that high trading volume and microsecond trade execution contributes to volatility in financial markets,<sup>17</sup> while proponents argue HFT increases market efficiency, provides liquidity, and actually stabilizes market systems.<sup>18</sup> This Note argues that much of the real danger behind HFT is the way in which it taints the public's perception of U.S. equity markets. Therefore, regulators should encourage HFT transparency, and impose rules that limit the possibility of a market failure similar to the flash crash of May 6, 2010.<sup>19</sup>

Part II of this Note describes HFT's primary features, and explains that it is not a monolithic trading technique, but consists of various strategies in constant flux to adapt to a highly competitive trading environment. It argues that understanding the differences between HFT strategies is crucial: although some strategies in fact benefit the market by reducing spreads and improving price efficiency, other strategies can be used to manipulate prices and must be regulated more closely. Part III examines the flash crash of 2010—critics' primary justification in arguing that HFT creates volatility—to show that HFT did not in fact trigger that event. Rather, HFT acting as the market's primary liquidity providers actually became liquidity takers during the rapid uncertainty of the event, withdrawing from markets thereby causing a liquidity crisis. Though HFT was not to blame at the outset, the total lack of accurate price information during the flash crash poses a fundamental problem to U.S. equities markets: if the markets are at risk of whimsical computers causing pricing uncertainty, investors have little incentive to risk their capital in such an environment. The threat to U.S. equities and its potential spillover into U.S. consumer confidence is the justification for HFT regulation.<sup>20</sup> Part IV discusses regulations that will improve transparency and limit volatility, reducing the downside risks HFT poses to the markets, while maintaining its upside benefits.

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<sup>17</sup> See Daniel Indiviglio, *Does High-Frequency Trading Cause Wild Stock Swings?*, ATLANTIC (Aug. 17, 2011), <http://www.theatlantic.com/business/archive/2011/08/does-high-frequency-trading-cause-wild-stock-swings/243772/>.

<sup>18</sup> ALDRIDGE, *supra* note 11, at 2.

<sup>19</sup> See *The Flash Crash: Autopsy*, ECONOMIST, Oct. 9, 2010, at 107. The article discusses the joint report issued by the Securities and Exchange Commission (SEC) and the Commodity Futures Trading Commission (CFTC) in October 2010, and concludes by saying that the report “provides some vindication for high-frequency trading firms, which had been widely blamed for the mayhem. . . . [But] [f]ast as they are, they may not be able to outpace regulators.” *Id.* at 108.

<sup>20</sup> See Daniel Indiviglio, *The Trading Game Is Causing the Manic Market*, ATLANTIC (Aug. 11, 2011), <http://www.theatlantic.com/business/archive/2011/08/the-trading-game-is-causing-the-manic-market/243488/> (“It’s always scary to see the Dow market fall by 500 points repeatedly. . . . This sort of erratic stock market behavior is terrible for consumer confidence. Americans worry that their savings aren’t safe, so they’ll likely cut spending . . .”).

## II. DEFINING HIGH FREQUENCY TRADING: EVOLUTION AND LOGISTICS

In order to establish an HFT regulatory regime, it is necessary to define it.<sup>21</sup> Describing its roots and recognizing basic HFT logistics are key factors in understanding it.

### A. *The Need for Speed (and Volume): HFT's Distinctive Feature*

As recently as twenty years ago, most financial markets operated on physical trading floors on which humans interacted face-to-face.<sup>22</sup> Today, the heart of most financial markets is an air-conditioned warehouse filled with computers, where machines operate as “matching engines” to process buy and sell orders and execute trades when orders are matched.<sup>23</sup> Furthermore, equity markets have increasingly fragmented, where investors can trade on more than half a dozen exchanges, multilateral trading platforms, and “dark pools,” in which large institutional investors trade in closed trading platforms in order to keep their trades quiet so as not to affect public pricing information.<sup>24</sup>

Accompanying these structural changes has been technological advancement, with exponential increases in computing power.<sup>25</sup> These

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<sup>21</sup>In fact, the CFTC's Technology Advisory Committee (TAC) established a Subcommittee on Automated and High Frequency Trading to develop recommendations regarding HFT's definition within the context of the broader field of automated trading. See Press Release, Commodity Futures Trading Comm'n, *supra* note 12. The CFTC's ultimate goal is to assess the impact of HFT in CFTC-regulated markets. *Id.*

<sup>22</sup>Donald MacKenzie, *How to Make Money in Microseconds*, LONDON REV. BOOKS, May 19, 2011, at 16. Mackenzie discusses the superseding importance placed on the warehouses storing these computers over the actual physical exchanges, citing the NYSE as an example. *Id.* (“The matching engines of the [NYSE] . . . aren't in the exchange's century-old Broad Street headquarters . . . but in a giant new 400,000-square-foot plain-brick data centre . . . classed as part of the critical infrastructure of the United States.”).

<sup>23</sup>*Id.* While these machines have led many to believe that the role of floor traders will be obsolete in the near future, the NYSE recently made a significant capital investment in brand new posts for human-designated market makers on its trading floor. James Armstrong, *Designated Market Making Alive and Well at NYSE*, TRADERS MAG. ONLINE NEWS (Dec. 23, 2011), <http://www.tradersmagazine.com/news/market-maker-nyse-trading-109684-1.html>. The importance of human market makers on an exchange's floor is illustrated in the 2010 flash crash: these NYSE traders were able to slow down sell-side activity, preventing prices from falling as low as they did on other exchanges, such as the NASDAQ. *Id.*

<sup>24</sup>Haldane, *supra* note 11, at 4; see also HAROLD BRADLEY & ROBERT E. LITAN, EWING MARION KAUFFMAN FOUNDATION, CHOKING THE RECOVERY: WHY NEW GROWTH COMPANIES AREN'T GOING PUBLIC AND UNRECOGNIZED RISKS OF FUTURE MARKET DISRUPTIONS 23 (2010), available at [http://www.kauffman.org/uploadedFiles/etf\\_study\\_11-8-10.pdf](http://www.kauffman.org/uploadedFiles/etf_study_11-8-10.pdf). To illustrate the extent to which trading has dispersed across markets, Haldane notes that in 2005, the NYSE accounted for 80% of the trading volume for NYSE-listed securities. Haldane, *supra* note 11, at 4. Contrast this with February 2011, where the trading share of the NYSE dropped to just 24% of volume for stocks that are listed on that exchange. *Id.*

<sup>25</sup>See Haldane, *supra* note 11, at 5.

advances have manifested in speed. Trade execution times have fallen dramatically since the 1960s and '70s, where it could take a minute or longer for a trade to be completed.<sup>26</sup> Compare this to the period between 2005 and 2009, when the average trade execution time on the NYSE fell by more than tenfold, from 10.1 seconds to just 0.7 second.<sup>27</sup>

Since timescales have been reduced into significantly smaller increments, the importance of space has changed as well. Only a few years ago, when traders' frame of reference was in terms of hour or minute, it was common to proclaim the "end of geography" in financial markets—a trader's location in the world in relation to the exchange on which he executed trades was of little consequence in "slow" markets.<sup>28</sup> However, in a market with reduced timescales, the distance a trader is located from an exchange's matching engine computers is increasingly important.<sup>29</sup> The shorter the length of the cable connecting traders to exchanges' matching engines, the faster the trade can be executed.<sup>30</sup> Trading firms have recognized this fact, as well as the exchanges themselves. Today, exchanges offer space as close as physically possible to their matching engines, where firms can locate their own servers.<sup>31</sup> This scheme is known as "co-location," and a single rack on which to place a server can cost \$10,000 per month.<sup>32</sup>

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<sup>26</sup> BRADLEY & LITAN, *supra* note 24, at 13.

<sup>27</sup> *Id.* at 13–14; *see also* Concept Release on Equity Market Structure, 75 Fed. Reg. 3594, 3595 (proposed Jan. 21, 2010) (to be codified at 17 C.F.R. pt. 242). The significant drop in trading execution times has changed time measurement in the markets. In 2007, the prevalent trading time unit was the millisecond; today, time is often measured in microseconds (*millionths* of a second). MacKenzie, *supra* note 22, at 16. To illustrate this point, MacKenzie provides an example of the London Stock Exchange boasting that its new Turquoise trading platform can process an order in as little as 124 microseconds. *Id.*

<sup>28</sup> MacKenzie, *supra* note 22, at 16.

<sup>29</sup> *See id.*

<sup>30</sup> Haldane, *supra* note 11, at 5–6 ("Every 100 miles might add a milli-second to estimated execution times."). For example, assume a trader's offices are in Chicago, and that the trader wants to trade on the NYSE. The trader is around 800 miles away from the NYSE's matching engines in Mahwah, New Jersey. Sending an order at that distance takes approximately sixteen milliseconds. This is a huge delay in the HFT sphere, putting that trader at a disadvantage to other traders located nearer the NYSE's Mahwah computer storage facility. For this hypothetical, see MacKenzie, *supra* note 22.

<sup>31</sup> Haldane, *supra* note 11, at 6.

<sup>32</sup> MacKenzie, *supra* note 22, at 16–17. Co-location is a big earner for the exchanges. *Id.* at 17. Presumably, the exchanges have incentive to encourage this evolution of speed. The NASDAQ, for instance, introduced computer cabinets with chimney stacks that channel heat exhaust from customers' servers to allow more computing power in the racks. Tom Steinert-Threlkeld, *Nasdaq Data Center Introduces Computing Cabinets with Chimneys*, SEC. TECH. MONITOR (Feb. 7, 2012), <http://www.securitiestechologymonitor.com/news/nasdaq-omx-computer-chimneys-40gbps-29976-1.html>. Even the precise location of a server within an exchange's computer facility is a sensitive matter for HFT firms. MacKenzie, *supra* note 22, at 17. The NYSE, for instance, takes great effort in ensuring that no single spot within its computer center is better than any other in terms of access speed. *Id.*

The ever-greater emphasis on speed in the new, technology-driven financial market structure is what some have labeled an arms race, or a “race to zero”<sup>33</sup>: “[t]he new trading frontier is nano-seconds—billionths of a second. And the twinkle in technologists’ (unblinking) eye is pico-seconds—trillionths of a second.”<sup>34</sup>

This emphasis on speed is the primary defining aspect to high frequency trading: it is the main difference between traditional investment management and HFT.<sup>35</sup> It also distinguishes HFT from other algorithmic trading strategies.<sup>36</sup> HFT is a subset of algorithmic trading, where both use programmed algorithms to execute automated order submissions and automated order management.<sup>37</sup> However, it is common for a non-HFT algorithmic strategy to hold traded securities for days, weeks or months, whereas HFT traders usually end the trading day flat, with no significant holdings.<sup>38</sup> Furthermore, ultra-fast trading speeds are not necessary in a non-HFT algorithmic strategy;<sup>39</sup> HFT, on the other hand, uses strategies that require speed to gain advantages in the market.

Speed allows for increased frequency in opening and closing positions in various securities, which subsequently allows HFT systems to profitably capture small deviations in securities prices.<sup>40</sup> Typically, HFT traders collect tiny gains, usually measured in fractions of a cent, in large volumes of shares traded throughout the day. For example, in 1988, the typical market maker

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<sup>33</sup> Haldane, *supra* note 11, at 5. “Zero” refers to zero latency, where the time it takes from sending an order to its actual execution reaches its natural limit, the speed of light. *Id.*

<sup>34</sup> *Id.* For additional discussion on the importance of speed in trading, see Joel Hasbrouck & Gideon Saar, *Low-Latency Trading* 1 (Johnson School, Working Paper No. 35-2010, 2012), available at [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1695460](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1695460) (“[B]eing faster than other traders . . . can create profit opportunities by enabling a prompt response to news or market activity.”).

<sup>35</sup> ALDRIDGE, *supra* note 11, at 26–27.

<sup>36</sup> Algorithmic trading, often used by large institutional investors, “involves splitting a trade into multiple orders in order to reduce visibility and market impact [on pricing]” ; the decision to initiate the main trade may or may not be automated. EDGAR PEREZ, *THE SPEED TRADERS: AN INSIDER’S LOOK AT THE NEW HIGH-FREQUENCY PHENOMENON THAT IS TRANSFORMING THE INVESTING WORLD* 18 (2011); see also MacKenzie, *supra* note 22, at 16 (discussing a phenomenon when executing large orders known as “slippage,” where prices rise when attempting to buy in large blocks and fall when attempting to sell in large blocks; algorithms are used to break up orders to limit these effects).

<sup>37</sup> GOMBER ET AL., *supra* note 13, at 14; see also RISHI K. NARANG, *INSIDE THE BLACK BOX: THE SIMPLE TRUTH ABOUT QUANTITATIVE TRADING* 105–07 (2009). Automated trading involves inputting certain command triggers into an algorithm, that when satisfied, automatically place an order. PEREZ, *supra* note 36, at 18. A small trade might be placed directly into the market, whereas a large order might be passed off to an execution algorithm to limit price impact. *Id.*; see also ALDRIDGE, *supra* note 11 at 277–80 (briefly discussing “slippage” and large order price impact).

<sup>38</sup> GOMBER ET AL., *supra* note 13, at 16.

<sup>39</sup> See *id.*

<sup>40</sup> ALDRIDGE, *supra* note 11, at 26–27.

netted roughly four cents in profit for every share traded; today, the typical HFT nets *7/100 of a cent or less* per share traded.<sup>41</sup> HFT traders are willing to take 98% less than market makers in previous years because technological advancements in speed allow for huge trading volumes to make up the difference.<sup>42</sup> Booking small gains consistently throughout the trading day results in a reasonable gain by market close.<sup>43</sup>

While speed and volume broadly define HFT, examining only these two features limits understanding and regulating it. HFT encompasses a range of strategies, all of which use speed and volume in different capacities.<sup>44</sup>

### B. *Understanding HFT Strategies as a Basis for Regulation*

HFT employs strategies that rely on fast execution. The SEC acknowledges that different HFT strategies exist, and is correct to examine the various strategies as each requires a different regulatory approach.<sup>45</sup> On the other hand, the universe of HFT strategies is “diverse and opaque”;<sup>46</sup> regulating HFT solely on strategies in a regulatory environment where HFT data is not easily accessible would prove difficult.<sup>47</sup> Furthermore, in order to remain competitive, HFT algorithms constantly adapt in the rapidly developing HFT programming world: an HFT algorithm’s half-life can often be measured in weeks.<sup>48</sup> Therefore, as discussed in Part IV, regulators must first implement transparency initiatives to assist in tracking HFT, which will subsequently assist in determining a proper HFT regulatory regime.

#### 1. *Liquidity Provision*

Market liquidity generally refers to the ease in which market participants can transact; it is the market’s ability to absorb large purchases or sales without

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<sup>41</sup> BRADLEY & LITAN, *supra* note 24, at 24.

<sup>42</sup> *Id.*

<sup>43</sup> ALDRIDGE, *supra* note 11, at 27.

<sup>44</sup> See PEREZ, *supra* note 36, at 48 (“Low latency, in nearly every case, is very important for high-frequency trading firms, but the degree of importance depends on the strategy and how often it is executed.”).

<sup>45</sup> Concept Release on Equity Market Structure, 75 Fed. Reg. 3594, 3607–08 (proposed Jan. 21, 2010) (to be codified at 17 C.F.R. pt. 242) (discussing the SEC’s classification of four broad HFT strategy types: passive market making, arbitrage, structural, and directional).

<sup>46</sup> GOMBER ET AL., *supra* note 13, at 24.

<sup>47</sup> See David S. Hilzenrath, *SEC Still Concerned About High-Frequency Trading*, WASH. POST, Feb. 23, 2012, at A14, available at [http://www.washingtonpost.com/business/economy/high-frequency-trading-raises-concerns-at-sec/2012/02/22/gIQAfpLdTR\\_story.html](http://www.washingtonpost.com/business/economy/high-frequency-trading-raises-concerns-at-sec/2012/02/22/gIQAfpLdTR_story.html) (“The chairman of the Securities and Exchange Commission is worried about the rise of high-frequency trading . . . [but] says regulators still don’t know enough to do much more about it.”).

<sup>48</sup> Haldane, *supra* note 11, at 4.



significantly impacting prices.<sup>49</sup> Traditionally, market makers, or specialists, are the mainstays of liquidity: they stand on the floors of exchanges ready and willing to act on both the buy- and sell-side of a transaction immediately upon receiving orders.<sup>50</sup> As compensation for performing this important function, market makers earn a spread between the bid (the price at which a buyer will pay for a share of stock) and the ask (the price at which a seller will sell a share of stock).<sup>51</sup> Spreads are transaction costs, and the primary factor in reducing this cost is the rate of transactions: “[t]he greater the frequency of transacting, the lower will be the cost of waiting in a trading queue of specified length, and, therefore, the lower will be the spreads that traders are willing to submit to preempt positions in the trading queue.”<sup>52</sup>

Market making is not without downsides, and the market maker also earns the spread as a type of insurance for bearing certain risks.<sup>53</sup> A high spread implies greater risk, such as when less willing buyers and sellers exist, and the market maker is exposed to the risk of holding inventory, i.e., shares of stock.<sup>54</sup> On the other hand, reduced spreads function as an illustration of higher market liquidity.<sup>55</sup> A lower spread means the market maker is better able to absorb buy and sell orders and execute them with little pricing impact.<sup>56</sup> As liquidity improves, execution certainty and price efficiency also improve.<sup>57</sup>

Today, HFT traders using a liquidity-provision strategy act as traditional market makers, and are the markets’ principal liquidity providers.<sup>58</sup> HFT allows

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<sup>49</sup> Timothy F. Geithner, President and CEO, Fed. Reserve Bank of N.Y., Keynote Address at the 8th Annual Risk Convention and Exhibition, Global Association of Risk Professionals (Feb. 28, 2007), available at <http://www.newyorkfed.org/newsevents/speeches/2007/gei070228.html>.

<sup>50</sup> See Harold Demsetz, *The Cost of Transacting*, 82 Q. J. ECON. 33, 35–37 (1968). Ironically, Demsetz, writing in 1968, mentions in passing the difficulty in completely computerizing the market maker’s role, as it involves “judgment, investment, and risk-taking.” *Id.* at 38.

<sup>51</sup> See *id.* at 35–37. Market makers earn this spread by matching market orders (the buyer or seller wishes their trade to be executed immediately at the going market value) and limit orders (the buyer or seller has a minimum or maximum cap on the price at which they are willing to buy or sell). The more rapidly market orders arrive, the sooner the limit orders will be executed. *Id.* at 40–41.

<sup>52</sup> *Id.* at 41.

<sup>53</sup> Market makers face two problems: the first is an inventory management problem—the amount of stock to hold and the price at which to buy and sell. Haldane, *supra* note 11, at 7. “The market maker earns a bid-ask spread in return for solving this problem since they bear the risk that [the stock for sale] loses value.” *Id.* The second is an information management problem: the risk of trading with someone possibly better informed about true prices than is the market maker himself, and it earns the bid-ask spread since he also bears this risk. *Id.*

<sup>54</sup> See *id.*

<sup>55</sup> See *id.*

<sup>56</sup> See *id.*

<sup>57</sup> *Id.*; see also Hasbrouck & Saar, *supra* note 34, at 21–28.

<sup>58</sup> BRADLEY & LITAN, *supra* note 24, at 20.

for fast transactions to occur, thereby narrowing spreads, lessening market risks, and improving efficiency.<sup>59</sup>

An HFT liquidity-provision strategy's primary sources of profits stem from two sources: (1) earning the bid–ask spread; and (2) capturing any liquidity rebates offered by exchanges.<sup>60</sup> Regarding profits by earning the spread, HFT employing this strategy act as traditional market makers, yet do not have formal obligations to quote in markets in which they are active.<sup>61</sup> With respect to liquidity rebates, exchanges provide these as an additional incentive to provide liquidity.<sup>62</sup> A rebate trader hopes to make money off the rebate, rather than on the price movement of the stock.<sup>63</sup> Therefore, the key is to quickly get in and out of a stock in order to capture the rebate without risking a loss on the price—it “can generate an enormous volume of orders and high cancellation rates of

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<sup>59</sup> *Id.*; GOMBER ET AL., *supra* note 13, at 30–31. Twenty years ago, spreads could sometimes reach twenty-five cents per share; today, shares are often as little as one cent. MacKenzie, *supra* note 22, at 17. Also, see generally Hasbrouck & Saar, *supra* note 34, for an in-depth analysis on narrower price spreads as a result of low-latency trading. Reduced spreads also decrease trading costs for large institutions, and these savings are passed directly on to pensioners and other investors. BRADLEY & LITAN, *supra* note 24, at 14.

<sup>60</sup> Haldane, *supra* note 11, at 7.

<sup>61</sup> GOMBER ET AL., *supra* note 13, at 25. Market making rules and obligations vary between exchanges, but most major exchanges, including the NYSE, the Toronto Stock Exchange, the London Stock Exchange, and the Deutsche Börse, all “designate market makers with affirmative obligations to supply liquidity for at least some stocks.” Hendrik Bessembinder, Jia Hao & Michael L. Lemmon, Why Designate Market Makers? Affirmative Obligations and Market Quality (June 2011) (unpublished paper), *available at* [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=989061](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=989061). The danger of not having quote obligations is illustrated in the flash crash of 2010, when HFT traders pulled out of the market thereby drying up liquidity. *See infra* Part III.A.

<sup>62</sup> GOMBER ET AL., *supra* note 13, at 26 (“In order to attract liquidity providers and react to increasing competition among markets, some trading venues have adopted asymmetric pricing: members removing liquidity from the market . . . are charged a higher fee while traders who submit liquidity to the market . . . are charged a lower fee or are even provided a rebate.”).

<sup>63</sup> Admin, *Rebate Trading*, TRADINGSIM BLOG (June 17, 2011), <http://tradingsim.com/blog/rebate-trading/>. To illustrate how the rebate-capture operates, assume an institutional investor is willing to buy shares in a stock in a range of \$1.00 to \$1.05. The investor places an order for 100 shares at \$1.00, and subsequently places another order for 500 shares at the same price. An HFT using a rebate-capture strategy will place a bid for the same stock at \$1.01—whoever had been selling at \$1.00 will now sell at the higher offer price of \$1.01. The rebate-capture HFT now owns shares at \$1.01 and earned the rebate of, say, 1/4 penny per share bought. It will then immediately sell the shares to the institutional investor at \$1.01, gaining no return from the sale, but earning another rebate for the second offer. This example is taken from SAL L. ARNUK & JOSEPH SALUZZI, THEMIS TRADING LLC, TOXIC EQUITY TRADING ORDER FLOW ON WALL STREET: THE REAL FORCE BEHIND THE EXPLOSION IN VOLUME AND VOLATILITY, *available at* [http://www.themistrading.com/article\\_files/0000/0348/Toxic\\_Equity\\_Trading\\_on\\_Wall\\_Street\\_12-17-08.pdf](http://www.themistrading.com/article_files/0000/0348/Toxic_Equity_Trading_on_Wall_Street_12-17-08.pdf).

90% or more.”<sup>64</sup> But above all, it relies on speed: the first trader that is able to adjust its limit orders, or buy and sell orders at market moves, will be at the “top of the book”—it will be first in line to execute trades, earning the spread and any associated rebate.<sup>65</sup>

## 2. Arbitrage

Arbitrage strategies exploit pricing differences between common securities quoted on competing trading platforms.<sup>66</sup> For example, Stock *A* could be listed on Exchange *X* for \$1.01 and simultaneously listed on Exchange *Z* for \$1.02. An HFT algorithm employing an arbitrage strategy would purchase the stock on Exchange *X* for \$1.01, and sell it on Exchange *Z* for \$1.02. Pricing discrepancies usually exist for fractions of a second, and low-latency HFT technology is useful in exploiting such opportunities.<sup>67</sup>

One subset that heavily uses quantitative and computational elements is statistical arbitrage and pairs trading.<sup>68</sup> This strategy uses data mining, statistics, and artificial intelligence to track stocks with fundamentals or market-based similarities.<sup>69</sup> When one stock in a pair outperforms the other stock, the poorer performing stock is bought long—the expectation is that it will climb towards its outperforming partner—while the outperformer is sold short.<sup>70</sup> This strategy propagates price information: it predicts the price movements of stocks that have not yet moved using the data of similar stocks that are currently moving.<sup>71</sup> This strategy is an important mechanism for transferring liquidity from a stock that is moving to a stock that is stagnating, thereby improving price efficiency.<sup>72</sup>

Understanding the difference between, for instance, a liquidity-provision strategy and an arbitrage strategy is important in promulgating a regulatory regime. While statistical arbitrage is an important mechanism in transferring market liquidity and propagating price information, blanket regulations that cover both a liquidity-provision strategy and an arbitrage trading strategy would

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<sup>64</sup> Concept Release on Equity Market Structure, 75 Fed. Reg. 3594, 3607 (proposed Jan. 21, 2010) (to be codified at 17 C.F.R. pt. 242).

<sup>65</sup> PEREZ, *supra* note 36, at 10.

<sup>66</sup> See ALDRIDGE, *supra* note 11, at 4.

<sup>67</sup> See GOMBER ET AL., *supra* note 13, at 27–28.

<sup>68</sup> PEREZ, *supra* note 36, at 19.

<sup>69</sup> *Id.* For example, one trader described an arbitrage scheme that involved shares of Southwest Airlines, Delta, and ExxonMobil. A rise in the price of oil benefitted Exxon’s shares, and hurt Delta’s, but because Southwest entered into futures contracts to hedge against oil pricing risk, it remained neutral. A rough equation developed: Delta + ExxonMobil = Southwest; if that equation temporarily broke down, a pairs trader would jump in and buy shares of a mispriced stock in the equation. This example was taken from MacKenzie, *supra* note 22, at 16.

<sup>70</sup> PEREZ, *supra* note 36, at 19–20.

<sup>71</sup> *Id.* at 147.

<sup>72</sup> See *id.* at 147–48.

be counterproductive. As discussed in Part II.B.1, liquidity provision plays a crucial role in the markets: in times of market stress, it is desirable for liquidity providers to remain market participants to reduce price impact and volatility.<sup>73</sup> Regulations providing incentives for such HFT traders would be beneficial to the market; yet, these same incentives provided to an HFT using an arbitrage strategy might exacerbate market stress in a volatile period.<sup>74</sup> For example, if a trader input an incorrect order,<sup>75</sup> and pricing information became incorrect in one stock, it would be harmful for arbitrageurs to use this information to trade on paired stocks, with one being incorrectly priced.<sup>76</sup> Instead, to limit the spread of incorrect pricing data, it is more useful for arbitrageurs to shut down during periods with clearly erroneous pricing information.

### 3. Predatory

Despite its benefits in improving liquidity and price efficiency, HFT can be used in manipulative ways;<sup>77</sup> certain strategies use speed and volume to earn consistent gains to the detriment of other market participants, mainly large institutional investors.<sup>78</sup> “Latency arbitrage” is the general practice of exploiting access to direct data feeds and co-located servers to impair prices at which other traders are able to trade.<sup>79</sup> By being the fastest obtainer of market data via co-location arrangements and data center feeds, HFT traders profit by exploiting slower market participants who offer executions at stale prices.<sup>80</sup>

For example, “stuffing” involves an HFT trader submitting an excessively large number of orders to the market, generating congestion on an exchange.<sup>81</sup>

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<sup>73</sup> See *supra* Part II.B.1 and *infra* Part III.A.

<sup>74</sup> See PEREZ, *supra* note 36, at 147.

<sup>75</sup> Similar to the events of the flash crash, discussed *infra* Part III.A.

<sup>76</sup> See discussion *infra* Part III.A.

<sup>77</sup> The blogosphere’s accusations regarding HFT are rampant. See, e.g., *Academic Paper Questions HFT Role in Volatility and Correlation*, THEMIS TRADING BLOG (Aug. 24, 2011), <http://blog.themistrading.com/academic-paper-questions-hft-role-in-volatility-and-correlation/>; Tyler Durden, *HFT Quote Stuffing Market Manipulation Caught In The Act*, ZEROHEDGE (Aug. 25, 2011, 3:38 PM), <http://www.zerohedge.com/news/hft-quote-stuffing-market-manipulation-caught-act>; *HFT Algorithms Running Wild*, NANEX.NET (Jan. 12, 2012), <http://www.nanex.net/aqck/2685.HTML>.

<sup>78</sup> SAL ARNUK & JOSEPH SALUZZI, THEMIS TRADING LLC, *LATENCY ARBITRAGE: THE REAL POWER BEHIND PREDATORY HIGH FREQUENCY TRADING* (2009), available at [http://www.themistrading.com/article\\_files/0000/0519/THEMIS\\_TRADING\\_White\\_Paper\\_-\\_Latency\\_Arbitrage\\_-\\_December\\_4\\_\\_2009.pdf](http://www.themistrading.com/article_files/0000/0519/THEMIS_TRADING_White_Paper_-_Latency_Arbitrage_-_December_4__2009.pdf) (“[I]t is about using HFT techniques . . . to determine what kind of institutional algo orders are in the market, such as those driven by commonly used volume weighted average price (VWAP) formulas, and how those orders will react if the bid / offer of a stock moves up or down.”).

<sup>79</sup> GOMBER ET AL., *supra* note 13, at 29–30.

<sup>80</sup> Concept Release on Equity Market Structure, 75 Fed. Reg. 3594, 3608 (proposed Jan. 21, 2010) (to be codified at 17 C.F.R. pt. 242).

<sup>81</sup> Bruno Biais & Paul Woolley, *High Frequency Trading 7* (Mar. 2011) (preliminary paper), available at [http://idei.fr/doc/conf/pwri/biais\\_pwri\\_0311.pdf](http://idei.fr/doc/conf/pwri/biais_pwri_0311.pdf).

Due to the unusually high volume of trades, non-HFT traders do not have a clear view of their orders' statuses, making it difficult to execute additional trades.<sup>82</sup> HFT traders are then able to execute trades at slow traders' expense.<sup>83</sup> Similarly, "smoking" is an HFT scheme that exploits slow traders by offering attractive limit orders, then quickly revising these prices to take advantage of an unsuspecting slow trader's market order.<sup>84</sup>

These strategies are not mere accusations: the Financial Industry Regulatory Authority (FINRA) recently fined Trillium Brokerage Services, an HFT firm, over \$2 million for what the regulatory agency called an "[i]llicit [e]quities [t]rading [s]trategy."<sup>85</sup> The firm engaged in a strategy that placed numerous orders it had no intention of filling to create the appearance of buy- or sell-side pressure.<sup>86</sup> It essentially baited unsuspecting market participants into executing trades at illegitimately high or low prices, exploiting these contra-side participants for its own gain.<sup>87</sup> The technique is called "spoofing" and Trillium executed the strategy over 46,000 times.<sup>88</sup>

Further contributing to fears of manipulation was an incident in the summer of 2009 when a computer programmer at Goldman Sachs, a New York-based

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<sup>82</sup> *Id.*

<sup>83</sup> *Id.*

<sup>84</sup> *Id.*

<sup>85</sup> Press Release, Fin. Indus. Regulatory Auth., FINRA Sanctions Trillium Brokerage Services, LLC, Director of Trading, Chief Compliance Officer, and Nine Traders \$2.26 Million for Illicit Equities Trading Strategy (Sep. 13, 2010), *available at* <http://www.finra.org/Newsroom/NewsReleases/2010/P121951>.

<sup>86</sup> *Id.* This is similar to a strategy where HFT algorithms place numerous immediate-or-cancel (IOC) orders to move the price up and discover the maximum limit order for the contra-side institutional algorithm. See Tobin Harshaw, *Weekend Opinionator: Is Wall Street Picking Our Pockets?*, N.Y. TIMES (July 24, 2009, 9:07 PM), <http://opinionator.blogs.nytimes.com/2009/07/24/weekend-opinionator-is-wall-street-picking-our-pockets/>. More recently, questions circulated over whether HFT traders contributed to the botched Facebook IPO on NASDAQ, where rapidly cancelled orders came in between the two millisecond timespan needed to calculate price—the exchange had to manually override the continuous order placement previously in place, which subsequently delayed order confirmations and created confusion for many. Telis Demos, *'Raindrops' raise questions after Facebook IPO*, FIN. TIMES (May 21, 2012, 1:29 AM), <http://www.ft.com/intl/cms/s/0/c1e84ac6-a2c8-11e1-826a-00144feabdc0.html#axzz20cMC1szk>; Barry Ritholtz, *How Facebook Fucked Up Its Own IPO*, THE BIG PICTURE (May 22, 2012, 7:21 AM), <http://www.ritholtz.com/blog/2012/05/how-facebook-fucked-up-its-own-ipo/>.

<sup>87</sup> Press Release, Fin. Indus. Regulatory Auth., *supra* note 85.

<sup>88</sup> *Id.* For a more detailed explanation of the mechanics of a "spoofing" trade, see Biais & Woolley, *supra* note 81, at 8; see also Barry Ritholtz, *FINRA Censures "Illicit Equities Trading Strategy" (HFT Trading)*, THE BIG PICTURE (Sept. 14, 2010, 9:06 AM), <http://www.ritholtz.com/blog/2010/09/finra-censures-illicit-equities-trading-strategy-hft-trading/> ("46,000 quotes over the course of a few hours—let alone seconds—should be unlawful."). Note, Ritholtz terms Trillium's actions "quote stuffing," but it is more congruent to Biais and Woolley's definition of "spoofing."

investment bank, was arrested for stealing his employer's HFT source code.<sup>89</sup> The assistant U.S. Attorney handling the bail hearing revealed to the court a startling piece of information: "The bank has raised the possibility that there is a danger that somebody who knew how to use this program could use it to manipulate markets in unfair ways."<sup>90</sup> If Goldman actually did provide this information to the U.S. Attorney, the question arises: what prevents Goldman or any other HFT trader from misusing its HFT code to manipulate markets?<sup>91</sup>

The basis for regulating and preventing these predatory strategies is the SEC's broad view of manipulation on the open market, whereby the trader's "sole intent" in placing an order is to move the price of a stock.<sup>92</sup> Under this view, manipulation occurs when a trader would not have bought or sold a stock without a manipulative intent.<sup>93</sup> The Second and Third Circuits have rejected the "sole intent" test, in favor of an "inaccurate information" test, where in addition to manipulative intent the trader must also inject inaccurate information into the market.<sup>94</sup> Courts have not faced the question of whether market manipulation occurs in HFT predatory strategies;<sup>95</sup> however, these

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<sup>89</sup> See generally *United States v. Aleynikov*, 785 F. Supp. 2d 46 (S.D.N.Y. 2011). In its denial for Aleynikov's motion for a new trial, the District Court noted that HFT traders are "extremely secretive about the various aspects of their [HFT] trading systems." *Id.* at 51. The programmer, Sergey Aleynikov, was convicted of violating the Economic Espionage Act and the Interstate Transportation of Stolen Property Act. Patricia Hurtado, *Ex-Goldman Programmer Aleynikov's Conviction Upheld by Judge*, BLOOMBERG (Mar. 16, 2011), <http://www.bloomberg.com/news/2011-03-16/ex-goldman-programmer-aleynikov-s-conviction-is-upheld-by-trial-judge.html>. Aleynikov's conviction was subsequently reversed. *United States v. Aleynikov*, No. 11-1126, 2012 WL 591980, at \*1 (2d Cir. Feb. 17, 2012); see also Patricia Hurtado, *Ex-Goldman Programmer Freed After Theft Conviction Thrown Out*, BLOOMBERG (Feb. 18, 2012), <http://www.bloomberg.com/news/2012-02-17/ex-goldman-programmer-s-conviction-overtured-on-appeal.html>. In a surprising twist, the Manhattan district attorney later brought state felony charges against Aleynikov for the "unlawful use of secret scientific material and duplication of computer-related material." Peter Lattman, *Former Goldman Programmer Is Arrested Again*, N.Y. TIMES DEALBOOK (Aug. 9, 2012, 5:06 PM), <http://dealbook.nytimes.com/2012/08/09/ex-goldman-programmer-is-arrested-again/>.

<sup>90</sup> Jonathan Weil, *Goldman Sachs Loses Grip on Its Doomsday Machine*, BLOOMBERG (July 8, 2009, 9:00 PM), <http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aFeyqdzYcizc>.

<sup>91</sup> *Id.*

<sup>92</sup> David L. Kornblau et al., *Market Manipulation and Algorithmic Trading: The Next Wave of Regulatory Enforcement?*, 44 SEC. REG. & L. REP. 369, 370 (2012).

<sup>93</sup> *Id.*

<sup>94</sup> *Id.*; see also *ATSI Commc'ns, Inc. v. Shaar Fund, Ltd.*, 493 F.3d 87, 100 (2d Cir. 2007) ("[C]ourts generally ask whether a transaction sends a false pricing signal to the market."); *GFL Advantage Fund, Ltd. v. Colkitt*, 272 F.3d 189, 205 (3d Cir. 2001) ("Requiring a Section 10(b) plaintiff to establish that the alleged manipulator injected 'inaccurate information' into the market . . . cures th[e] problem [of determining which activities artificially affect prices].").

<sup>95</sup> The Dodd-Frank Act recently expanded the CFTC's enforcement powers against market manipulators. Most notably it defined disruptive trading practices, which some

regulators are unlikely to limit their investigations into HFT and other algorithmic trading merely because the manipulation standard is unclear.<sup>96</sup> Regulators frequently cite the flash crash of May 6, 2010 as their basis for investigating HFT.

### III. THE FLASH CRASH OF 2010 AND PUBLIC PERCEPTION

Some critics of HFT assert that the common academic arguments supporting HFT as increasing market efficiency, i.e., that HFT adds liquidity and tightens spreads, should be viewed skeptically as many of those authors have vested interests in supporting certain parties.<sup>97</sup> Most of this research shows that HFT alleviates liquidity problems and increases market efficiency in peaceful market periods, as discussed in section II.B. However, HFT contributes to market volatility in stressful periods by halting trades and drying up liquidity.<sup>98</sup> Part III of this Note uses the market events of May 6, 2010, commonly known as the “flash crash,” to show that HFT did not trigger the crash, but propagated the ensuing downward spiral in prices by halting their trades and removing market liquidity. The flash crash’s lasting effect is that minor computer errors have damaged the markets’ credibility in reflecting accurate price information, which has reduced investor confidence.<sup>99</sup> As such, regulators are correct to impose regulations that limit the risk of another market failure like the flash crash of 2010.

#### A. Market Events of May 6, 2010: HFT Responses to Volatility

The official report on the flash crash, issued by a joint advisory committee comprised of staffs from both the Commodity Futures Trading Commission

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expect will be useful in bringing future enforcement actions against algorithmic traders. *See* Kornblau et al., *supra* note 92, at 370.

<sup>96</sup> *Id.* at 371.

<sup>97</sup> *European Regulators Summarize The Drivers and Risks of HFT*, THEMIS TRADING (Nov. 15, 2011), <http://blog.themistrading.com/european-regulators-summarize-the-drivers-and-risks-of-hft/>.

<sup>98</sup> Haldane, *supra* note 11, at 8–9.

<sup>99</sup> Today, institutions are the largest and most influential investors. *See* THE ASPEN INST., *OVERCOMING SHORT-TERMISM: A CALL FOR A MORE RESPONSIBLE APPROACH TO INVESTMENT AND BUSINESS MANAGEMENT 2* (2009). The increasing emphasis placed on short-run price performance and short-run returns by institutional investors plays out negatively in a market where ultrafast algorithms trade in microseconds. Some market watchers have described the need, generally, for such investors to return to longer-run strategies of “patient” capital, aligned interests of financial intermediaries and investors, and improved investor-side disclosures. *Id.* at 3–5. The implication is that the regulatory impetus is not to protect retail investors, but rather institutional investors who may be targeted by HFT. *Cf.* Indiviglio, *supra* note 20 (regarding the link between wild stock market swings and drops in consumer confidence and spending due to public fears concerning personal investments).

(CFTC) and the Securities and Exchange Commission (SEC), does not directly blame HFT firms for starting the dramatic and rapid price plummets.<sup>100</sup> Instead, the Report notes an already tense market. Trading on May 6 began with uncertainty due to troubling political and economic news regarding the European debt crisis.<sup>101</sup> By 1:00 p.m., widespread negative market sentiment caused increased price volatility in select individual securities.<sup>102</sup>

Clearly, the markets were jittery as a result of the European turmoil that day. Amid this already volatile trading day was a mutual fund trader initiating an unusually large program to sell 75,000 E-Mini S&P 500 futures contracts (the E-Mini),<sup>103</sup> valued at a total of approximately \$4.1 billion.<sup>104</sup> For this large 75,000 E-Mini contracts sale, the trader used an algorithm to manage the sale of this huge block of orders, but mistakenly input commands into the algorithm: the commands accounted for volume, but not price or time.<sup>105</sup> The firm had

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<sup>100</sup> U.S. COMMODITY FUTURES TRADING COMM'N & U.S. SEC. & EXCH. COMM'N, FINDINGS REGARDING THE MARKET EVENTS OF MAY 6, 2010: REPORT OF THE STAFFS OF THE CFTC AND SEC TO THE JOINT ADVISORY COMMITTEE ON EMERGING REGULATORY ISSUES (2010) [hereinafter JOINT REPORT]; *see also* U.S. COMMODITY FUTURES TRADING COMM'N & U.S. SEC. & EXCH. COMM'N, RECOMMENDATIONS REGARDING REGULATORY RESPONSES TO THE MARKET EVENTS OF MAY 6, 2010: SUMMARY REPORT OF THE JOINT CFTC-SEC ADVISORY COMMITTEE ON EMERGING REGULATORY ISSUES 2 (2011) [hereinafter SUMMARY REPORT] (“The broad, visible, and often controversial, topic of . . . HFT . . . has been pervasive in our discussions and in comments received from others. Rather than detail specific recommendations about HFT[,] . . . steps to address issues associated with this practice are evident throughout our report.”). The Joint Report may have even offered some vindication for HFT firms, but “[t]hat may not save them from stricter rules.” *The Flash Crash: Autopsy*, *supra* note 19, at 108.

<sup>101</sup> JOINT REPORT, *supra* note 100, at 1.

<sup>102</sup> *Id.* Just before the crash, at approximately 2:30 p.m., the S&P 500 volatility index (VIX) was up 22.5% and ten-year U.S. Treasury yields fell as investors fled to safer securities, conversely causing the Dow Jones Industrial Average (DJIA) to drop by roughly 2.5%. *Id.*

<sup>103</sup> *Id.* at 2. A futures contract is “an agreement to purchase or sell a commodity for delivery in the future at a price that is determined when the contract is bought or sold.” U.S. COMMODITY FUTURES TRADING COMM'N & U.S. SEC. & EXCH. COMM'N, PRELIMINARY FINDINGS REGARDING THE MARKET EVENTS OF MAY 6, 2010: REPORT OF THE STAFFS OF THE CFTC AND SEC TO THE JOINT ADVISORY COMMITTEE ON EMERGING REGULATORY ISSUES app. B-1 (May 18, 2010) [hereinafter PRELIMINARY FINDINGS]. Index futures, like the E-Mini S&P 500, are financial instruments through which traders buy and sell contracts for a standardized value of a stock index to be executed on a future date and set price. *Id.* at app. B-3. These index futures contracts are primarily used by financial institutions and other market participants as risk management tools. *Id.*

<sup>104</sup> JOINT REPORT, *supra* note 100, at 2. The Joint Report notes that a market participant has a few options when executing a large trade: the participant can use an intermediary to execute a block trade to manage the position; the participant can choose to manually enter orders into the market; or the participant can use an algorithm to manage the sale, taking price, time and/or volume into consideration to meet the participant's needs. *Id.*

<sup>105</sup> *Id.* In accounting for only volume, and not price or time, the algorithm dumped a large number of futures contracts into the market in an unusually short amount of time. *Id.* If the price and/or time functions were factored in, the sales would have slowed, thereby



executed an E-Mini sale on a similar scale before, but it had used both manual and automated execution mechanisms—taking into account price, time and volume—which took more than five hours to complete the first 75,000 E-Mini contracts.<sup>106</sup> On May 6, however, when the markets were already under significant stress, it executed a sell algorithm targeting only volume, not price or time—the 75,000 contracts sale executed in just twenty minutes.<sup>107</sup>

The point to highlight is that the algorithm that triggered the crash was not a sophisticated, ultra-low latent HFT algorithm.<sup>108</sup> Where HFT comes in is when the sell algorithm first commenced: initially, HFT algorithms were the first buyers of the contracts, and it looked like the market would absorb the huge sell-off.<sup>109</sup> However, to counterbalance their purchases to remain “market neutral,”<sup>110</sup> these HFT algorithms bought and sold the contracts simultaneously, in what the Report termed a “hot-potato” effect.<sup>111</sup> The non-HFT algorithm that initiated the huge sell order “responded to the increase in volume by unloading the contracts faster, pushing prices down further.”<sup>112</sup> By 2:45:27 p.m., the price of E-Mini futures “had declined by more than [five] per cent from its level just four and a half minutes earlier.”<sup>113</sup> Prices moved so quickly that buyers were either unable or unwilling to provide buy-side liquidity.<sup>114</sup>

In reaction to the volatility in the E-Mini market, a significant number of participants completely withdrew from other markets.<sup>115</sup> Many liquidity providers in the equities markets, including HFT traders, paused trading due to

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alleviating sell-side pressure. The mistake resulted in the largest net change in a daily position of any E-Mini trader year-to-date in 2010. *Id.*

<sup>106</sup> *Id.*

<sup>107</sup> *Id.*

<sup>108</sup> MacKenzie, *supra* note 22, at 17. Instead, the algorithm is believed to have belonged to Waddell & Reed, a Kansas City investment manager who was attempting to protect a large market position from further declines. *Id.*

<sup>109</sup> *Id.* (“Algorithmic trading was still in the benign zone that it occupies most of the time: electronic market makers and arbitrageurs were ‘providing liquidity’ . . . making it possible for the volume participation algorithm to do its intended large-scale selling.”); see also JOINT REPORT, *supra* note 100, at 3.

<sup>110</sup> This is a mechanism to limit risk. See MacKenzie, *supra* note 22, at 17 (“[HFT traders] usually program their algorithms to be ‘market neutral,’ in other words to insulate their trading positions from fluctuations in overall market levels.”).

<sup>111</sup> JOINT REPORT, *supra* note 100, at 3. In the fourteen-second period between 2:45:13 p.m. and 2:45:27 p.m., 27,000 E-Mini futures contracts traded via HFT. JOINT REPORT, *supra* note 100, at 3.

<sup>112</sup> *The Flash Crash: Autopsy*, *supra* note 19, at 108.

<sup>113</sup> MacKenzie, *supra* note 22, at 17.

<sup>114</sup> See *id.*

<sup>115</sup> JOINT REPORT, *supra* note 100, at 5. In interviews conducted for the Joint Report, some market participants said they feared that the price drops meant some catastrophic event had occurred of which they had not yet heard; others believed that the data feeds carrying price information had a technical glitch and stopped trading in response. *Id.*; see also MacKenzie, *supra* note 22, at 17.

the sudden and drastic price declines.<sup>116</sup> Although some HFT traders continued to trade throughout the volatile period, others reduced trading activity or completely withdrew from the market, making HFT traders net sellers as volume increased.<sup>117</sup>

Official market makers attempted to halt their trades, as well.<sup>118</sup> However, these participants are required to quote prices at which they would buy and sell shares in the markets in which they are active.<sup>119</sup> Therefore, even when they want to stop trading, they cannot. They instead use a scheme known as a “stub quote” to meet their formal obligations of continuous trading, while effectively pausing trades.<sup>120</sup> Stub quotes reduce the bids in shares of a stock to the lowest possible value (\$0.01), and the asks to the maximum possible value (\$99,999.99), making the bids and asks so unattractive that no rational trader would take a market maker up on these quotes.<sup>121</sup>

By 2:40 p.m. on May 6, liquidity had vanished so drastically that the stub quotes for some securities were the only available prices left at which to trade.<sup>122</sup> Between 2:40 p.m. and 3:00 p.m., over 20,000 trades across 300 securities, many of which were retail investors’ market orders (orders to simply buy or sell at the best available market price), were executed at prices that were 60% or more away from their price before 2:40 p.m., i.e., a “normal” level.<sup>123</sup> Two startling instances of pricing absurdities due to stub quote executions were the cases of Accenture and Sotheby’s. In Accenture’s case, shares of its stock traded at around \$40 per share at 2:47 p.m., only to plummet to \$0.01 at 2:48 p.m.<sup>124</sup> In Sotheby’s case, shares of its stock opened the day at \$34.61, later reaching \$100,000 only to close at \$33.<sup>125</sup> Prices were “dislocated to the point where they had no information content whatsoever.”<sup>126</sup>

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<sup>116</sup> JOINT REPORT, *supra* note 100, at 4. The Report later states that “liquidity providers” include traditional market makers and HFT traders, among others. *Id.* at 35.

<sup>117</sup> *Id.* at 5.

<sup>118</sup> MacKenzie, *supra* note 22, at 17–18.

<sup>119</sup> *Id.*

<sup>120</sup> *Id.* at 18.

<sup>121</sup> *Id.*

<sup>122</sup> *Id.*

<sup>123</sup> JOINT REPORT, *supra* note 100, at 6; *see also* MacKenzie, *supra* note 22, at 18.

<sup>124</sup> Matt Phillips, *Accenture: Went to a Penny at 2:48 p.m.*, WSJ BLOGS: MARKETBEAT (May 6, 2010, 4:17 PM), <http://blogs.wsj.com/marketbeat/2010/05/06/accenture-went-to-a-penny-at-248-pm/>.

<sup>125</sup> Stephen Grocer, *Six Mega Drops of the Flash Crash; Sam Adams Goes Flat*, WSJ BLOGS: DEAL JOURNAL (May 6, 2010, 5:47 PM), <http://blogs.wsj.com/deals/2010/05/06/four-mega-drops-of-the-flash-crash-sam-adams-goes-flat/>. Other stocks with bizarre price movements at similar times were Exelon, CenterPoint Energy, TransMontaigne Partners, Impax Laboratories, and Samuel Adams. *See id.*

<sup>126</sup> Haldane, *supra* note 11, at 12.

### B. *The Dangers of HFT*

While HFT did not spark the flash crash, it is clear that it contributes to market volatility in times of stress. The “hot-potato” effect and the endogenous self-exciting nature of HFT certainly contributed to the cascading downward spiral of E-Mini futures, and later, other stock prices.<sup>127</sup> However, the exchanges had in place mechanisms to correct these market failures. With respect to the E-Mini, the Chicago Mercantile Exchange’s circuit breaker triggered at 2:45:28 p.m. to prevent a further cascade of prices.<sup>128</sup> The circuit breaker paused trading on the E-Mini for five seconds, and in that short timeframe, sell-side pressure eased and buy-side interest increased allowing prices to stabilize shortly after trading resumed.<sup>129</sup>

With respect to equities, market-wide circuit breakers were not triggered.<sup>130</sup> In fact, the cause of the nonsensical stock prices was the fact that HFT traders, along with other liquidity providers, exited the market.<sup>131</sup> But market stability returned gradually on its own, and prices largely stabilized by 3:00 p.m.<sup>132</sup> In an ex post regulatory move, FINRA met with the exchanges after markets closed that day and agreed to break (i.e. cancel) all trades that occurred during the flash crash.<sup>133</sup>

What does this mean for HFT and market failures? The day’s problems were corrected, and there has not been a market-wide failure similar to the flash crash since it occurred in May 2010.<sup>134</sup> Indeed, one study declares that the

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<sup>127</sup> See D. SORNETTE & S. VON DER BECKE, *CRASHES AND HIGH FREQUENCY TRADING: AN EVALUATION OF RISKS POSED BY HIGH-SPEED ALGORITHMIC TRADING* 11 (2011) (report commissioned as part of the UK Government’s Foresight Project, *The Future of Computer Trading in Financial Markets*).

<sup>128</sup> JOINT REPORT, *supra* note 100, at 4.

<sup>129</sup> *Id.*

<sup>130</sup> *Id.* at 6.

<sup>131</sup> See *supra* text accompanying notes 109–17; see also JOINT REPORT, *supra* note 100, at 45–48 (discussing specific findings regarding HFT in the markets that day). The Report concludes, “[I]t appears that the 17 HFT firms traded with the price trend on May 6 and, on both an absolute and net basis, removed significant buy liquidity from the public quoting markets during the downturn.” *Id.* at 48.

<sup>132</sup> See MacKenzie, *supra* note 22, at 18.

<sup>133</sup> JOINT REPORT, *supra* note 100, at 6.

<sup>134</sup> Sornette and von der Becke argue that mini flash crashes occur rather frequently in individual stocks. They cite, among other examples, crashes in shares of Progress Energy in September 2010, Apple in February 2011, as well as a sharp move in the USD/Yen on the currency market one month later. See SORNETTE & VON DER BECKE, *supra* note 127, at 13; see also Philip Elmer-DeWitt, *Snapshot of an Apple Flash Crash*, CNNMONEY (Feb. 10, 2011, 2:50 PM), <http://tech.fortune.cnn.com/2011/02/10/snapshot-of-an-apple-flash-crash/>. A second crash in Apple shares occurred in March 2012, where the stock “plunged [nine] percent on a single trade,” triggering circuit breakers. John Melloy, *Apple Flash Crash: Stock Halted After Trade Causes 9% Plunge*, CNBC FASTMONEY (Mar. 23, 2012, 8:12 PM), [http://www.cnbc.com/id/46835129/Apple\\_Flash\\_Crash\\_Stock\\_Halted\\_After\\_Trade\\_Causes\\_9\\_Plunge](http://www.cnbc.com/id/46835129/Apple_Flash_Crash_Stock_Halted_After_Trade_Causes_9_Plunge). Sornette and von der Becke believe that the activity levels of these securities

events of May 6 are “not representative of the manner in which low-latency activity impacts market conditions outside of such extreme episodes.”<sup>135</sup>

The real crux of the HFT issue then is that it impacts investors’ confidence in the markets’ ability to provide accurate pricing information.<sup>136</sup> The flash crash, in which stock prices were “dislocated to the point where they had no information content whatsoever,”<sup>137</sup> compounded with the negative publicity HFT predatory strategies receive,<sup>138</sup> causes the public to perceive HFT as propagating a rigged game, where prices have little basis in market realities.<sup>139</sup> Further adding to this notion is that although HFT comprises a large portion of daily trading on U.S. markets, a relatively small number of firms are actually responsible for this surge in volume.<sup>140</sup>

The historical purpose and importance of our equity markets is that they perform a crucial role in financing companies: efficiently matching investors with growing companies lowers capital costs for businesses.<sup>141</sup> In a market comprised of ultra-fast computers executing huge numbers of orders in mere seconds, creating the possibility for dramatic price alterations by design or accidental fluke, investors have little incentive to risk their capital in an environment where market fundamentals, namely pricing, are increasingly uncertain.<sup>142</sup> The fact that prices may not reflect their true underlying value at

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“point[] to HFT,” but concede that the “involvement of HFT is not evident.” *Id.* They use increased frequency in quotes to base their suggestion that HFT was responsible. *See id.*

<sup>135</sup> Hasbrouck & Saar, *supra* note 34, at 31.

<sup>136</sup> *See* SUMMARY REPORT, *supra* note 100, at 2 (“[T]he net effect of [May 6, 2010] was a challenge to investors’ confidence in the markets.”).

<sup>137</sup> Haldane, *supra* note 11, at 12.

<sup>138</sup> *See supra* Part II.B.3, namely, the public censure of Trillium Brokerage Services, LLC for using HFT to manipulate stock prices. Furthermore, before the *New York Times* published an article on HFT in July 2009, few had heard of it. The article focused on the manipulative aspects to HFT, and immediately after the article hit newsstands, Senator Charles Schumer wrote to the SEC telling them to curb flash orders; shortly thereafter, the British Financial Services Authority, following in the SEC’s steps, announced it was examining HFT’s market impact. PEREZ, *supra* note 36, at 81–83.

<sup>139</sup> The mainstream media captures this sentiment. *See, e.g.,* Jeff B. Cohen, ‘Chunk’ from “The Goonies” on High Frequency Trades and the Flash Crash, CNBC GUEST BLOG (Oct. 13, 2011, 11:14 AM), [http://www.cnbc.com/id/44875871/Chunk\\_from\\_The\\_Goonies\\_on\\_High\\_Frequency\\_Trades\\_and\\_the\\_Flash\\_Crash](http://www.cnbc.com/id/44875871/Chunk_from_The_Goonies_on_High_Frequency_Trades_and_the_Flash_Crash) (“[T]he enormous impact the HFTs have on the market[] makes it extremely difficult for individual investors to determine if a 200 point increase in the Dow is based upon fantastic economic news or just robo traders playing footsie with their equations.”); Jim Cramer, *Jim Cramer’s Best Blogs: Repelling High Frequency Fire*, THE STREET (Aug. 6, 2011, 3:25 PM) [http://www.thestreet.com/\\_yahoo/story/11212534/1/jim-cramers-best-blogs.html](http://www.thestreet.com/_yahoo/story/11212534/1/jim-cramers-best-blogs.html) (“[HFT traders] have a speed edge and weapons that are like machine guns in World War I and individual investors are foot soldiers, mowed down by a new technology they can’t understand.”); *60 Minutes: The Speed Traders* (CBS television broadcast Oct. 10, 2010).

<sup>140</sup> LARRY TABB, ROBERT IATI & ADAM SUSSMAN, US EQUITY HIGH FREQUENCY TRADING: STRATEGIES, SIZING AND MARKET STRUCTURE 2 (2009) [hereinafter TABB ET AL.].

<sup>141</sup> *See* BRADLEY & LITAN, *supra* note 24, at 7.

<sup>142</sup> *But see* sources cited *supra* note 99.

any given moment is enough of a reason for regulators to step in to ensure market efficiency.

#### IV. REGULATORY APPROACHES AND RECOMMENDATIONS

Regulators' goal in HFT oversight should be to restore confidence in the markets while not detracting from the efficiencies it creates. It is easy to fall victim to a one-sided approach in understanding HFT: either proponents' arguments of its undoubted benefits, or detractors' "sometimes exaggerated fear of out of control computers."<sup>143</sup> As discussed in Part II.B, HFT is not a homogenous trading form, and regulators must therefore understand the participants and their roles in the market. This approach should also be consistent with the "long-standing view of the SEC and CFTC that market-based solutions play a preferential role in the efficient functioning of markets."<sup>144</sup>

##### A. Regulations that Improve Transparency

The first problem regulators face is their lack of knowledge about HFT.<sup>145</sup> As discussed in Part II.B, in order to be effective, regulations governing HFT must account for the different strategies these firms employ. To institute an effective regulatory regime, regulators must begin to understand HFT as a trading method comprised of varied strategies with different goals. Therefore collecting data on the trading patterns of HFT firms is a logical starting point: HFT firms should be required to register with the SEC and describe their strategies in general terms. The SEC has begun this process by adopting Rule 13h-1, "Large Trader Reporting."<sup>146</sup> Rule 13h-1 (Rule) imposes recordkeeping, reporting, and limited monitoring requirements on certain registered broker-

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<sup>143</sup> MacKenzie, *supra* note 22, at 18. Furthermore, HFT lends itself to conspiracy theories and alleged unfair practices, common to other industry scapegoats. Yet, market critics and politicians often misplace sources of risk in the system. Until 2008, hedge funds were said to pose systemic risk to the banking system, yet banks were in fact the risky entities—many hedge funds were burned by Lehman Brothers' failure, for example, while hedge funds that went under did not cause reported losses beyond their own investors. See TABB ET AL., *supra* note 140, at 1.

<sup>144</sup> SUMMARY REPORT, *supra* note 100, at 14.

<sup>145</sup> See Hilzenrath, *supra* note 47, at A14 ("The chairman of the Securities and Exchange Commission is worried about the rise of high-frequency trading . . . [but] says regulators still don't know enough to do much more about it."); see also *supra* note 12 and accompanying text (regulators do not even have consensus on a precise definition for HFT).

<sup>146</sup> See Large Trader Reporting, 76 Fed. Reg. 46,960 (Aug. 3, 2011) (to be codified at 17 C.F.R. pts. 240 and 249) (defining a "large trader" as someone whose "transactions in NMS securities equal or exceed 2 million shares or \$20 million during any calendar day, or 20 million shares or \$200 million during any calendar month"); see also Press Release, U.S. Sec. & Exch. Comm'n, SEC Adopts Large Trader Reporting Regime (July 26, 2011).

dealers through whom large traders execute their transactions.<sup>147</sup> Though it does not mention HFT outright, the Rule itself strongly implies that HFT is its target.<sup>148</sup> The SEC's goal is to identify market participants engaged in substantial trading activity; obtain information needed to monitor the impact of those trades on the market; and analyze such market participants' trading activity.<sup>149</sup>

Ultimately, large trader reporting should assist regulators in better understanding which firms comprise the HFT sub-group. It might also minimize the time it takes regulators to collect market data on HFT traders after trades are executed, which was one of the problems the SEC faced after the flash crash.<sup>150</sup>

However, targeting large traders encompasses the much broader category of algorithmic trading, which also generate large trades. By being overly inclusive, regulators' task remains difficult to police manipulative HFT practices and quickly and efficiently analyze market data in the event of another flash crash. Furthermore, the Rule does little to assess and differentiate between strategies: a liquidity-provision strategy can generate just as many orders as a manipulative predatory strategy. More focus should be placed on tracking manipulative practices as opposed to liquidity providers, but the Rule fails to encapsulate this distinction.<sup>151</sup>

Imposing requirements on the stock exchanges to monitor HFT might be a better alternative than government regulators sifting through enormous amounts of data. The exchanges already have relationships with HFT traders, as they rent space to HFT firms in their computer warehouses for co-location purposes.<sup>152</sup>

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<sup>147</sup> Large Trader Reporting, 76 Fed. Reg. 46,960 (Aug. 3, 2011) (to be codified at 17 C.F.R. pts. 240 and 249).

<sup>148</sup> See *id.* at 46,961 (“[The SEC] is in the process of conducting a broad and critical look at U.S. market structure in light of the rapid development in trading technology and strategies.”); *id.* (“[P]rofessional market participants . . . employ sophisticated trading methods to trade electronically on multiple venues simultaneously in huge volumes with great speed.”). The final Rule also notes HFT as a significant subcategory of large traders, whereby the large trader reporting requirement “will provide the Commission a mechanism for obtaining the information necessary to reliably identify the most significant of these market participants and promptly and efficiently obtain information on their trading on a market-wide basis.” *Id.* at 46,963.

<sup>149</sup> *Id.*

<sup>150</sup> *Id.* (“As the events of May 6, 2010 demonstrated, the reconstruction of trading activity during an extremely active trading day in our high-speed . . . markets can involve an enormous undertaking to collect uniform data and analyze thousands of products, millions of trades, and hundreds of millions . . . of data points.”).

<sup>151</sup> The Technology Advisory Committee to the CFTC expressed a similar sentiment, stating that “regulators would waste budget resources by requiring registration and audits of automated trading algorithms.” Silla Brush, *High-Frequency Trading Registration Studied by U.S. Regulator*, BLOOMBERG (June 20, 2012, 7:02 AM), <http://www.bloomberg.com/news/2012-06-20/high-frequency-trading-registration-studied-by-u-s-regulator.html> (“Focus should be on specific behaviors that undermine market integrity irrespective of the means or pace of order entry.”).

<sup>152</sup> Haldane, *supra* note 11, at 6.

Presumably, the exchanges know the players and have a better starting point than government regulators in attempting to understand HFT methods and strategies. HFT computers are also tied directly into the exchanges' computer systems which provide the exchanges an advantage in compiling data. On the other hand, the exchanges have strong incentives to provide free reign to HFT traders<sup>153</sup>: they earn high rents from co-location, and significant fees from large amounts of trading. The exchanges want HFT traders to continue playing a significant role in the markets, and may not be a reliable regulator.

Regardless of the monitoring system imposed, reporting and filing requirements are only a start: regulators are behind HFT traders in terms of technological capacity and understanding. Due to the competitive nature of HFT, and the quickly evolving computer codes with half-lives of only a few weeks,<sup>154</sup> regulatory agencies must recruit skilled programmers who understand this complex language. This will be difficult given the stakes involved for HFT firms: the private sector will be able and willing to pay a good programmer a highly competitive salary to recruit him or her, and keep them out of the regulatory side.<sup>155</sup> If regulatory agencies are unable to recruit skilled programmers in sufficient numbers, they may have to expend considerable costs in hiring outside consultants who can assist in understanding complex computing code.

Regulators are also behind in terms of speed and tracking the market in real time. Currently, there is no single database of comprehensive and readily accessible data regarding orders and executions, putting regulators at a significant disadvantage when trying to make sense of enormous amounts of trading data points.<sup>156</sup> The SEC has proposed a consolidated audit trail (CAT), a multibillion dollar computer monitoring system that would allow it to keep pace with the rapidly evolving markets.<sup>157</sup>

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<sup>153</sup> See *supra* note 32 and accompanying text.

<sup>154</sup> Haldane, *supra* note 11, at 4.

<sup>155</sup> Sarah N. Lynch & Jonathan Spicer, *Exclusive: Regulators Seek Trading Secrets*, REUTERS (Sept. 1, 2011, 7:24 PM), <http://www.reuters.com/article/2011/09/01/us-financial-regulation-algos-idUSTRE7806J420110901> (“‘Let’s just say the good developers in the industry are being hired by the industry—not by an SEC salary,’ a trader said.”). However, one HFT firm recently provided improved technology and assistance to the SEC, which will help it better monitor high speed trading. Nathaniel Popper & Ben Protess, *To Regulate Rapid Traders, S.E.C. Turns to One of Them*, N.Y. TIMES, Oct. 8, 2012, at B1. Some experts have stated that this collaboration is “the quickest and, at a cost of \$2.5 million this year, the cheapest way for the agency to catch up with the high-speed trading industry.” *Id.*

<sup>156</sup> Scott Patterson, *SEC Pushes Plan for Audit System*, WALL ST. J., Sept. 21, 2011, at C1.

<sup>157</sup> *Id.* In July 2012, the SEC voted 3–2 to approve a limited version of the CAT, its goal being to “track orders, cancellations and executions of all U.S.-listed stocks and options, across all markets, delivering the data to the SEC in uniform fashion by the next trading day.” Jessica Holzer, *SEC Arms Itself to Better Track Trades*, WALL ST. J., July 12, 2012, at C3. However, the approved plan only sets out broad parameters, leaving the exchanges and FINRA to work out specifics. *Id.*

However, the CAT may impose an undue burden on market participants: the SEC will not pay for the project.<sup>158</sup> Instead, it plans on passing the costs onto stock exchanges, brokerage firms and FINRA, which would likely result in costs ultimately going to investors and traders.<sup>159</sup> Increased costs on SEC-regulated exchanges could mean thinning liquidity in U.S. markets.<sup>160</sup> Also unclear is whether the SEC actually needs the CAT to achieve its goal—it could build off existing audit trails such as FINRA’s Order Audit Trail System (OATS), thereby reducing unnecessary costs incurred in developing a completely new system.<sup>161</sup>

Access to information should not come without limits. Regulators should avoid intrusive and burdensome inquiries into HFT, resorting to these tactics only when a firm is under strong suspicion of engaging in manipulative practices. More specifically, asking a firm directly for computing code is troubling. Algorithmic code is an HFT firm’s intellectual property, where it is developed at great cost and sometimes over years. The concern is that regulators will eventually leave their public posts for the private sector, and will take the knowledge they gained on the job to use against competitors.<sup>162</sup> Therefore, regulators should avoid requesting algorithmic code, reserving it for the most serious instances of market failure or manipulation.

Finally, educating the investing public is a key component to restoring confidence in the markets. While regulatory agencies would restore confidence through the appearance of an effective regulatory regime, HFT firms best serve their interests by becoming more transparent in their practices. The principals of HFT firms should view speaking to financial media outlets as opportunities for educating the investing public. To date, individuals involved with HFT are notoriously reluctant to speak to the press: they do not want to disclose top-secret strategies; their time is better spent on developing algorithms; and they fear being misrepresented on television or in print.<sup>163</sup> However, rather than complain that Washington and the financial media do not have the necessary sophistication to understand HFT’s nuance,<sup>164</sup> the active players in HFT ought to make themselves available to explain the ways in which they add value to the markets and investors. Doing so would alleviate suspicions regarding secretive HFT traders, and would help prevent overly burdensome regulations brought on by lawmakers reading harsh media reports concerning HFT.<sup>165</sup>

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<sup>158</sup> Patterson, *supra* note 156, at C1.

<sup>159</sup> *Id.* at C2.

<sup>160</sup> *Id.* (“[T]he SEC could create a monster that impacts liquidity in a negative way.”).

<sup>161</sup> SIFMA, IMPACT OF HIGH FREQUENCY TRADING AND CONSIDERATIONS FOR REGULATORY CHANGE 7 (2011).

<sup>162</sup> Lynch & Spicer, *supra* note 155.

<sup>163</sup> PEREZ, *supra* note 36, at 45.

<sup>164</sup> *Id.*

<sup>165</sup> *See id.* at 81–83.



### B. Regulations that Limit Volatility

New transparency and reporting requirements will help regulators better oversee trading activity to potentially catch manipulative practices.<sup>166</sup> But additional steps must be taken to prevent a flash crash-like scenario from happening again.

HFT's contributory role in the downward cascade of stock prices during the flash crash was caused by its withdrawal from the markets, pulling out a significant source of buy-side liquidity.<sup>167</sup> The primary source of liquidity in today's markets comes from HFT firms engaged in a liquidity-provision strategy, who effectively act as market makers.<sup>168</sup> Traditionally, market makers "stand[] ready to buy and sell a particular stock on a regular and continuous basis at a publicly quoted price."<sup>169</sup> Their obligation to continuously quote prices, irrespective of the market conditions, stem from rules stock exchanges impose on them.<sup>170</sup> However, the difference between traditional market makers and HFT market makers is that exchanges impose rules and obligations on traditional market makers, whereas HFT liquidity providers have none.<sup>171</sup>

HFT traders engaged in a liquidity-provision strategy should therefore be required to register as market makers on the exchanges on which they trade.<sup>172</sup> Market makers bear considerable risk in the responsibilities they owe to the market; HFT traders should not gain market making benefits in relatively peaceful periods, while having the ability to stop trading in volatile market periods. Requiring HFT traders to register as market makers and bringing them within the scope of an exchange's market making rules creates accountability on the part of HFT traders, and will serve to provide some assurance to market liquidity in the event of another flash crash-like trigger—having an obligation to

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<sup>166</sup> See Patterson, *supra* note 156.

<sup>167</sup> See *supra* Part III.A. It is important to note that HFT traders did not have a uniform response to the events of May 6, 2010. Although some HFT traders exited for reasons similar to other market participants, such as internal risk controls triggered due to rapidly plummeting prices, other traders continued to trade. On a net basis, however, high speed traders were primary sellers during the crash, removing significant buy-side liquidity from the markets. See JOINT REPORT, *supra* note 100, at 45–48.

<sup>168</sup> See *supra* note 58 and accompanying text.

<sup>169</sup> *Market Maker*, U.S. SEC. & EXCH. COMM'N, <http://www.sec.gov/answers/mktmaker.htm> (last modified March 17, 2000); see also *supra* Part II.B.1.

<sup>170</sup> See Haldane, *supra* note 11, at 17.

<sup>171</sup> SUMMARY REPORT, *supra* note 100, at 2 ("In the present environment, where high frequency and algorithmic trading . . . [have] essentially eliminated rule-based market maker obligations, liquidity problems are an inherent difficulty that must be addressed."); see also Haldane, *supra* note 11, at 17.

<sup>172</sup> Cf. Peter Chapman, *Exchanges Balk at Forcing Market Maker Obligations onto HFTs*, TRADERSMAGAZINE.COM (Oct. 29, 2010), <http://www.tradersmagazine.com/news/high-frequency-trading-market-maker-nyse-nasdaq-106601-1.html?> ("It would be very difficult to properly define the responsibilities and correspondent privileges you would give to market participants.").

quote prices will ensure that HFT liquidity providers do not exit the market in volatile periods.

Another mechanism that can be used to incentivize HFT liquidity providers to continually supply liquidity irrespective of market conditions is “peak load pricing.”<sup>173</sup> A “peak-load pricing” model would reward trading firms for staying in the market during periods of high volatility.<sup>174</sup> The idea is for exchanges to increase the rebates they pay for offers during periods of volatility, while lowering the rebates during calm periods.<sup>175</sup>

While these obligations and incentives work for HFT traders engaged in a liquidity provision strategy acting as market makers, they are not logical when applied to an HFT arbitrage strategy.<sup>176</sup> Again, understanding the differences between strategies is crucial. Arbitraders propagate price information, finding pricing irregularities and trading accordingly.<sup>177</sup> It is wrong to provide incentives and/or obligations for these HFT traders to remain in the market during a flash crash, where prices do not accurately reflect the underlying value of a stock or security. If this were the case, arbitraders would trade according to incorrect price information, spreading this inaccurate information to other stocks that are “paired” with a stock affected by a flash crash.<sup>178</sup> Essentially, if arbitraders were to remain in the market during a flash crash, they would exacerbate the pricing problems associated with flash crashes. Therefore, unlike HFT liquidity providers, HFT arbitraders should withdraw from markets during periods of extreme price volatility. If prices in one stock fluctuate by more than a certain percentage in a given period of time, HFT arbitraders should halt trading in that stock and any other paired security. While penalties for trading may not be necessary, more important is that the incentives for remaining in markets during volatile periods should not be offered to arbitraders.

Finally, regulators should impose internal risk management requirements within the HFT firms themselves. For example, firms should have minimum testing requirements for newly developed algorithms before these are deployed onto the market. The tests should include simulations of stressful market conditions to determine how these algorithms will react in a scenario akin to a flash crash. Risk management controls should also ensure that proper notifications exist within the HFT firm’s computer systems to notify programmers whether an algorithm becomes overly erratic. Once a notification is sounded, human programmers should have the capability to intervene with an out-of-control algorithm. Finally, firms should have set procedures in place in

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<sup>173</sup> SUMMARY REPORT, *supra* note 100, at 9.

<sup>174</sup> See Jonathan Spicer, “Flash Crash” Panel Mulls Big Market Changes, REUTERS (Feb. 4, 2011, 3:43 PM), <http://www.reuters.com/article/2011/02/04/us-flashcrash-idUSTRE7134PI20110204>. Peak load pricing raises prices during popular times and cuts pricing during off-times to limit the amount of participants in popular, or peak, times. *See id.*

<sup>175</sup> *Id.*

<sup>176</sup> *See supra* Part II.B.2.

<sup>177</sup> *See supra* Part II.B.2.

<sup>178</sup> *See supra* Part II.B.2 for a discussion on pairs trading.

the event that markets hit an extremely volatile period. The firms should file these procedures with the exchanges on which they trade, so that the exchanges will be able to better coordinate efforts to limit pricing impacts in the event of another flash crash. Imposing internal risk controls is a relatively cheap and easy ex ante precaution that should not be overly intrusive or burdensome on HFT participants.

## V. CONCLUSION

Throughout history, financiers and other market participants have tried to get ahead of markets by obtaining information faster than other investors.<sup>179</sup> Firms often employ cutting-edge technology to gain these advantages over their competitors. Yet, technological advancement and increased efficiency is positive for the overall financial markets' functioning. High frequency trading is just one example of markets adjusting their structure to technological improvement. HFT's problem is its secretive nature, potential for manipulative pricing practices, and the appearance of out-of-control computers that can lead to inaccurate pricing information. All of these factors lead to other investors' loss of confidence in the financial markets. Regulators' challenge is to restore investor confidence by educating the public about HFT through increased transparency and limiting the potential for another flash crash, without hindering technological advancement and the efficiencies this creates. Ken Jennings, eloquently quoting *The Simpsons*,<sup>180</sup> summed up this sentiment: new technology with stunning speeds difficult for a human to comprehend should not be feared for lack of understanding, but embraced for the potential value it can add to society.

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<sup>179</sup> For example, Nathan Rothschild hired a private intelligence envoy to inform him of Wellington's victory over Napoleon at Waterloo a full day before the British government itself had the information. The government expected Wellington's defeat, but Rothschild used the information in the stock exchange and added to his already significant fortune. See Martin Fagan, *Special Report: Equity Capital Markets—Need For Speed Raises Concerns About Fairness*, FIN. TIMES MANDATE, Feb. 1, 2010.

<sup>180</sup> See *supra* note 6 and accompanying text.