No. 14-11
APRIL 2014

WORKING PAPER

AN ANALYSIS OF GLOBAL HFT REGULATION
Motivations, Market Failures, and Alternative Outcomes

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Abstract

Market events like the "flash crash" of 2010 and Michael Lewis's claims that markets are "rigged" have brought increased scrutiny on high-frequency trading (HFT), triggering calls for aggressive regulation. While there are several empirically demonstrated benefits of HFT, including improved liquidity and reduced transaction costs, the current arguments against HFT are largely qualitative in nature. This paper provides a qualitative analysis of global HFT regulation designed to identify regulatory motivations, determine whether they suggest a market failure attributable exclusively to HFT, and distinguish the implications of regulations for markets and their stakeholders. Our study finds that regulatory goals fall into two broad categories: (1) shared (or market integrity) goals and (2) divergent (or fairness) goals. We find little evidence for the existence of a market failure that requires additional aggressive regulation, or suggesting that government intervention will improve market integrity or "fairness" better than the market and existing regulation already have.

JEL codes: D530, G10, G180

Keywords: high-frequency trading, financial market regulation, global financial market regulation, regulatory outcomes, financial market integrity, fairness in financial markets, market failures, manipulative market practices, stock market, market efficiency, informational market efficiency, emerging high-frequency trading markets, market liquidity

An Analysis of Global HFT Regulation:

Motivations, Market Failures, and Alternative Outcomes

Holly A. Bell and Harrison Searles

High-frequency trading (HFT) has come under scrutiny over the past several years as the media, legislators, and regulators around the world have raised concerns about the potential market risks associated with HFT and with algorithmic trading in general. But are existing and proposed regulations designed to correct a market failure attributable to HFT? Or, like the first people who experienced the steam engine and its then-inconceivable speed of 30 mph, are individuals and institutions concerned they will be harmed in some way by market speeds they cannot comprehend?

The release of Michael Lewis's (2014) new book, *Flash Boys: A Wall Street Revolt*, and his claims that markets are "rigged" have brought increased attention to HFT and calls for additional regulation to ban HFT strategies, but Lewis paid little attention to the market benefits of HFT. The book and subsequent *60 Minutes* story appear to be primarily designed to convince traders to use the new Investors Exchange (IEX) established by individuals in the story. These accounts fail to mention several issues. First, the book and *60 Minutes* story demonstrate that markets are not rigged. Brad Katsuyama, head of IEX, developed an algorithm to neutralize one HFT strategy and has also developed a competing trading venue. If markets were truly rigged, neither would be possible. Second, the accounts fail to mention that IEX is a "dark pool"—an exchange that trades away from central exchanges so that other markets do not see large block trades, preventing price shocks—a controversial practice in and of itself. Finally, the book and *60 Minutes* story do not mention that high-frequency traders will be allowed to trade on the

platform, but IEX is "building in extra cable lengths to slow down some transactions" in an effort to reduce the effectiveness of high-frequency traders by eliminating some of their competitive strategies (Javers, 2014).

Finally, along with failing to mention the benefits of HFT to all investors, the author has also failed to analyze the potential downsides to additional HFT regulation in global markets. This paper explores the global HFT regulatory environment, examines the regulatory motivations set forth by legislators and regulators, and looks at outcomes of existing regulation and potential downfalls of proposed regulation. One question to consider when reading this paper is, Do additional regulatory policies designed to curb or eliminate HFT and algorithmic trading lead to less complexity and better market outcomes than a competitive market that allows for competing algorithms and alternative trading platforms?

This paper is not designed to substantiate the benefits of HFT that others have empirically demonstrated. These benefits include improved liquidity, lower transaction costs, price synchronization, greater overall market speed, more efficient price discovery, reduced impacts of volatility, and increased availability of direct market access (Gerig, 2012; Hendershott & Riordan, 2009; Brogaard, 2010; Brogaard, Hendershott & Riordan, 2010; Hasbrouck & Saar, 2010; Hendershott, Jones & Menkveld, 2011; Hendershott & Riordan, 2012; Menkveld, 2012). Based on previous research, we assume that these benefits exist and that they are advantageous to all investors, not just the large HFT firms Lewis (2014) claims "rig" the market. The advantages include reduced trading costs, better investment performance for long-term investors, and giving small and retail investors an advantage they have not had before: the ability to trade what they want, when they want due to narrow bid–offer spreads and a market with a small average trade size (Asness & Mendelson, 2014).

Nor is the purpose here to defend or condemn HFT per se. Rather, we qualitatively analyze existing and proposed regulations to address the following questions:

1) Are there broad classifications of motivations or regulatory purposes that emerge from a comprehensive review of global HFT regulation?
2) If so, are these motivations or purposes consistent with the need for regulatory intervention to remedy market failures associated exclusively with HFT?
3) Will regulation be effective at resolving perceived problems, and/or are alternative outcomes possible?

While the literature cited has quantitatively identified the benefits of HFT, many criticisms of HFT that drive calls for regulation are qualitative: these include financial market quality and complexity, lack of social benefit, and qualitative risk control for externalities. This paper addresses a gap in the literature by providing a qualitative analysis of HFT regulation designed to identify latent social issues and structures motivating regulatory efforts, a categorization of regulatory goals, and a discussion of their implications for markets and their stakeholders. We are not trying to address all concerns about HFT and algorithmic trading that all parties have raised, only to address those that legislators and regulators have raised in their proposed regulation and to derive broad themes and potential outcomes.

The first section of this paper provides a global overview of the HFT regulatory environment, in particular existing and proposed HFT regulation and emerging HFT markets. It also explores the purposes of the regulation and the market indices the regulation is intended to influence. The second section determines broad classifications of motivations or regulatory purposes, examines whether these suggest a market failure attributable exclusively to HFT, and evaluates whether regulation will be effective or whether alternative outcomes are possible.

1. A Survey of the Global HFT Regulatory Environment

This section provides an overview of proposed and existing global HFT regulation. We have attempted to highlight the regulation's stated purposes as regulators have put them forth as well as the regulation's primary provisions. More in-depth information on specific regulations is available in the appendices. Table 1 (page 24) summarizes the global regulatory environment for developed HFT markets.

Some of the most aggressive existing and proposed regulation exists in the European Union and its member states, with the United States evolving toward regulatory proposals that are increasingly similar to those in Europe. Meanwhile, Asia is generally supporting the growth of HFT, with Japan and Singapore most aggressively seeking to create environments conducive to HFT. There are also four emerging HFT markets—Russia, Brazil, Mexico, and New Zealand—that desire to improve liquidity and attract capital by creating HFT-capable market environments. Of the four, Russia and Mexico appear best positioned to attract HFT.

The European Union

In 2012, HFT represented approximately 39 percent of the value of stocks traded in Europe. This number has been relatively unchanged since 2009 (World Federation of Exchanges, 2013). The EU operates as a "single market" system in which all member states work within the same regulatory framework. To that end, the EU has established the Markets in Financial Instruments Directive (MiFID), designed to be the basis for member state regulations.

MiFID, adopted in 2007 and amended in 2008 and 2010, serves as a regulatory guide for investor transactions by stock markets, trading systems, and investment firms and requires member states to standardize the rules governing investment services and activities. It allows

firms to be regulated in their home states, but once approved by the European Commission, firms may provide services in any member state through a "passport" program. There are also requirements for pre- and post-trade transparency designed to minimize the effects of market fragmentation by EU members trading across multiple markets in multiple countries (European Commission 2007 & 2011a).

While MiFID provided a general structure to guide EU members in more traditional stock exchanges, the MiFID II draft is designed to target both high-frequency traders (HFTs) and algorithmic trading in general. The initial draft, described here, has been voted on, but the final draft has not yet been released, so the specific regulations may differ from those described here, yet their purpose remains the same.

According to the 221-page MiFID II (European Commission, 2011b) the directive's general purpose is to "level the playing field" (p. 5). The regulation requires HFTs to provide "organizational safeguards" both internally and for those offering market access to HFTs. Safeguards include requiring venues to ensure the resiliency of trading platforms, to work with "competent authorities" in the oversight and monitoring of HFT activities, and to adopt appropriate risk controls to mitigate disorderly trading (pp. 7–8). Appendix A contains specific details of the proposed regulation.

The proposed European Union financial transaction taxes (FTTs) may also have a significant impact on HFTs. The latest amendments to the proposed FTTs (European Parliament, 2013) indicate that firms that provide liquidity using modern trading technology—which includes, but is not limited to, HFTs—will be required to pay the tax on both successfully executed transactions *and* order cancelations. This rule would discourage price discovery by HFTs. If regulators implement such a tax, it will wipe out HFTs' operations in EU markets.

According to the European Parliament (2012b), 11 countries—Austria, Belgium, Estonia, France, Germany, Greece, Italy, Portugal, Slovakia, Slovenia, and Spain—agreed to participate in an FTT as of December 2012.

Several member states are attempting to get ahead of the EU's MiFID II and FTTs by establishing their own HFT regulation. Not all member states agree with the EU initiative, and while EU policy recommends that member states not establish regulations that are more stringent than EU policies, some member states appear to be moving away from the EU's standards, creating a fragmented EU regulatory environment. It may be difficult for the EU to enforce a "single market" passport system if member states bypass this process through their own regulations. The following sections detail the member state initiatives.

Germany

Germany has moved beyond regulatory proposals to enacting HFT-specific regulation. When the *Bundestag* passed the German High Frequency Trading Act of 2013 (*Hochfrequenzhandelsgesetz*) in February 2013 (Gesetz zur Vermeidung, 2013; Eurex, 2013a; Eurex, 2013c; Schuster & Dreibus, 2013), HFT represented approximately 40 percent of German exchange transactions (Kindermann, 2013). The act requires HFTs to register with the Federal Financial Supervisory Authority, more commonly known in Germany by its abbreviation BaFin (for *Bundesanstalt für Finanzdienstleistungsaufsicht*), and requires them to obtain licenses as banks or financial trading institutions consistent with the German Banking Act. This licensing requirement preempts the reforms of the EU's MiFID and applies to anyone trading directly or indirectly on a German regulated market, regardless of the trader's location. The creation of a German license for HFT lays the groundwork for German passport-style regulation in the spirit

of MiFID, but does not allow other EU countries to trade in Germany without a German-issued passport. (Cleary Gottlieb, 2013).

The purposes of the High Frequency Trading Act in Germany have been described as (a) increasing the stability and integrity of German financial markets, (b) minimizing market risks, (c) preventing market manipulation, (d) closing a regulatory gap, and (e) protecting long-term investors (Kindermann, 2013). As a result of the regulation, at least one firm, Cologne Independent Traders, has announced it will close due to the "significant" burden (Cave, 2013). There is widespread, growing concern that uncertainty about post-regulation liquidity in Germany is going to drive traders elsewhere in search of more certain and reliable liquidity (German HFT, 2014).

Supervisors at BaFin and the Exchange Supervisory Authority are allowed to request descriptions of trading strategies or parameters and are permitted to deny the use of any algorithmic trading strategy they believe is undesirable (Eurex, 2013c; Schuster & Dreibus, 2013). The regulation requires exchanges to determine an appropriate order-to-trade ratio, to develop a minimum tick size, and to charge a fee for excessive system usage, including amendments and cancelations of orders, and it requires traders to flag each order generated by an algorithm (Eurex, 2013b).

In addition, the exchange must ensure "that orderly price discovery is granted even in situations of large price fluctuations" (Eurex 2013c, p. 3). Algorithmic traders must develop and maintain risk-management processes and procedures and must document all algorithms used. The regulation also more clearly defines "market abuse" as disrupting or delaying the trading system, making it difficult for others to determine actual purchase or sale orders, and creating false or misleading signals (Schuster & Dreibus, 2013).

United Kingdom

TABB Group, a research and strategic advisory firm, estimates that high-frequency trading represents approximately 36 percent of UK stock-market transactions (Credit Suisse, 2012). A 2010 report by the London Stock Exchange Group indicated HFT represented 33 percent of order-book executions by number of trades and 32 percent by value traded (London Stock Exchange Group, 2010). Government authorities in Europe first called for restrictions designed to facilitate the "extinction" of HFT in 2012 in response to the 2012 US "flash crash" and collapse of Knight Capital due to a faulty algorithm (Ross, Fitzgibbon & Mathiason, 2012). Recent fines imposed on Panther Energy Trading LLC by the UK's Financial Conduct Authority (FCA), the U.S. Commodities Futures Trading Commission, and the Chicago Mercantile Exchange for deliberately manipulating commodities markets have led to increased calls to "curb" HFT in the UK (Wessing, 2013; Jones & McCrank, 2013).

The UK Treasury, which commissioned a study on HFT, opposes the eradication of HFT in Europe. The report (Foresight 2012) found that technology is an important aspect of financial market innovation and new market services; that computer-based trading that includes HFT improves liquidity, reduces transaction costs, and makes market pricing more efficient; and that there is no direct evidence that HFT increases volatility. The report concluded that "it is highly desirable" that any new policies or market regulation preserve the benefits of HFT, and any new policies or regulations should be evidenced-based and consider the associated risks and benefits. The report did propose the monitoring of computer-based trading and the development of safety mechanisms. Based on the report, the UK Treasury stated it believed the benefits of HFT outweighed the current risks.

However, immediately following the July 2013 fines of Panther Energy Trading LLC, the Business, Innovation and Skills Committee of the UK House of Commons responded by proposing the implementation of an FTT on high-frequency trading of publicly listed stocks. According to Taxation (2013a), "the Committee called for a financial transaction tax to be set '. . . at a level which is the average profit made on a high-frequency trade in the UK'" (para. 3).

The purpose of the proposed regulation seems to be the eradication of HFT in the UK, even though regulators recognized the benefits of HFT. To justify the committee's position, the UK secretary of state for business, innovation and skills commissioned a report on the UK equity markets (Kay, 2012). The report's purpose was to "review activity in UK equity markets and its impact on the long-term performance and governance of UK quoted companies" (p. 9). The report found that "short-termism" is a problem and that the UK legislature should promote "long-termism" in equity markets. The report describes high-frequency trading as emerging as "an aspect of a broader trend which favours trading over trust relationships" (p. 39), but it does not place significant blame for the trend toward short-termism on HFT. It finds there has been a shift from "owning" to "trading" stock in the market as a whole (Kay, 2012; Penny, 2013).

However, the House of Commons Business, Innovation and Skills Committee Third Report of Session 2013–14 from July 16, 2013 (House of Commons, 2013), focused on HFT as a problem of short-termism that needed to be resolved. Support for an HFT transaction tax emerged in this work. These efforts are moving forward despite the testimony of economist and professor John Kay, chair of the Review of UK Equity Markets and Long-Term Decision Making, whom the committee hired to study UK financial markets hoping to confirm their negative perceptions of HFT and justify their proposed financial transaction tax. Kay testified before the Business, Innovation and Skills Select Committee on February 5, 2013, that "the

existence of high-frequency trading is not something that one could say is very supportive of longterm decision making in British business, [but] I concluded quite quickly that it is not the principal issue and problem" (p. Ev 14). In fact, Kay's report (2012) made no recommendations for high-frequency trading, in part because he found HFTs do not own a large proportion of British stocks.

Alternatively, EBS, a private foreign-exchange platform owned by ICAP PLC, is currently implementing one market solution to the concerns about HFT in the UK. EBS plans to modify the way in which orders are processed in an effort to take away the advantages of HFTs. Prior to the new rule, EBS had a first-in, first-out processing routine within which the first firm to place its order would be the first to have it cleared. This process, practiced by most exchanges, gives those with the fastest technology an edge in order processing. The modified system will organize orders into bundles ranked by who was first to put in the order. A computer program will then randomly select the sequence of individual order processing from the bundle of orders that came in earliest. While there remains an incentive to be *one* of the first to submit an order, the modified system eliminates the incentive to be *the* first. A spokeswoman for EBS told the BBC that the motivation for reform was "about creating a fairer marketplace" (BBC, 2013; Iosebashvili, 2013). However, it appears to be designed to address the public relations problem associated with HFT in the UK rather than a market failure. It remains to be seen whether the race to be *among* the first rather than *the* first will have any impact on slowing HFT, as there still remain strong incentives to gather information quickly. If additional aggressive regulation is implemented simultaneously, it may be difficult to determine the impact of any individual change.

France

In 2012, France implemented a package of FTTs that impose taxes on HFT and other financial transactions (see Rosenman, 2012). In an effort to make HFT unprofitable, the package included a "non-transaction" tax of 0.01 percent on modified or canceled stock orders exceeding 80 percent of all orders transmitted in a month. HFTs will be subject to the tax if they "transmit, modify, or cancel their orders within a half a second" (Rosenthal, 2012). This tax is in addition to a 0.20 percent transaction tax on purchased shares of French companies with market capitalizations of at least €1 billion (≈ $1.32 billion) (Rosenman, 2012; Rosenthal, 2012; Gide Loyrette Nouel, 2012).

More recently, France has updated its banking laws in a way that appears to bring its regulatory environment closer to that of the EU proposal. It seeks to provide a separation between "useful" and "speculative" financial activities in the economy (see Séparation, 2013). According to Voigt (2013),

> A lot of details are still uncertain but it appears that firms using "traitement automatisé" (automated processing) are now required by that law to register with the French regulator. Those firms must have an audit trail for each order sent to the market and store that audit trail, together with details of all the algos involved, for a certain period of time.

The purpose of the FTTs that include HFT appears to be first getting investors to hold local companies for longer periods (not unlike the UK's desire for "owners" rather than "traders"). France's additional goals appear to be to minimize order-to-trade ratios and, like Germany, to avoid the EU's "passport" rules associated with MiFID by creating its own registration system. A final goal looks to bring France in line with the EU directive by maintaining audit trails and records of algorithmic strategies.

The short-term impact so far of France's FTTs has been to significantly decrease market liquidity. France's share of European equity turnover has been reduced from 23 percent in 2011 to an estimated 12.85 percent in 2013 (*The Trade*, 2013).

North America

While HFT originated in the United States, its prevalence and profitability in North America has been declining since 2009. To date, the United States has largely exercised restraint in reining in HFT, but the regulatory climate is changing. The Canadian government has implemented a financial transaction tax and executed an alternative trading system that taxes away HFT profits.

United States

In 2014, HFT in the United States is expected to account for approximately 48.5 percent of exchange trade volume. This percentage represents a steady decline from HFT's peak of 61 percent in 2009, resulting in a drop in profitability for high-frequency traders from $7.2 billion in 2009 to an anticipated $1.3 billion in 2014, according to TABB Group (Bell, 2013; Bogard, 2014; Tabb, 2014). A report on high-frequency trading completed by the World Federation of Exchanges found that one reason for this drop is that exchanges have adapted to the HFT environment and have started to provide "faster, more transparent and more efficient" market structures that disrupt informational asymmetries that had previously existed. They have also "enacted many safeguards to ensure orderly markets" and the integrity of exchanges in which HFT takes place (World Federation of Exchanges, 2013). The report also concluded that while

> the substantial majority of empirical research has concluded that HFT has had measurable beneficial impacts on a variety of core market quality metrics, including tighter spreads, increased liquidity, more efficient price formation, reduced transaction costs for market users and lower market volatility . . . critics have focused on qualitative issues concerning fairness and systemic risk (p. 4).

The desires for "fairness," market stability, formal regulation for existing market integrity practices utilized by traders and exchanges, and income redistribution appear to be driving factors in US regulatory efforts. A complex array of regulation is under consideration in the

United States to meet these goals. First, the Commodity Futures Trading Commission (CFTC) has issued a Concept Release, which proposes several potential areas of regulation for both high-frequency and automated traders in general, including pre-trade controls, post-trade controls, system safeguards, mandatory registration and reporting, and efforts to standardize order types. (Detailed information on the CFTC Concept Release is available in Appendix B.) The proposed CFTC regulations attempt to create formal regulation and standardization for practices that traders and exchanges already engage in voluntarily as part of their risk-management strategies.

Second, then-representative Edward J. Markey proposed the PROTECT Act in 2013. PROTECT stands for "Protection from Rogue Oil Traders Engaging in Computerized Trading." The bill would amend the Commodity Exchange Act (7 U.S.C. 1 et seq.) to include requirements for all futures traders using HFT to (1) register as high-frequency traders with the CFTC, (2) test all computer programs and algorithms used for HFT, (3) document system safeguards, and (4) implement standardized reporting. It would also ban the purchase and sale "through the same or different accounts the same commodity contract, agreement, or transaction, unless the simultaneous purchases and sales are of a minimis quantity and are reported to the Commission" (pp. 2–3).

Third, utilizing its ability to self-regulate, CME Group Inc. (CME) has submitted a plan to the CFTC that will do a better job of detecting "wash trades"—the practice of buying shares from one broker while selling them through another—a practice already banned under US law, but difficult to detect. While the CFTC asked CME to reconsider its original plan, it has been resubmitted to the CFTC for approval and may be implemented at a later date (CME Group, 2013; Brush, 2013; Polansek, 2013; Leising, 2013). IntercontinentalExchange is exploring similar efforts to detect and curb wash trading (Trindle & Bunge, 2013).

A fourth regulatory effort, the SEC's Regulation Systems Compliance and Integrity rule (Regulation SCI) (Securities and Exchange Commission, 2013), is designed to replace the current Automation Review Policy as virtually all equity trading in the United States utilizes some form of automation. The new rule would require exchanges and any traders using computerized trading systems, including HFTs, "to establish written policies and procedures reasonably designed to ensure that their systems have levels of capacity, integrity, resiliency, availability, and security adequate to maintain their operational capability and promote the maintenance of fair and orderly markets, and that they operate in the manner intended" (p. 3). It would also require regularly scheduled testing of systems, continuity and disaster recovery plans, and system redundancy. It would require SCI entities to report on system events and take corrective action if they occur. Like the CFTC proposal, Regulation SCI essentially creates regulatory mandates for market integrity processes that traders and exchanges are already engaging in (Melendez, 2013; Walter, 2013a).

In addition to Regulation SCI, the SEC also implemented the Market Access Rule (Rule 15c3-5) in 2011, requiring brokers and dealers to have risk controls for market access (Ziliak & Brown, 2013). The SEC also recently introduced the Market Information Data Analytics System (MIDAS) that has allowed regulators to better monitor market activity and that determines root causes of flash crashes and other market phenomena. The MIDAS system has allowed the SEC to fill a huge institutional technology gap between traders and regulators that has caused many to call for regulatory action when no empirical data on causes of specific market phenomena exist. Bannister, 2013; Michaels & Mamudi, 2013; Walter, 2013b).

Finally, two proposed pieces of legislation seek to impose financial transaction taxes. The Inclusive Prosperity Act (2013), proposed by Representative Keith Ellison, would place a 0.5

percent sales tax on the trading of derivatives, stocks, bonds, and other financial instruments. Its two purposes are to generate $300 billion per year in tax revenue and to limit high-frequency trading (Inclusive Prosperity Act, 2013; Can the HR 1579, 2013).

Similar to the Inclusive Prosperity Act, the Wall Street Trading and Speculators Tax Act (2013), proposed by Senator Tom Harkin and Representative Peter DeFazio, would place a 0.03 percent tax on the sale of stocks, bonds, and other securities by banking and financial firms. There would be no tax on individual consumers.

Canada

According to the Investment Industry Regulatory Organization of Canada (IIROC), HFT in Canada is estimated to account for approximately 34 percent of trades, 24 percent of value, and 16 percent of volume. This represents a decline in HFT from 2011 when the numbers were 42 percent, 32 percent, and 22 percent, respectively (*The Globe and Mail*, 2013; Pinnington, 2013; Shecter, 2013). The Canadian Securities Administrators (CSA) have approved regulation, subject to ministerial approval, on electronic trading. The purpose of National Instrument 23-103 Electronic Trading (2013) is to "address the risks to Canadian markets related to the speed and automation of electronic trading, including the risks related to [direct electronic access]" (Canadian Securities Administrators, 2013, para. 2).

In particular, the regulation requires risk management and supervisory controls, including documentation of those controls, and requires that automated systems do "not interfere with fair and orderly markets" (National Instrument 23-103, 2013, p. 4). Additionally, exchanges must provide immediate access to market information and not permit the execution of orders for exchange-traded securities that exceed price and volume thresholds that regulators

or exchanges can set. Market participants must be able to cancel, vary, or correct trades that are clearly erroneous.

Simultaneously, the IIROC, a self-regulatory authority that sets industry standards and shared rules of conduct under the CSA's oversight, released its Universal Market Integrity Rules (UMIR) (Investment Industry Regulatory Organization of Canada, 2013). The UMIR are designed to be aligned with the CSA regulations described previously. The IIROC has also started collecting trading data with its Surveillance Technology Enhancement Platform (STEP) that will allow a more data-driven approach to policy recommendations (Sussman, 2013). And as of April 1, 2012, the IIROC implemented message-processing and trade-volume fees based on trades and order submissions, cancelations, and modifications. The purpose is to recover a portion of its costs (IIROC, 2012; Malinova, Park & Riordan, 2013).

The Royal Bank of Canada, mutual fund conglomerates IGM and CI Financial, pension fund PSP Investments, and international banks ITG and Barclays are creating a competing market, called Aequitas, designed to curb HFT. The new market will eliminate rebates for HFTs and make HFT strategies unprofitable through a combination of trading fees and "speed bumps." It will also cap the execution priority of designated market makers in an attempt to limit their ability to crowd out others. The goal, similar to that of the UK, is to encourage more long-term ownership of stocks. The new exchange is expected to launch early in 2015 (CBC, 2013; D'Antona Jr., 2014a; Kwan, 2013; Lam & Alexander, 2014; Sharo, 2014; Sharp & Rocha, 2013).

Asia-Pacific

Several parts of the Asia-Pacific region are taking a different approach to HFT than Europe and North America by encouraging its growth. Much of the HFT taking place in Asia is the result of

US and European firms establishing the technology in the region in an effort to expand their global presence as the United States and EU consider implementing regulatory restrictions on HFT.

Japan

In Japan, HFT accounted for approximately 45 percent of trading volume in 2011 (Grant, 2011). Direct, high-speed trading routes between Japan and Singapore and the Chicago Mercantile Exchange were established in March 2014 (KVH Co. Ltd. 2014).

In 2010, the Tokyo Stock Exchange (TSE) launched the Arrowhead Trading System to remove existing capacity constraints and accommodate the order-response time and information-distribution speeds required for low-latency algorithmic trading, reducing speeds from 2–3 seconds to 3 milliseconds. The more efficient system decreased trading costs by as much as 36 percent during early 2010. It also keeps transaction data in its memory, and triply redundant servers providing robust data integrity process these data in parallel. The system is designed to support HFT in particular and has allowed the TSE to introduce colocation services. According to Yuichiro Yamamoto, manager of the TSE IT Development Department, the Arrowhead system allows the TSE to "monitor and manage traffic on each participant's gateway server," thereby increasing transparency, and lets it apply a "fixed maximum limit to each gateway in terms of orders per second so as to prevent message flooding" (Webb, 2010). The new trading system has increased HFT volume on the TSE to approximately 50 percent of volume, making it equivalent to US and European markets, according to Ko Nakayama, director of the Financial Markets Department at the Bank of Japan. Rather than attempting to regulate away HFT, Japan has embraced it while monitoring it and putting systemic limitations in place (Fangqin, 2010; Fujitsu, 2010; Markets Media, 2013; Webb, 2010; World Federation of Exchanges, 2013).

Singapore

Singapore has also embraced HFT in derivatives trading, with approximately 30 percent of derivatives trading volume attributed to HFT on the Singapore Exchange (SGX). Due to a stamp duty of $0.20 per $100 of the value of shares transferred, the percentage of equities trading using HFT in Singapore is near zero. While SGX launched a new, faster trading engine called "Reach" in 2012, it may still be difficult to attract new HFTs due to the stamp duty. However, Singapore is considering offering rebates to HFTs that will make trading there more affordable. It has also installed ultralow latency routes to the Chicago Mercantile Exchange to increase HFT (Burgos, 2013; Ho, 2013; Inland Revenue Authority of Singapore, 2013; Kingsley, Phadnis & Stone 2013; Kok, 2012; Kuen, 2013; KVH Co. Ltd., 2014).

Hong Kong

The Hong Kong Securities and Futures Commission reports that approximately 20 percent of volume comes from HFT (Kingsley, Phadnis & Stone, 2013). Relatively low HFT volumes are due, in part, to a 0.1 percent stamp tax on securities transactions (GovHK, 2013). Hong Kong has taken a somewhat cautious approach to HFT even while undertaking a major technology upgrade to Hong Kong Exchanges and Clearing (HKEx). The lack of HFT opportunities in Hong Kong has recently caused some firms to consider a move to India, which is establishing itself as the world's fastest-growing derivatives market. However, GETCO, one of the world's largest high-frequency trading firms, entered the Hong Kong market in 2012 as Dutch rival IMC was leaving. Charles Li, chief executive of HKEx, describes a desire to maintain "speed bumps" in the HFT arena in Hong Kong (Cave, 2012; *Futures & Options World*, 2013).

A consultation study conducted by the Securities and Futures Commission (2012) on the regulation of electronic trading resulted in several recommendations that HFTs will implement in Hong Kong in 2014. Among the new "Code of Conduct" policies, HFTs must implement policies and procedures to control and supervise orders, manage and supervise the "design, development, deployment and operation of the electronic trading system," ensure adequate security, reliability, and capacity, and keep detailed records of all aspects of the trading system including audit logs. Service providers must monitor for and prevent erroneous orders and identify any orders or trading activities post-trade that may be "manipulative" or "abusive" in nature. All systems need to be tested at least once per year with adequate recordkeeping maintained for at least two years, and risk management controls must be in place (King & Wood Mallesons, 2013; Securities and Futures Commission, 2013).

China

Algorithmic traders are beginning to enter China as regulatory and tax structures have driven traders out of other markets and into developing countries. The CME Group anticipates significant influx in China, Singapore, Malaysia, South Korea, and Indonesia as new regulations are implemented in Europe. China recently began centrally clearing over-the-counter derivatives, which provides a more attractive environment for HFT in the derivatives market as it can reduce credit risk and provide increased liquidity and transparency (Chitkara, 2013). China does have a stamp duty on stock trading that has fluctuated between 0.1 and 0.3 percent in recent years; however, the government has been willing to eliminate it completely—at least temporarily—to encourage investment, as it did in 2008 (Bloomberg News, 2013; China Knowledge, 2013; Taxation, 2013b; Reuters, 2008). Unstable tax rates may be discouraging HFTs, but with costs

rising in other countries, China could attract HFTs by lowering or eliminating its taxes. Ronald Gould, then-CEO of Asia Pacific, Chi-X Global, sees additional challenges before HFT will be a significant part of Chinese markets, including development of a regulatory and user environment that supports change and encourages innovation and significant technological development (Gould, 2010). There also remain complex rules for foreign investors in China that may dissuade some from moving algorithmic trading and HFT to Chinese markets (see Robinson, Egbert, Tao & Lovel, 2013).

China is moving somewhat slowly into algorithmic trading in general, and the HFT speeds found in other markets do not exist there (Grant, 2012). Discussions about HFT as it relates to China generally appear to be referring to algorithmic trading as a whole and not to trading at high speeds and holding securities for milliseconds. In 2012, Song Liping, general manager of the Shenzhen Stock Exchange, said, "China is not ready for HFT" (Nan, 2012, para. 5). (In this case, he is referring to high-speed trading, not algorithmic trading.)

The "flash spike" that occurred when Everbright Securities sent 26,082 erroneous buy orders directly to the Shanghai Stock Exchange on August 16, 2013, may cause China to consider more aggressive monitoring and controls of algorithmic trading. The China Securities Regulatory Commission (CSRC) found significant flaws in Everbright's information-technology and risk-control systems. The CSRC has already announced it will scrutinize all 110 brokerages operating in China and will be inspecting all systems (Junli, 2013; Miller & Wildau, 2013; Yu, 2013). While the trading systems are undergoing broad scrutiny, shortly after the "flash spike," the CSRC ordered Everbright "to suspend lead-underwriting of any new debt financing instruments of non-financial enterprises in the country's interbank bond market, after an unrelated trading mistake—this one caused by human error—resulted in a trading loss of $32

billion" (Miller & Wildau, 2013, Mercrtsoft Software section, para. 7). This additional problem suggests there may not be a systemic algorithmic trading problem, but rather procedural and risk management problems, at Everbright.

Australia

HFT in Australia currently accounts for approximately 22–27 percent of daily trading volumes (Australian Securities and Investments Commission, 2013c; Kingsley, Phadnis & Stone 2013). Australia recently imposed market integrity rules on high-frequency traders. Its goals are to "improve transparency and integrity of crossing systems and strengthen the requirements for market participants to deter market manipulation" (Australian Securities & Investments Commission, 2013a). The rules for HFT are designed to minimize "manipulative trading" and noise in the form of frequently placing, canceling, or amending orders with thresholds determined by market operators (see Australian Securities & Investments Commission, 2013b).

While Australian regulatory authorities have established new rules to harmonize and more specifically describe what constitutes manipulative trading (Australian Securities and Investments Commission, 2013d), a study by the Australian Securities & Investments Commission (ASIC) determined that HFT was not a threat to Australian markets and led to a rejection of previous proposals to implement a pause of 500 milliseconds for small orders of $500 or less. According to ASIC's report, "some of the commonly held negative perceptions about high-frequency trading are not supported by our analysis of Austrian markets" (Australian Securities and Investments Commission, 2013c, p. 6; Alembakis, 2013; Pearce, 2013).

Table 1. HFT Regulation Summary for Developed HFT Markets

E = Existing regulation; P = Proposed regulation

Country/region	Regulation	Purpose
EU	P: Risk controls; report algorithmic strategies to regulators; audit trail; negotiated market-making agreements designed to provide market liquidity regardless of market conditions; controls for direct market access; 500 millisecond hold times (believed to be struck from final proposal); circuit breakers; algorithmic testing; max OTR; minimum tick size; ability to cancel erroneous orders; creation of volume and price thresholds; financial transaction taxes on executed and canceled orders	"Level the playing field," government revenue
Germany	E: Registration with BaFin; licensing; ability to deny use of any algorithmic trading strategy; OTR; minimum tick size; fee for order amendments and cancelations; flagging of algorithmic orders; risk management processes and procedures; documentation of algorithms; clarification of market abuse definition	Market integrity, fairness
UK	P: Financial transaction tax set at the average HFT profit	Reduce trading, control market outcomes, remove behavioral factors in markets to obtain social optimality, fairness
France	E: Financial transaction tax of 0.01% on modified or canceled orders that exceed 80% of all orders or are executed within half a second; 0.20% transaction tax on French companies with market cap of at least €1B; registration with French regulators; audit trails; documentation of algorithms	Reduce trading, discourage "speculative" financial activities and encourage "useful" ones
United States	P: Pre-trade controls; post-trade controls; system safeguards; mandatory registration and reporting; standardized order types; testing of algorithms; documented evidence of capacity, integrity, resiliency, availability, and security adequate to maintain operational capability; scheduled testing; continuity and disaster recovery plans; system redundancy; financial transaction taxes	Fairness, market stability, income redistribution, creating formal regulation for existing market integrity practices utilized by traders and exchanges
Canada	E: Message processing and trade volume fees on trades and order submissions, cancelations, and modifications P: Risk management and supervisory controls; price and volume thresholds; cancelation and/or modification of erroneous orders	Government/regulator income generation, market integrity
Japan	E: Monitoring; systemic limitations	Encourage HFT growth, lower transaction costs
Singapore	E: Stamp duty of $0.20 per $100 of value for equities P: Stamp duty rebates for HFTs	Encourage HFT growth
Hong Kong	P: Code of conduct; control and supervision of orders; management and supervision of design, development, deployment, and operation of electronic trading; provision of adequate security, reliability, and capacity; required recordkeeping including audit logs; post-trade controls; required testing schedule; risk management controls	Market integrity, discourage HFT growth
China	E: Stamp duty on equities fluctuating between 0.1% and 0.3%	Discourage HFT
Australia	E: Recent market integrity rules banning manipulative trading practices	Market integrity

2. Emerging HFT Markets

Several countries are looking for ways to improve their liquidity, market quality, depth of book, and spreads and are using the trend toward curbing HFT in Europe and the United States as an opportunity to attract HFT to their markets. These markets have been described as having a "second mover advantage," as they will be able to develop systems and procedures that will avoid many of the problems other markets have experienced. They also benefit from having more centralized markets, making some problematic HFT strategies ineffective (High-frequency traders, 2013; Timms, 2013). Next, we describe the aggressive steps four countries are taking to increase HFT in their markets.

New Zealand

New Zealand is actively seeking ways to increase algorithmic trading and in particular HFT. According to Sean Hughes, then–chief executive of the Financial Markets Association (FMA), regulator of New Zealand Markets (NZX), "the NZX is largely populated by small players and it's largely illiquid," and HFT could add the liquidity the market needs. To this end, the FMA is recommending fee reductions and is undergoing a review of the New Zealand markets to seek other ways to attract and incentivize HFT (Australian Legal Business, 2013). These changes are ongoing so it is too early to determine whether New Zealand will be a significant HFT destination.

Brazil

HFT currently represents approximately 10 percent of total market volume in Brazil, but the country is actively trying to attract HFTs by upgrading market technology. The BM&FBovespa

stock exchange moved from open trading pits to electronic trading networks in 2009 and is taking the next steps to support algorithmic trading. It added a new computer system called "Puma" that will support high-speed traders, and order execution times have been cut from 30 milliseconds nearly down to 1 millisecond. It has also put in place messaging limits designed to disrupt high order cancelation rates, and it already has transparency practices in place to make it easy for regulators to track the "life cycle" of a trade. To facilitate HFT and encourage growth in the sector, Brazil removed its 6 percent financial transaction tax, but there remain some complexities associated with the tax structure on equities that may not yet make Brazil an HFT destination of choice (Horch & Popper, 2013; Timms, 2013).

Russia

With a new low-latency connection between Moscow and London with a sub-40-millisecond round trip, Russia is continuing to embrace a move to algorithmic trading and HFT. The goal is to increase liquidity and open Russia's exchanges to international trading firms. The Moscow Exchange estimates HFT to be 40 percent of total trading volume, but expects this figure to rise significantly. Other estimates put HFT at 25 percent of equity volume and 35 percent of derivatives. To help prevent harmful market consequences from an influx of HFT, Russia has put pre-trade controls in place that prevent erroneous orders (Kilburn, 2011; Murray, 2013; O'Hara, 2013; Puaar, 2013; Timms, 2013).

There is evidence that trading volumes in the foreign exchange (FX) market are growing overall as a result of low latency trading in Russia. Average daily volumes across all FX instruments on the Moscow Exchange rose 25 percent during 2012. Average daily volumes grew 40 percent for dollar-ruble swaps longer than overnight during the first nine months of 2012 (The

hammer, 2013). In February 2014, the Exchange Council of the Moscow Exchange recommended moving forward with developing a unified collateral and margining system, as well as a single trading and clearing platform for all markets. These initiatives, in addition to establishing a task force to promote algorithmic trading on the Moscow Exchange, are designed to further increase the presence of HFT in Russia (Moscow Exchange, 2014). Tim Bevan, managing director at BCS Prime Brokerage, describes the Russian market as attractive to HFT due to risk-return or benefit-cost factors, as it has become much easier to enter the Russian market as a high-frequency trader in recent years (High-frequency traders, 2013).

Mexico

The Mexican Stock Exchange operated by BMV Group is the second largest exchange in Latin America and also an emerging HFT market. The exchange has invested more than $20 million in technology over the past two years to attract HFTs, increasing daily trade capacity from 75,000 in 2005 to 3.9 million in 2013. Mexico is unique because it is the only country in Latin America that allows dark pools—trading of large blocks of equities away from the central exchanges so they do not cause price shocks in public exchanges—making it more attractive as an HFT destination. To avoid potential market problems, foreign HFT firms cannot connect directly to the exchange, but must go through a local broker (Rodier, 2011; Rogow, 2013; Timms, 2013).

3. Discussion: Motivations, Alternative Outcomes, and Market Efficiency

The following strategies and goals associated with proposed and existing regulations appear repeatedly throughout the literature reviewed:

- Level the playing field; create fairness.

- Create formal regulatory requirements for market-integrity practices that exchanges and traders already engage in voluntarily.
- Require adequate safeguards for firms offering direct market access to HFTs.
- Maintain orderly markets and price discovery.
- Minimize volatility due to overreactions to market information or market "problems."
- Ensure regulators' ability to monitor HFTs' market activity; maintain transparency.
- Ensure that HFTs continue to provide liquidity regardless of market conditions.
- Ensure adequate and effective testing of algorithms.
- Reduce order-to-trade ratios.
- Increase market stability and integrity; minimize market risk; protect investors; improve investor confidence.
- Discourage short-term trading and encourage and protect long-term investing.
- Improve competitiveness in financial markets.
- Curb or eliminate HFT; slow down the speed of trading.
- Generate tax revenue.

Not all countries share all these goals, but together these strategies encompass a broad spectrum of market regulatory intervention.

Classifications of Regulatory Purpose

Our first two qualitative research question asked, (1) Are there broad classifications or regulatory purposes that emerge from a comprehensive review of global HFT regulation? (2) If so, are these motivations or purposes consistent with the need for additional regulatory intervention to remedy market failures associated exclusively with HFT? Our review of the global HFT regulatory

environment found two broad classifications or motivations of regulatory purposes: (1) shared (or market integrity) goals, and (2) divergent (or "fairness") goals. The following sections describe these goals in depth.

While the goals are generally qualitative in nature, there is little evidence to suggest they are related to a market failure associated exclusively with HFT. We consider a market failure to exist in informationally efficient financial markets when securities prices do not fully reflect all available information in an efficient manner. A broader definition of market failure in this context could include the market's inability to transfer ownership of securities (a good) efficiently or its inability to process information (a service) efficiently. One key to identifying a financial market failure is determining whether there is another possible market outcome in which one market participant can be made better off without making someone else worse off. A market failure can also exist when a change in the market environment occurs and the market fails to adequately adjust. The risk of a market failure is greater when the interests of the involved parties—in this case, exchanges, traders, and regulators—are not compatible. The following sections address more specific discussions of market failures.

Shared (or Market Integrity) Goals

Several of the regulatory goals listed previously are at low risk of being associated with a market failure because all parties generally have compatible goals. Exchanges, traders, and regulators all agree that financial markets should be secure, reliable, and orderly to enable effective price discovery and limit market manipulation and abuses. No market participant ultimately has anything to gain in an unstable or chaotic market. While HFTs may trade more actively and have greater opportunities for profits during times of relative volatility, no reasonable market

participant desires to create extreme volatility or introduce inadequately tested algorithms into the marketplace. In these cases there are significant market incentives to self-regulate. There also already exist regulations and voluntary market integrity practices that help to control these factors. Some examples of how the market and its participants are managing these shared goals along with existing regulation include the following:

- circuit breakers
- limit-up/limit-down controls
- controlled and monitored sponsored market access programs
- improved algorithms that sort through and ignore "noise," and algorithms that neutralize HFT strategies
- market systems with pre- and post-trade controls that detect erroneous orders
- the implementation of the MIDAS system by US regulators and of STEP in Canada to improve market monitoring
- the emergence of non-HFT exchanges
- IPO test runs by the New York Stock Exchange
- voluntary market surveillance
- the self-reporting and subsequent repairing of system loopholes (see Bell, 2013; McCrank, 2013; D'Antona, 2014b; Patterson & Hope, 2014)

Serious problems with market integrity, reliability, extreme volatility, or out-of-control algorithms related to HFT are also not widespread; nor are they caused by a failure of the market to execute trades or to adequately reflect all available information in the price of a security. One challenge facing high-frequency traders is that even when market events are not directly related to HFT, the media often assigns cause to HFT due to a widespread lack of understanding of what

HFT is and how it operates within markets. One recent example involved journalists and academics using the NASDAQ "flash freeze"—caused by a connection problem with its securities information processor—as an opportunity to declare HFT dangerous to markets and the source of all disruptions (see Kimball, 2013; Najarian, 2013; Watts & Reklaitis, 2013), even though the problem was not directly related to HFT. Such commentators also perpetuate the myth that HFT caused the "flash crash" when the CFTC and SEC's report emphatically stated otherwise (Commodity Futures Trading Commission & Securities & Exchange Commission, 2010; Ackerman, 2013; Lynch, 2013).

The reality of financial markets is that they are going through a major structural transformation to an all-electronic marketplace. At the same time, market speeds have increased, stressing systems that are not always designed to handle them. This issue is not associated exclusively with HFT, as market speeds overall are increasing at a time when HFT is declining in the US and European marketplaces. Yet academics, journalists, and regulators are subject to the same propensity to overreact to the most recent information and events as the market participants they criticize. They do this while ignoring the fact that, overall, markets are functioning well, technical issues are being resolved as they emerge, and the transition to faster, automated market systems is moving forward, making HFT a less competitive strategy.

At a recent Brookings Institute–sponsored forum, Gregg E. Berman, associate director of the Office of Analytics and Research at the SEC, made similar assertions. He does not believe that the market overall is "broken," but that the debate on market structure is, particularly the assertion that high-frequency trading, algorithms, and market complexity and fragmentation are harming the market. He states, "In spite of what you read everywhere, in spite of what many market participants say, and in spite of what many jurisdictions and other regulators might say

about the equity markets, they're not broken" (Brookings Institute, 2014, p. 9). Berman bases his statement on the fact that 5 billion to 6 billion shares continue to be efficiently and effectively traded every day with an extremely low failure rate. Unfortunately, it is only the rare failure that makes the news, thereby perpetuating the broken debate on market structure.

HFT and algorithmic trading in general enhance markets' ability to execute trades and to rapidly reflect available information in the prices of securities. These benefits have been manifested in improved liquidity, lower transaction costs, price synchronization, greater overall market speed, more efficient price discovery, reduced impacts of volatility, and increased availability of direct market access (Gerig, 2012; Hendershott & Riordan, 2009; Brogaard, 2010; Brogaard, Hendershott & Riordan, 2010; Hasbrouck & Saar, 2010; Hendershott, Jones & Menkveld, 2011; Hendershott & Riordan, 2012; Menkveld, 2012). As the velocity of information within society as a whole has sped up due to electronic communications and other factors, financial markets have adjusted by increasing their speed for everyone, not just HFTs, also indicating that a market failure does not exist.

Adding regulations to accomplish shared goals where participants are already engaging in cooperation and self-regulation assumes there is an alternative Pareto-optimal outcome that insiders (exchanges and traders) are not identifying and that a benevolent external third party must identify. The lack of apparent market failure associated with the shared goals does not support this assertion and creates a risk of government failure. Technology challenges will always be an issue in a computerized market environment, but market stakeholders are working to install safeguards to minimize market disruptions.

Efforts to create formal, one-size-fits-all regulation for practices that traders and exchanges already engage in voluntarily or in cooperation with regulators imply the desire to

impose sanctions when there is an unintentional technological or other type of problem with trading systems or practices. Sanctions diminish the incentive to publicly self-report, as firms may try to evade detection to avoid fines. Additionally, they discourage private investment in system and risk-mitigation innovations and create significant implementation delays, as changes would require new regulation or exceptions.

Some participants will engage in manipulative market practices with or without HFT, but since most countries already have regulations that prohibit manipulative trading practices, the rational approach is for exchanges, traders, and regulators to continue to work together to maintain and improve the self-regulation of shared goals.

Divergent (or Fairness) Goals

Where the discussion of compatible self-interest becomes more difficult is in the areas of a "level playing field," "fairness," slowing down the speed of trading, reducing order-to-trade ratios, minimizing market risk, requiring the continuous operation of algorithms to provide liquidity regardless of market conditions, discouraging short-term trading while encouraging long-term investing, generating tax revenue and/or redistributing income, creating formal regulation for market integrity practices that traders and exchanges are already engaging in, and significantly "curbing" or eliminating HFT. In these areas all parties do not agree on the goals or on how to achieve them. Many of these goals are not new or exclusive to HFT, so are not necessarily consistent with the need for regulatory intervention. They are essentially normative value judgments about what market outcomes *should* be based on subjective ideals of social optimality. They lead us to consider our third research question: Will regulation be effective in resolving perceived problems and/or are alternative outcomes possible?

Market critics often cite concerns about the need to level the playing field or improve fairness as reasons to impose regulation. In fact, the divergent goals listed are more accurately described as nonmarket *strategies* regulators wish to implement to minimize or eliminate HFT issues and/or general market phenomena perceived as "unfair." The issue of perceptions of fairness is a motivating factor in many regulatory arguments against HFT and against free markets more generally.

Fairness is not an unusual theme in market discussions. As Angel and McCabe (2010) state, "the words 'fair,' 'unfair,' or 'fairness' are mentioned 130 times in the recently passed Dodd-Frank Wall Street Reform and Consumer Protection Act" (p. 3; Dodd-Frank, 2010). One difficulty with this basis for regulation is determining what constitutes "fairness" in a market and how to determine what perceived factors associated with "unfairness" are directly related to HFT. Unique strategies to outperform competitors, short-term asymmetric information, overreactions and overcorrections, flash crashes, market noise, and concerns about market integrity have been topics of discussion as long as there have been markets (see Bell, 2013). Since these arguments are not new, they raise concerns about the desire to utilize HFT as an excuse to manipulate market outcomes more broadly.

One problem with the issue of fairness is how it is defined and from whose perspective it is viewed. To whom is it fair? Are attempts to ban HFT fair to traders who have invested substantial capital to modernize their operations in order to compete efficiently in a high-velocity-information environment? Is it fair to all market participants to minimize the benefits of improved liquidity, lower costs, and less volatility in order to limit HFTs' profits?

One example of the precariousness of using "fairness" as a basis for regulation is the EU's proposed MiFID II. It states in Article 51(5a) (European Parliament, 2012a, p. 104) that

one of the regulation's goals is that all fee structures must be "transparent, fair, and nondiscriminatory," *and higher fees should be placed on participants* "*placing a high ratio of canceled orders to executed orders and on those operating a high-frequency trading strategy*" (emphasis ours). It appears that the terms "fair" and "nondiscriminatory" are being used for political purposes to impose "fairness" on a portion of the market, but not on all aspects of it.

Those who have a vested interest in their own profits—or other financial or political gain—and who base their arguments on an inability to "compete" with HFTs or others in the market often make the argument for "fairness" in financial markets as a whole; however, this argument does not indicate a market failure, only a difference in outcomes associated with different strategies. It does not make HFT undesirable from an informationally efficient market perspective. It does, however, make efforts to curb or eradicate HFT look less like a pursuit of fairness and more like rent-seeking.

A study by James J. Angel and Douglas McCabe (2010) on the impacts of market fairness related to HFT found that in the case of procedural fairness (equal opportunity) in markets, the same rules applied to HFTs as to other traders. Any trader is permitted to "buy a computer and co-locate it in an exchange data center" (p. 22) so it is procedurally fair. Regarding the equality of outcomes (distributive fairness), they found that HFT strategies are beneficial to both HFTs and other market participants in the form of "reduced trading costs and prices that accurately reflect related instruments" (p. 23), so one cannot categorically denounce HFT as unfair. In fact, neither markets nor regulation guarantee equality of outcome nor, in the case of informationally efficient markets, do they guarantee that everyone will receive information that informs pricing decisions at exactly the same time (Fama, 1965a; 1965b). Even though markets can still be efficient without equal information or outcomes, this does not mean that low-latency and high-frequency traders do

not engage in practices inconsistent with market efficiency, but there are generally already regulations in place that predate HFT to cover these practices. This is why we need to differentiate between HFT and algorithmic *technology* and strategies and practices *both inside and outside* HFT and algorithmic trading that are manipulative and do not promote efficient price discovery. The strategies of "layering" or "spoofing" are good examples of manipulative practices that are already illegal in many countries, as evidenced by the recent fines levied by multiple countries on Panther Energy Trading and its owner, Michael J. Corsica, for using these practices.

Alternative Outcomes

Our third research question asks us to consider whether regulatory efforts will be effective in resolving perceived problems and/or whether alternative outcomes are possible. Several potential alternative outcomes emerged when we considered the application of formal one-size-fits-all regulation of shared goals, including fewer incentives to self-report technological or trading problems, disincentives for investment in system and risk-mitigation innovations, and informational inefficiencies in markets. To explore this question further, we look more closely at specific strategies within the divergent goals category that are designed to enhance "fairness."

Eliminating HFT. Two regulatory strategies designed to increase market fairness and stability are to slow down the speed of trading and to "curb" or eliminate high-speed trading. These strategies assume that the speed of trading by HFTs is creating an unfair, volatile, or dangerous market environment. Regulatory tactics being executed to accomplish these goals include eliminating HFT profits through FTTs, introducing required minimum hold times, and implementing policies that encourage holding securities long-term rather than short-term.

Regarding market volatility, Eugene Fama (2011) said that one of the greatest misconceptions about the efficiency of markets is that it "implies low volatility. It doesn't. It implies high volatility. Prices adjust quickly to new information. When uncertainty is very high, you expect volatility to be very high" (para. 4). Supporting Fama's assertion, a review of 150 years of financial data from around the world found that stock market volatility is highest during episodes of economic and political turbulence and is exacerbated during wars (Gerlach, Ramaswamy & Scatigna, 2006). As most of these observations of market volatility predate HFT, we can assume that even if HFT is eliminated, periods of market volatility, including flash crashes, will continue to emerge—as they did before HFT in 1962 and 1987 (Jones, 2013; Bell, 2013).

One problem with the tactics described previously is that it is difficult to reduce market speed without eliminating the benefits of improved liquidity, reduced transaction costs, and efficient market pricing, especially since the speed of market transactions has increased for all traders. Regulators in the UK admit that setting a transaction tax to eliminate HFT would be impossible without diminishing the benefits produced by high-frequency trading technology. The speed of trading alone does not cause instability in markets; it is simply the reality of a high-technology market environment. High-speed market transactions are not a market failure; they are a key to contemporary market efficiency. Eliminating HFT will not prevent overreactions, overcorrections, or other forms of volatility, as these market phenomena predate HFT (see Mills, 1927; Gerlach, Ramaswamy & Scatigna, 2006; Fama, 2011; Bell, 2013).

Rather than improving market stability, the alternative outcome would be a redistribution of profits to less competitive, non-HFT firms and governments, and lower overall returns for all investors as rising taxes, fees, and transaction costs would be passed on to them. Declines in

trading volume caused by new global regulations and decreases in HFT through competition are already increasing transaction costs overall, with US costs remaining the lowest according to a report by Credit Suisse (Mackintosh & Baudewyn, 2014). It is not clear how the disruption of market outcomes and the redistribution of income can be more "fair" than the market outcome in quality or efficiency.

Detractors often argue that HFT should be eliminated because the technology arms race associated with HFT provides no social benefit and traders are trading on speed, not price. Yet speed is designed to obtain the best price for investors. Eliminating HFT will not necessarily eliminate the desire for speed, as the desire to be first to get the best price has existed as long as there have been markets. Someone will always be first regardless of overall market speed. It is this very desire to be first that keeps markets liquid and informationally efficient. Regulation designed to eliminate HFT in France and Italy has demonstrated how quickly liquidity can decline significantly without HFT (*The Trade*, 2013).[1]

Trading speed is also subject to the same economic limitations of marginal cost and marginal benefit as any other infrastructure investment. There is some empirical evidence that nanosecond-trading speeds may not actually increase profits for HFTs (Ye, Yao & Gai, 2013). As diminishing marginal returns set in for HFT technology, there will be less incentive to compete in an "arms race." As with any market, those HFT firms that were first to enter the market made the most profit. Additional competitors have since entered, driving profits toward zero. There is no reason to think the market for HFT will continue to function any differently.

[1] Both France and Italy implemented transaction taxes on canceled orders to reduce order-to-trade ratios. France's share of European equity turnover has declined from 23 percent in 2011 to an estimated 12.85 percent in 2013. In Italy equity turnover has dropped from €101 billion in 2012 to €50 billion in 2013.

Another challenge associated with the elimination of HFT is that the regulatory proposals reviewed here generally failed to provide a vivid definition of HFT or to make a distinction between HFT and algorithmic trading. Increasingly, the term "HFT" is being used in the public forum and the language of regulation to describe algorithmic trading as a whole, rather than a form of algorithmic trading in which firms use high-speed market data and analytics to look for short-term supply-and-demand trading opportunities that often are the product of predictable behavioral or mechanical characteristics of financial markets (Bell, 2013). While this definitional creep is not surprising, as changes in algorithmic trading more broadly have blurred the line between it and HFT, it can be problematic because the lack of distinction appears to direct accountability toward HFT for events that are caused by a variety of forms of algorithmic and technology-related issues and not by HFT specifically.

As we are operating in a global financial market, eliminating HFT in one or a number of countries will not eliminate it on a global scale or eliminate the negative impacts of market manipulation strategies. Countries like Japan, Singapore, Russia, Brazil, and Mexico are actively seeking to attract HFT, as they believe it will improve their markets by increasing liquidity and attracting foreign traders and capital. Eliminating or significantly "curbing" HFT in any country—rather than engaging in oversight and monitoring—may result in the offshoring of HFT to emerging HFT markets. When offshoring of HFT occurs, the losing country will no longer be able to monitor HFT or enforce penalties for manipulative market practices undesirable to market efficiency. Such a country also risks losing capital to more liquid markets. As discussed previously, HFT volumes in FX are already growing substantially in Russia as firms are leaving countries like Germany (The hammer, 2013; Cave, 2013). Regulators should give the risks of offshoring HFT serious consideration before eliminating it domestically.

Minimum hold times, financial transaction taxes, and order-to-trade ratios. The tactic of introducing minimum hold times makes trend trading much more difficult for HFTs and other algorithmic traders. Trend trading is not a new strategy; pit traders used it to attempt to determine an impending price-breakout level. In the case of HFT, algorithms try to find similar price-trend indicators and act on them. This strategy is risky, just as it was for pit traders, but it provides valuable liquidity to markets (see Kingsley, Phadnis & Stone, 2013).

The SEC has also found that high-frequency traders are not canceling orders nearly as often as people had suspected and that market speed has increased for all participants. SEC chair Mary Jo White stated,

> Though we can clearly see that quotes are sometimes canceled within a millisecond or faster, the data show that the high-speed market is not dominated by such cancellations. . . . In fact, over a quarter of all exchange-based trades in corporate stocks are executed against orders that have rested for only half a second or less (Lynch, 2013, SEC Seeing Trends section, para. 5).

Minimum hold times would significantly decrease market efficiency by not allowing HFTs or other algorithmic traders to respond to new information in a timely manner and would discourage traders from buying, once again reducing liquidity and informational efficiency in the market. One of the concerns with HFT is that small and "fleeting" orders (those not held for a meaningful period of time) lead to increased market volatility; however, there is no significant empirical research that confirms this perception (Bollen & Whaley, 2013). The study of Australian markets (Australian Securities & Investment Commission, 2013) found that the vast majority of small and "fleeting" orders are not associated with HFT, but are shared with other algorithmic traders. Again, market speed has increased for all traders and is not an HFT-exclusive phenomenon.

Both minimum hold times FTTs on canceled orders make price discovery difficult for all types of algorithmic traders. Markets are dynamic and evolving environments, and the high velocity of available information makes it necessary for traders to quickly change their opinions about appropriate pricing. An alternative outcome is that government intervention creates significant informational distortions through minimum hold times that do not allow markets to reflect via price the most recent information, creating significant informational inefficiencies. FTTs can also create informational distortions by not allowing prices to adjust to "minor" information (i.e., small price changes) because any profits would be taxed away. These informational distortions will result in wider spreads and less liquidity.

A recent study finds that "speed competition may be a consequence of failed price competition" (Ye, Yao & Gai, 2013, p. 13) in large part because of the regulated minimum tick size. The authors suggest deregulating the tick size to allow for smaller price adjustments, which will take the speed advantage away from HFTs because they are less likely to trade on a smaller tick size. As discussed earlier, minimum hold times and FTTs will only increase spreads and not allow prices to reflect minor information, making markets even less informationally efficient and price competitive. Plus, even if HFTs were eliminated, the speed of algorithmic trading in general is increasing and the speed race would continue there.

Financial transaction taxes on canceled orders will also decrease liquidity. Liquidity has decreased in both France and Italy, where financial transaction taxes have been recently implemented. France's share of European equity turnover has been reduced from 23 percent in 2011 to an estimated 12.85 percent in 2013. In Italy equity turnover has dropped from €101 billion in 2012 to €50 billion in 2013 over the same time period for each year, according to information from TABB Group (*The Trade*, 2013).

Along with minimum hold times and FTTs, another related strategy, reducing order-to-trade ratios, is designed to slow market speed while reducing "noise" and improving market integrity. As discussed earlier, attempts by HFTs to create noise with the desire to manipulate markets by creating a false sense of demand in order to trigger other algorithms to behave in a way that will benefit the noise-creating algorithm are already illegal under existing regulation in most countries. Plus, algorithms are getting better at sniffing out false signals from other algorithms, and developing algorithms that neutralize HFT strategies makes this tactic of market manipulation less effective.

In April 2012, Canada's IIROC began "charging a portion of its cost recovery fees based on the number of market messages (i.e., trades and order submissions, cancelations, and modifications)" (Malinova, Park & Riordan, 2013, p. 2). The result, according to the same study, was that trades, quotes, and order cancelations dropped by 30 percent; however, bid-ask spreads marketwide increased by 9 percent. The study, conducted by the University of Toronto, found that a 1.6 percent decline in HFT messaging leads to a 0.48 basis point increase in spreads.

The idea of noise in the form of competing or contradictory information in financial markets is also not a new phenomenon, nor is it associated exclusively with HFT. As Bell (2013) discusses, economist Frank W. Taussig noted in 1921 "that insider information, rumors, and technical knowledge held by some professionals cause markets to act in ways we would not expect based on supply and demand for securities alone" (p. 8). The challenge is to determine what, if any, noise being created by HFT—not already illegal due to intentional market manipulation—is related to a market failure that requires additional regulatory intervention.

It also may not be feasible to force algorithms to operate continuously to provide liquidity regardless of market conditions. It will be nearly impossible if market conditions

change dramatically for algorithms to continue to operate as they did before the change in market condition. For example, during the "flash crash" in the US market, a large number of securities flooded the market at the same time, and high-frequency traders initially continued to operate as they usually do. However, once an imbalance existed in the market between shares entering the market and available buyers, they quit trading because while they could continue to provide *some* liquidity by purchasing stock, they were unable to turn shares over in the short run. Continuing to purchase stock would have been irrational given the market uncertainties present at the time and the inherent limit of capital available to HFTs when they could not turn equities over. HFTs did what any investor would have done when a security turns toxic.

Short-term vs. long-term investing. The UK, Canada, and others have taken a more behavioral perspective by expressing an interest in minimizing "short-termism" (trading) in equity markets and encouraging "long-termism" (owning) in their proposed regulation designed to essentially eliminate HFT in their markets. The House of Commons Business, Innovation and Skills Committee is basing its concerns about HFT in UK markets on The Kay Review of UK Equity Markets and Long-Term Decision Making (Kay, 2012), which identified short-term decision-making as a problem associated with long-term performance of UK markets, even though Kay specifically stated in the report and in testimony before the committee that HFT is not the root cause.

Kay describes how human beings, motivated by human tendencies, can make decisions based on short-term desires that they end up regretting in the long term. He calls this short-term thinking (or "short-termism") "myopic behavior." This behavior causes individuals to place too

much weight on recent events or information and not enough on the long-term "big picture," a theme raised in financial markets long before HFT (Mills, 1927) and in contemporary market theories of behavioral economics (DeBondt & Thaler, 1985). Kay suggests that patterns of aggregated myopic behavior result in regretted decisions across the economy, exchanging a long-term Pareto-superior state for a short-term payoff, resulting in a state of the world that regulation could improve.

Kay's argument—that trading decisions that maximize traders' utility in the short run cannot possibly result in an outcome that is best for society—is the essence of the global HFT debate. His assumptions, and those of critics of HFT and of free markets in general, are based on the tenets of prospect theory that assume individuals and their agents cannot make rational decisions due to cognitive errors that do not "correctly reflect their long-term financial interests" or the interests of society. In particular, he states, "Optimism bias, anchoring and loss aversion have been widely documented in human behavior generally, and in business and financial contexts specifically" (Kay, 2013, p. 35).

Yet he does not see the process of HFT as "damaging short-term behavior" that is harmful to the economy as a whole because he is not concerned with the decision-making process, only the outcomes. He states, "The outcome, not the process, is what matters, and that perspective has been central to this Review" (p. 14). In other words, it doesn't matter how financial markets arrive at an outcome. What matters is that the outcome is controlled and acceptable to society because individual decision makers are not inherently capable of reaching the socially optimal decision. He does not, however, suggest how the correct socially optimal decision should be determined.

However we wish to describe or arrange markets is ultimately irrelevant to critics of HFT and of free markets in general who wish to control market outcomes in the pursuit of "fairness." But it cannot be emphasized enough that, as James M. Buchanan famously stated,

> the "order" of the market emerges *only* from the *process* of voluntary exchange among the participating individuals. The "order" is, itself, defined as the outcome of the *process* that generates it. The "it," the allocation-distribution result, does not, and cannot, exist independently of the trading process. Absent this process, there is and can be no "order" [emphasis in original] (Buchanan, 1982, RF.1.2)

Efficient financial markets are indifferent about whether participants are behaving as fully rational "global" optimizers or as myopic "individual" decision makers, as long as they are making the best personal utility-maximizing choice possible in response to the decision-making of others. Individuals making decisions in a purely myopic sense can reach an outcome in which no other market participant will be better off by unilaterally changing his or her strategy, implying that the social optimum is being achieved—or more accurately, being perpetually moved toward at any point in time—even in rapidly evolving high-speed markets. The relative transparency of the price mechanism makes this possible. To declare there is a better method, or speed, of price discovery than the market outcome, we must assume that a benevolent outsider has all available information, including future information, which allows this individual to determine the most socially optimal market outcome at any moment in time; that this outcome can never be determined or achieved by society; and that it is fixed and does not evolve or emerge as part of a process. As no all-knowing benevolent and impartial observer exists, we must assume regulation designed to disrupt market outcomes will only serve to distort the market process and render markets inefficient and thereby ineffective as a means of social optimization of allocation-distribution.

Conclusions

The regulatory goals of legislators and regulatory authorities globally appear to fall into two broad categories: shared, market integrity goals and divergent, fairness goals. Market integrity is a goal shared by traders, exchanges, and regulators, as no party will be made better off if there is a significant market failure that results in chaos. As a result, several existing regulations and cooperative nonregulatory solutions have been implemented to maintain the integrity of markets. Circuit breakers, HFT-neutralizing algorithms, exchange systems that detect erroneous orders, the self-reporting of system issues and their subsequent repair, the emergence of non-HFT exchanges, and the implementation of systems that allow regulators to monitor market activity are some examples of these solutions.

The concept of "fairness" and the regulatory strategies designed to foster it create divergences between traders, exchanges, and regulators. Evidence suggests that HFT is already fair from both a procedural and a distributive perspective. Attempts to treat HFTs differently than other market participants from a regulatory perspective—by creating specific fees or taxes, limiting speeds and price discovery mechanisms, or eliminating HFT as a technology—deviate from the concept of procedural fairness. Instead, they move toward rent-seeking activities designed to transfer wealth to governments or to other competitors that have not increased their productivity to compete in a high-velocity-information environment. Rent-seeking decreases social wealth by reducing market efficiency and liquidity and by increasing spreads, costs of trades, and volatility currently smoothed by HFT.

There is little evidence suggesting a market failure exists that requires additional regulatory intervention. The price of securities reflects all available information in a rapid and efficient manner, and the market continues to transfer ownership of securities efficiently. The

market is adjusting to the increased speed of information in the external environment by finding ways to process and respond to it at similar speeds inside the market. Shared goals associated with market integrity are leading to market-driven solutions by traders, exchanges, and regulators. Regulators need to be cautious not to engage in "regulatory creep" into areas that the market and its participants are already managing. Too much regulatory formalization of existing practices, including stiff consequences, can create disincentives for market participants to do what is best for the market. For example, if stiff penalties are in place for algorithmic or exchange technology problems, traders and exchanges have little incentive to self-report and make public such problems.

Kay suggests that behavioral failures are leading to less than socially optimal long-run market outcomes and that regulation would create more responsible outcomes regardless of the market process utilized. Accomplishing this goal requires the assumption of a benevolent and impartial observer who has all information past, present, and future and thereby can determine the social optimum. However, we are forced to cope with the unavoidable human ignorance about what the optimal arrangements of resources in future states of the world should be and whether HFT contributes to the hypothetical negative outcomes. Not even Kay believes HFT is the problem driving the short-term holding of stocks, yet UK regulators and others continue to focus on it as an issue. Markets are complex systems that require the interaction of a variety of factors to reach an outcome. Focusing on a single factor as the cause of a market behavior is not helpful in determining its root causes.

The media, regulators, and academics are all subject to the same behavioral flaws Kay describes. In assigning blame for inherent market phenomenon to HFT, they are often overreacting to infrequent and recent market events and ignoring the fact that flash crashes and

other market disruptions have happened before. Reacting to these events, they observe that markets as a whole have sped up, so they blame speed. When they think of speed, they focus on HFT. In their overreaction, they clamor for fast and aggressive regulation, forgetting that their criticism of HFT is that it is too fast and too aggressive. One of the issues creating this environment is the definitional "creep" of HFT, as fewer commentators are differentiating between HFT and computer- or algorithm-based trading technology and strategies in general. This definitional failure may be leading regulators to recommend regulation designed for financial markets broadly, rather than designed for specific practices used by high-frequency traders that negatively impact market price discovery. Regulators should be careful to utilize empirically based evidence of market failures before proposing regulatory intervention.

Where no market failure exists, as in the case of HFT, we do not want to introduce a government failure, since there is little indication that additional government intervention will improve market integrity or "fairness" more than the market has. The market and its participants can use open competition through alternative exchanges and/or algorithms designed to neutralize HFT if the market determines HFT is undesirable. HFT strategies can be beaten, and the market will determine whether HFT's extinction or survival is ultimately beneficial. Markets have already contained the proliferation of HFT and driven its profits down consistently since 2009.

The regulatory strategies described here will fail to meet each country's goals while simultaneously diminishing the benefits of HFT. Aggressive regulation may cause high-frequency traders to seek out growing and emerging HFT markets like those in Japan, Singapore, Russia, and Brazil, and highly regulated or taxed countries will lose capital and the ability to monitor HFT to minimize manipulative practices in the global marketplace. There is evidence of

at least one firm leaving Germany due to the burdens of regulation, and HFT in FX is growing substantially in Russia. The potential for offshoring is real and the risks of lost capital and the inability to monitor HFT activities for manipulative practices must be considered.

Appendix A. MiFID II

The amended version of MiFID II (European Parliament, 2012a), which regulators have voted in favor of but have not yet released a final document for, sets forth in its draft the following regulatory guidelines for HFTs:

- HFTs must develop effective systems and risk controls [Article 17(1), p. 61; Article 51(1), p. 102].
- HFTs must report their algorithmic strategies to regulators [Article 17(2), p. 61].
- HFTs must create and store a raw audit trail that contains all quotation and trading activities that can be made available to regulators on request [Article 17(2a), p. 61].
- Firms must enter into market-making agreements with the trading venue that must include a liquidity provision. The HFT firm must operate the algorithm continuously to provide liquidity regardless of market conditions unless the written agreement provides otherwise [Article 17(3), p. 62].
- Firms may not "provide sponsored and naked market access to a trading venue." They may provide direct market access with proper controls [Article 17(4), p. 62].
- Firms must hold orders, unchanged, for a minimum of 500 milliseconds [Article 51(1b), p. 103].
- Trading firms must be able to "reject orders that exceed pre-determined volume and price thresholds or are clearly erroneous" and have circuit breakers in place in the event of "significant price movement in a financial instrument," and they must be able to cancel or correct any transaction should it become necessary [Article 51(2), p. 116].
- All algorithms must be tested [Article 51(3), p. 103].

- Member states shall impose a maximum order-to-trade ratio and minimum tick size [Article 51(3), p. 103].
- All fee structures must be transparent, fair, and nondiscriminatory, and higher fees should be placed on participants placing a high ratio of canceled orders to executed orders and on those operating a high-frequency trading strategy [Article 51(5a), p. 104].

Appendix B. CFTC Concept Release

The Commodity Futures Trading Commission (2013) has published a Concept Release "intended to serve as a high-level enunciation of potential measures intended to reduce the likelihood of market disrupting events and mitigate their impact when they occur" (p. 38). It published the Concept Release recognizing that derivatives market participants are already taking steps to manage the risks of automated trading, with HFT as a subset. The document states, "The Commission acknowledges these efforts, and, through this Concept Release, seeks public comment on the extent to which measures already in place may be sufficient to safeguard markets in automated trading environments" (p. 7).

While the CFTC recognizes the existence of risk controls, the Concept Release is designed to determine whether enforced standardization via regulation is in the market's best interest. The proposed regulations fall into four broad categories: pre-trade controls, post-trade reports and measures, system safeguards, and other protections.

Pre-trade Controls

The CFTC recommends message rate and execution throttles. A maximum message rate could be established to mitigate strategies like "order stuffing" that the CFTC describes as "manipulative" or "disruptive." Execution throttles would "prevent an algorithm from exceeding its expected message rate or rate of execution, and when tripped, [could] alert monitors at both the exchange and the trading firm" (p. 42). The CFTC also suggests implementing volatility awareness alerts, which "could be triggered when price movements in a given product move beyond a certain threshold within a previously specified time period" (p. 45).

The Concept Release recommends self-trade controls that would prevent traders from executing trades with themselves and price collars that would require trading platforms to develop a range of acceptable order and execution prices for each of their products. If an order came in outside that range, it would not be executed. Additional recommended pre-trade controls include maximum order sizes, trading pauses, and more aggressive pre-trade credit risk limits.

Post-Trade Controls

Trading platforms would be required to generate order and trade reports that provide duplicate copies of each order and executed trade to the originating market participant. Derivative clearing organizations could be asked to submit a position report on net position per maturity per contract to the originating market participant and the market participant's clearing firm. Trading platforms and market participants might be asked to develop "uniform adjust or bust error trade policies" that would adjust or remove trades executed due to an error with policies favoring adjustments rather than cancelations being the priority. Standard reporting for trade errors is another post-trade control recommendation.

System Safeguards

Trading platforms, clearing members, and market participants must have systems and processes in place to be able to auto-cancel orders upon a system disconnection, cancel select working orders and deploy kill switches for all orders when appropriate, and automatically turn off trading when maximum orders have been reached (this is the system support mechanism of execution throttles discussed earlier). Systems must utilize "system heartbeats" to indicate proper connectivity between systems.

The automated trading system (ATS) must (1) be designed in a way that does not violate any rules or laws, (2) maintain a development environment isolated from the marketing system that is in operation, (3) maintain a source code repository, (4) document all system functionality, changes, and communications, and (5) develop and maintain documented policies and procedures to allow representatives from trading, risk, and software management to approve changes and verify adequate internal testing. All ATSs must be adequately tested internally, and trading platforms must provide test environments to simulate the trading environment.

Market participants operating ATSs must provide trained and qualified staff to monitor and supervise all systems while engaged in trading. These individuals must be empowered to take action if a problem occurs. Crisis management procedures must be in place for all trading platforms and market participants operating ATSs. All firms operating ATSs, as well as clearing firms, require annual self-certification of ATSs, and the firm must notify the CFTC when an algorithm violates its design parameters or whenever risk-control technologies or processes do not function as planned. Algorithms should be assigned identifiers that will be attached to all orders, and firms operating ATSs should implement "reasonability checks" on incoming market data or external information, including social media sources.

Other Protections

All firms operating ATSs would be required to register with the CFTC and all trading platforms must provide a daily summary of market quality to market participants. The report should include the following information:

1. effective spreads
2. order-to-fill ratios

3. execution speed for different order types and sizes
4. aggressiveness imbalance
5. price impact for given trade sizes
6. average order duration
7. order efficiency
8. rejection order ratio
9. net position changes versus volume
10. branching ratios
11. volume imbalance and trade intensity
12. Herfindahl-Hirschman indexes based on market share of open positions under common control
13. metrics on the number of price-changing trades involving ATSs (pp. 130–31)

Trading platforms must work with the CFTC to standardize order types across exchanges and to implement policies and procedures for identifying securities or products listed on other exchanges that would constitute "related" contracts to those listed on their own exchanges.

References

Ackerman, A. (2 October 2013). SEC's White: Recent trading glitches not byproducts of high-frequency trading, dark pools.

Alembakis, R. (19 June 2013). ASIC vetoes HFT and dark liquidity regulation. *Global Custodian*. Retrieved from http://www.globalcustodian.com/au/news/news_article.aspx?id=2147484408#.UhaAxVOE6iY

Angel, J. J., & McCabe, D. (2010). Fairness in financial markets: The case of high frequency trading. Retrieved from http://www.sec.gov/comments/s7-02-10/s70210-316.pdf

Asness, C. S., & Mendelson, M. (1 April 2014). High-frequency hyperbole. *The Wall Street Journal*. Retrieved from http://online.wsj.com/news/articles/SB10001424052702303978304579475102237652362?mg=reno64-wsj

Australian Legal Business. (28 May 2013). NZ: Regulator to push for more algorithmic trading. Retrieved from http://au.legalbusinessonline.com/news/breaking-news/nz-regulator-to-push-for-more-algorithmic-trading/110931

Australian Securities and Investments Commission. (2013a). Dark liquidity and high-frequency trading. Retrieved from http://www.asic.gov.au/asic/asic.nsf/byheadline/Dark-liquidity-and-high-frequency-trading?openDocument

Australian Securities and Investments Commission. (2013b). ASIC market integrity rules (competition in exchange markets) 2011. Retrieved from http://www.comlaw.gov.au/Details/F2013C00335

Australian Securities and Investments Commission. (2013c). Report 331: Dark liquidity and high-frequency trading. Retrieved from http://www.asic.gov.au/asic/pdflib.nsf/LookupByFileName/rep331-published-18-March-2013.pdf/$file/rep331-published-18-March-2013.pdf

Australian Securities and Investments Commission. (2013d). ASIC market integrity rules (competition in exchange markets) amendment 2013 (no. 2). Retrieved from http://www.comlaw.gov.au/Details/F2013L01558

Bannister, D. (20 June 2013). SEC hopes for Midas touch from HFT surveillance system. *Banking Technology*. Retrieved from http://www.bankingtech.com/149362/sec-hopes-for-midas-touch-from-hft-surveillance-system/

BBC. (29 April 2013). High-frequency traders face speed limit on deals. Retrieved from http://www.bbc.co.uk/news/business-22342770

Bell, H. A. (2013). High frequency trading: Do regulators need to control this tool of informationally efficient markets? *Cato Institute Policy Analysis, No. 731*. Retrieved from http://www.cato.org/publications/policy-analysis/high-frequency-trading-do-regulators-need-control-tool-informationally

Bloomberg News. (2 August 2013). China cuts transaction fees for share trading. *Bloomberg Businessweek*. Retrieved from http://www.businessweek.com/news/2012-08-02/china-cuts-transaction-fees-for-share-trading

Bogard, V. (2014). High-frequency trading: An important conversation. *Tabb Forum*. Retrieved from http://tabbforum.com/opinions/high-frequency-trading-an-important-conversation

Bollen, N. P. B., & Whaley, R. E. (2013). Futures market volatility: What has changed? Retrieved from http://www.futuresindustry.org/downloads/Volatility_Study_8-27-2013.pdf

Brogaard, J. A. (2010). High frequency trading and its impact on market quality (Working Paper). Retrieved from http://www.fsa.gov.uk/static/FsaWeb/Shared/Documents/pubs/consumer-research/jonathan-brogaard-hft.pdf

Brogaard, J., Hendershott, T., & Riordan, R. (2010). High frequency trading and price discovery (Working Paper). Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1928510

The Brookings Institute. (30 January 2014). Trading stocks in America: Key policy issues [forum transcript]. Retrieved from http://www.brookings.edu/~/media/events/2014/1/30%20trading%20stocks/20140130_trading_stocks_transcript

Brush, S. (24 July 2013). CFTC's Chilton seeking review of CME wash-trade restrictions. *Bloomberg*. Retrieved from http://www.bloomberg.com/news/2013-06-24/cme-high-frequency-wash-trade-plan-needs-review-chilton-says.html

Buchanan, J. M. (1982). A note stimulated by reading Norman Berry, 'The tradition of spontaneous order,' *Literature of Liberty, V* (Summer 1982), 7–58. The Forum at The Online Library of Liberty. Retrieved from http://www.econlib.org/library/Essays/LtrLbrty/bryRF1.html

Burgos, J. (28 October 2013). Singapore Exchange seeks high-frequency traders: Southeast Asia. *Bloomberg*. Retrieved from http://www.bloomberg.com/news/2013-10-27/singapore-exchange-seeks-high-frequency-traders-southeast-asia.html

Canadian Securities Administrators. (2013). Canadian securities regulators establish regulatory framework to manage risks associated with direct electronic access. Retrieved from http://www.securities-administrators.ca/aboutcsa.aspx?id=1158&terms=+NI+23-103

Can the HR 1579, Inclusive Property [*sic*] Act, rebuild U.S. financially? (2013). International Finance Magazine. Retrieved from http://www.internationalfinancemagazine.com/article/Can-the-HR-1579-Inclusive-Property-Act-Rebuild-US-Financially.html

Cave, T. (11 June 2012). Leading high-frequency trading firm makes Hong Kong push. *Financial News*. Retrieved from http://www.efinancialnews.com/story/2012-06-11/leading-high-frequency-trading-firm-makes-hong-kong-push?ea9c8a2de0ee111045601ab04d673622

Cave, T. (5 June 2013). German firm quits over tough high-frequency trading rules. *The Wall Street Journal* [blog]. Retrieved from http://blogs.wsj.com/moneybeat/2013/06/05/german-firm-quits-over-tough-high-frequency-trading-rules/?mod=google_news_blog

CBC. (25 June 2013). Aequitas, new RBC-led stock exchange, to rival TSX. *Huffington Post*. Retrieved from http://www.huffingtonpost.ca/2013/06/25/aequitas-stock-exchange-canada-tsx_n_3496095.html

China Knowledge. (2013). China's stamp duty on stock trading to rise 8.7% in 2013. Retrieved from http://www.chinaknowledge.com/Newswires/NewsDetail.aspx?type=1&cat=INV&NewsID=50710

Chitkara, G. (19 June 2013). OTC clearing presents HFT opportunities in Asia. Retrieved from http://www.risk.net/asia-risk/news/2275905/otc-clearing-presents-hft-opportunity-in-asia

Cleary Gottlieb. (2013). Alert memo: Germany adopts new prudential rules for high-frequency trading. Retrieved from http://www.cgsh.com/files/News/853d08bb-cb30-4c24-82b6-27584a4a06cb/Presentation/NewsAttachment/c1eda727-f478-4b4d-a6fe-28365b166940/Germany%20Adopts%20New%20Prudential%20Rules%20for%20High-Frequency%20Trading.pdf

CME Group. (2013). Advisory notice: Wash trades prohibited. Retrieved from http://www.cmegroup.com/tools-information/lookups/advisories/market-regulation/CMEGroup_RA1308-5.html

Commodity Futures Trading Commission. (2013). Concept release on risk controls and system safeguards for automated trading environments. *Federal Register, 78*(177). Retrieved from http://www.cftc.gov/ucm/groups/public/@lrfederalregister/documents/file/2013-22185a.pdf

Commodity Futures Trading Commission & Securities and Exchange Commission. (2010). Findings regarding the market events of May 6, 2010. Retrieved from www.sec.gov/news/studies/2010/marketevents-report.pdf

Credit Suisse. (5 December 2012). AES Analysis: High frequency trading—The good, the bad, and the regulation. *Trading Strategy*.

D'Antona Jr., J. (21 January 2014a). HFT-free Aequitas gets the "go-ahead." *Traders Magazine*. Retrieved from http://www.tradersmagazine.com/news/hft-free-aequitas-gets-the-go-ahead-112017-1.html

D'Antona Jr., J. (1 April 2014b). Careful speed traders: ITG unveils anti-HFT algo. Retrieved from http://www.tradersmagazine.com/issues/26_362/Careful-Speed-Traders-ITG-Unveils-Anti-HFT-Algo-112326-1.html

DeBondt, W. F. M., & Thaler, R. (1985). Does the market overreact? *Journal of Finance, 40*(3), 793–805.

Dodd-Frank Wall Street Reform and Consumer Protection Act. H. R. 4173, 111th Cong. (2010).

Eurex. (2013a). Circular 099/13. Retrieved from https://www.eurexchange.com/blob/exchange-en/4060-499420/499416/2/data/er13099e.pdf.pdf

Eurex. (2013b). Circular 077/13. Retrieved from https://www.eurexchange.com/blob/exchange-en/4060-474482/474480/3/data/er13077e.pdf.pdf

Eurex. (2013c). German HFT Bill—Client information session. Retrieved from http://www.eurexchange.com/blob/exchange-en/455384/457548/4/data/presentation_german_hft_bill_client_information_session.pdf

European Commission. (2007). Markets in financial instruments (MiFID) and investment services. Retrieved from http://europa.eu/legislation_summaries/internal_market/single_market_services/financial_services_transactions_in_securities/l24036e_en.htm

European Commission. (2011a). Markets in Financial Instruments Directive. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0039:EN:HTML

European Commission. (2011b). Proposal for a Directive of the European Parliament and of the Council on Markets in Financial Instruments Repealing Directive 2004/39/EC of the European Parliament and of the Council. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0656:FIN:EN:PDF

European Parliament. (2012a). Report on the proposal for a directive of the European Parliament and of the Council on markets in financial instruments repealing Directive 2004/39/EC of the European Parliament and of the Council (recast). Retrieved from http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A7-2012-0306+0+DOC+PDF+V0//EN

European Parliament. (2012b). Eleven EU countries get Parliament's all clear for a financial transaction tax. Retrieved from http://www.europarl.europa.eu/news/en/pressroom/content/20121207IPR04408/html/Eleven-EU-countries-get-Parliament%27s-all-clear-for-a-financial-transaction-tax

European Parliament. (2013). Report on the proposal for a Council directive implementing enhanced cooperation in the area of financial transaction tax. Retrieved from http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A7-2013-0230+0+DOC+PDF+V0//EN

Fama, E. (1965a). Random walks in stock market prices. *Financial Analysts Journal, September/October 1965*, 55–59.

Fama, E. (1965b). The behavior of stock-market prices. *Journal of Business, 38*(1), 34–105.

Fama, E. (2011). Examining the financial crisis with Professor Eugene Fama. *ChicagoBooth News*. Retrieved from www.chicagobooth.edu/news/2011-10-28_fama.aspx

Fangqin, W. (2010). TSE's arrowhead system lowers trading costs. *Securities Technology Monitor*. Retrieved from http://www.securitiestechnologymonitor.com/news/-24864-1.html

Foresight. (2012). *The future of computer trading in financial markets. Final project report*. London: The Government Office of Science. Retrieved from http://www.bis.gov.uk/assets/foresight/docs/computer-trading/12-1086-future-of-computer-trading-in-financial-markets-report.pdf

Fujitsu. (2010). TSE launches next-generation "arrowhead" trading system. Retrieved from http://www.fujitsu.com/global/news/pr/archives/month/2010/20100108-01.html

Futures & Options World. (2013). High-frequency traders race to find new markets. Retrieved from http://www.fow.com/Article/3227934/High-frequency-traders-race-to-find-new-markets.html

Gerig, A. (2012). High-frequency trading synchronizes prices in financial markets. Retrieved from http://arxiv.org/pdf/1211.1919v1.pdf

Gerlach, S., Ramaswamy, S., Scatigna, M. (2006). 150 years of financial market volatility. *BIS Quarterly Review, September 2006*, 77–91.

German HFT ban may hit liquidity—Nasdaq OMX NLX. (2014). *Futures & Options World Intelligence*. Retrieved from http://www.fointelligence.com/Article/3308981/German-HFT-ban-may-hit-liquidity-Nasdaq-OMX-NLX.html

Gerner-Beuerle, C. (2012). United in diversity: Maximum versus minimum harmonization in EU securities regulation. *Capital Markets Law Journal, 7*(3). doi: 10.1093/cmlj/kms025.

Gesetz zur Vermeidung von Gefahren und Missbräuchen im Hochfrequenzhandel (Hochfrequenzhandelsgesetz). (May 2013). *Bundesgesetzblatt Jahrgang, 7*. Retrieved from http://www.bgbl.de/Xaver/start.xav?startbk=Bundesanzeiger_BGBl#__Bundesanzeiger_BGBl__%2F%2F*[%40attr_id%3D%27bgbl113s1162.pdf%27]__1375491455729

Gide Loyrette Nouel. (2012). France-FTT and high-frequency trading. Retrieved from http://www.aima.org/objects_store/gide_note_re_french_ftt_-_august_2012.pdf

The Globe and Mail. (25 June 2013). The influence of high-frequency trading in Canada. Retrieved from http://www.theglobeandmail.com/report-on-business/the-influence-of-high-frequency-trading-in-canada/article12790125/

Gould, R. (15 September 2010). Market structures change in China: Prospects for HFTs. *Global Trading*. Retrieved from http://fixglobal.com/content/market-structure-change-china-prospects-hfts

GovHK. (2013). Stamp duty rates. Retrieved from http://www.gov.hk/en/residents/taxes/stamp/stamp_duty_rates.htm

Grant, J. (11 May 2011). U.S. high-frequency trading firms look eastward. *Advanced Trading*. Retrieved from http://www.advancedtrading.com/infrastructure/us-high-frequency-trading-firms-look-eas/229500005

Grant, J. (6 August 2012). China moves to algorithmic trading. *Financial Times*.

The hammer, the sickle and the algo: Russia's unorthodox journey to a thriving market. (2013). *Automated Trader Magazine, Q1*(28).

Hasbrouck, J., & Saar, G. (2010). Low-latency trading (Working Paper). Retrieved from http://people.stern.nyu.edu/jhasbrou/Research/Working%20Papers/HS10-11-10.pdf

Hendershott, T., & Riordan, R. (2009). Algorithmic trading and information (Working Paper). Retrieved from http://people.stern.nyu.edu/bakos/wise/papers/wise2009-3b2_paper.pdf

Hendershott, T., Jones, C. M., & Menkveld, A. J. (2011). Does algorithmic trading improve liquidity? *Journal of Finance, LXVI*(1), 1–33.

Hendershott, T., Riordan, R. (2012). Algorithmic trading and the market for liquidity. *Journal of Finance and Quantitative Analysis, Forthcoming*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2001912##

High-frequency traders race to find new markets. (2013). *Futures & Options World*. Retrieved from http://www.fow.com/Article/3227934/High-frequency-traders-race-to-find-new-markets.html

Ho, F. (8 January 2013). High-frequency trading still controversial two years after 2010 flash crash. *The Edge*. Retrieved from http://www.theedgemalaysia.com/personal-finance/227073-high-frequency-trading-still-controversial-two-years-after-2010-flash-crash.html

Horch, D., & Popper, N. (22 May 2013). Despite risks, Brazil courts the millisecond investor. *DealBook*. Retrieved from http://dealbook.nytimes.com/2013/05/22/despite-risks-brazil-courts-the-millisecond-investor/?_r=0

House of Commons Business, Innovation and Skills Committee. (2013). The Kay review of UK equity markets and long-term decision making: Third report of session 2013–14. Retrieved from http://www.publications.parliament.uk/pa/cm201314/cmselect/cmbis/603/603.pdf

IIROC. (2011). The HOT study: Phases I and II of IROC's study of high frequency trading on Canadian equity marketplaces. Retrieved from http://www.iiroc.ca/Documents/2012/c03dbb44-9032-4c6b-946e-6f2bd6cf4e23_en.pdf

IIROC. (2012). IIROC fee model guidelines. Retrieved from http://www.iiroc.ca/Documents/2012/bf393b26-7bdf-49ff-a1fc-3904d1de3983_en.pdf

IIROC. (2013). Administrative notice: IIROC study of high frequency trading—Phase III—request for assistance. Retrieved from http://www.iiroc.ca/Documents/2013/fdc69272-9280-4e14-8308-88958f959c29_en.pdf

Inclusive Prosperity Act, S. 1, 113th Cong. (2013). Retrieved from http://www.govtrack.us/congress/bills/113/hr1579

Inland Revenue Authority of Singapore. (2013). Stamp duty rates & computation. Retrieved from http://www.iras.gov.sg/irasHome/page04.aspx?id=8684

Investment Industry Regulatory Organization of Canada. (2013). Universal market integrity rules (UMIR). Retrieved from http://www.iiroc.ca/industry/rulebook/Pages/UMIR-Marketplace-Rules.aspx

Iosebashvili, I. (29 April 2013). EBS to rein in high-frequency traders. *The Wall Street Journal* [online edition]. Retrieved from http://online.wsj.com/article/SB10001424127887323528404578453183303289790.html

Javers, E. (3 April 2014). Interactive brokers to offer direct routing to 'Flash Boys' dark pool IEX. CNBC. Retrieved from http://www.cnbc.com/id/101552626

Jones, C. M. (2013). What do we know about high-frequency trading? Social Science Research Network. Retrieved from http://ssrn.com/abstract=2236201

Jones, H., & McCrank, J. (23 July 2013). U.S. and UK fine high-speed trader for manipulation. *Reuters* [online edition]. Retrieved from http://in.reuters.com/article/2013/07/22/us-britain-fca-hft-idINBRE96L0G620130722

Junli, F. (19 August 2013). No rewind button on Everbright's trades in China. *MarketWatch, The Wall Street Journal.* Retrieved from http://www.marketwatch.com/story/no-rewind-button-on-everbrights-trades-in-china-2013-08-19

Kay, J. (2012). *The Kay review of UK equity markets and long-term decision making*. Retrieved from http://www.ecgi.org/conferences/eu_actionplan2013/documents/kay_review_final_report.pdf

Killburn, F. (31 March 2011). Russian roulette: Is HFT in Russia worth the risk? *Waters Technology*. Retrieved from http://www.waterstechnology.com/waters/feature/2039264/russian-roulette-hft-russia-worth-risk

Kimball, M. (23 August 2013). How to avoid another Nasdaq meltdown: Slow down trading. *Quartz*. Retrieved from qz.com/118110/how-to-avoid-another-nasdaq-meltdown-slow-down-trading/

Kindermann, J. (2013). Legal framework conditions for the High Frequency Trading Act ("HFT-Act) [PowerPoint Slides]. Retrieved from http://www.eurexchange.com/blob/exchange-en/3150-410008/410090/4/data/HFT-BAI-presentation.pdf

King & Wood Mallesons. (2013). Electronic trading: New Hong Kong regulations in 2014. Retrieved from http://www.mallesons.com/publications/marketAlerts/2013/Pages/Electronic-trading-New-Hong-Kong-regulations-in-2014.aspx

Kingsley, T., Phadnis, K., & Stone, G. (2013). HFT: Perspectives from Asia—Part I. *Bloomberg Tradebook*. Retrieved from http://www.bloombergtradebook.com/blog/hft-perspectives-from-asia-part-i/

Kok, C. (16 March 2012). High frequency trading in SGX equities almost zero-report. *Reuters.* Retrieved from http://www.reuters.com/article/2012/03/15/singaporeexchange-idUSL4E8EF83G20120315

Kuen, Y. L. (4 November 2013). Singapore exchange mulls giving rebates to frequent traders. *The Star*. Retrieved from http://www.thestar.com.my/Business/Business-News/2013/11/04/Singapore-exchange-mulls-giving-rebates-to-frequent-traders/

KVH Co. Ltd. (24 March 2014). KVH optimizes network to launch industry's fastest routes to CME from Tokyo and Singapore [press release]. In *The Wall Street Journal.* Retrieved from http://www.marketwatch.com/story/kvh-optimizes-network-to-launch-industrys-fastest-routes-to-cme-from-tokyo-and-singapore-2014-03-24?reflink=MW_news_stmp

Kwan, J. (17 July 2013). Will Aequitas succeed against TSX by restricting high-frequency trading? *Canadian Business*. Retrieved from http://www.canadianbusiness.com/investing/a-bold-new-challenger-to-the-tsx/

Lam, E., & Alexander, D. (16 January 2014). Regulators rebuff Aequitas curbs on 'predatory' trading. *Bloomberg Businessweek*. Retrieved from http://www.bloomberg.com/news/2014-01-16/canadian-regulators-rebuff-aequitas-curbs-on-predatory-trading.html

Leising, M. (11 July 2013). CME requests CFTC approval to change rule barring wash trades. *Bloomberg*. Retrieved from http://www.bloomberg.com/news/2013-07-11/cme-requests-cftc-approval-to-change-rule-barring-wash-trades.html

Lewis, M. (2014). *Flash Boys: A Wall Street Revolt*. New York: W. W. Norton & Company, Inc.

London Stock Exchange Group. (2010). London stock exchange group response to CESR call for evidence on micro-structural issues of the European Equity Markets (CESR/10-142). Retrieved from http://www.londonstockexchange.com/about-the-exchange/regulatory/responsetocesrscallforevidenceonmicro-structuralissuesoftheeuropeanequitymarkets.pdf

Lynch, S. N. (2 October 2013). SEC website will shed light on high-speed trading. *Reuters*. Retrieved from www.reuters.com/article/2013/10/02/us-sec-market-data-idUSBRE9910ZE20131002

Mackintosh, P., & Baudewyn, L. (20 February 2014). Beware, transaction costs are trending up. Credit Suisse.

Malinova, K., Park, A., & Riordan, R. (2013). Do retail traders suffer from high frequency traders? Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2183806

Markets Media. (16 May 2013). HFT comes to Japan. Retrieved from http://marketsmedia.com /hft-comes-to-japan/

McCrank, J. (26 October 2013). Exclusive: Aiming to avoid Facebook chaos, NYSE runs Twitter IPO test. Retrieved from http://www.reuters.com/article/2013/10/26/us-nyse -twitter-testing-idUSBRE99P0BB20131026

Melendez, E. D. (12 March 2013). SEC proposal to curb high-frequency trading falls far short of goal: Industry experts. *Huffington Post*. Retrieved from http://www.huffingtonpost.com /2013/03/12/sec-high-frequency-trading_n_2853004.html

Menkveld, A. J. (2012) High frequency trading and the new-market makers (Working Paper). Retrieved from http://personal.vu.nl/a.j.menkveld/papers/menkveld2.pdf

Michaels, D., & Mamudi, S. (30 September 2013). SEC once slowed by data gap to report high-speed trader research. *Bloomberg*. Retrieved from www.bloomberg.com/news/2013-10 -01/sec-once-slowed-by-data-gap-to-report-high-speed-trader-research.html

Miller, M., & Wildau, G. (22 August 2013). China vets brokerages' computer systems after $3.8 billion buy error. *Reuters*. Retrieved from http://www.reuters.com/article/2013/08/22 /us-everbright-tradingerror-idUSBRE97L09O20130822

Mills, F. C. (1927). *The behavior of prices*. Cambridge, MA: National Bureau of Economic Research.

Moscow Exchange working group to promote algorithmic trading. (2014). *Automated Trader*. Retrieved from http://www.automatedtrader.net/news/at/149256/moscow-exchange -working-group-to-promote-algorithmic-trading

Murray, T. B. (20 August 2013). Otkritie online with additional London presence, beckoning global HFT. *Waters Technology*. Retrieved from http://www.waterstechnology.com/sell -side-technology/news/2290059/otkritie-online-with-additional-london-presence -beckoning-global-hft

Najarian, J. (23 August 2013). Blame the high-frequency traders for yesterday's Nasdaq mess. Retrieved from http://finance.yahoo.com/blogs/the-exchange/blame-high-frequency -traders-yesterday-nasdaq-mess-162509029.html

Nan, M. (18 May 2012). China is not ready for high-frequency trading: Official. *Morning Whistle* [Guangzhou, China].

National Instrument 23-103: Electronic Trading. (2013). Retrieved from http://www.bcsc.bc.ca /uploadedFiles/securitieslaw/policy2/23-103_%5BNI%5D.pdf

O'Hara, M. (4 March 2013). HFT in Russia. *HFT Review*. Retrieved from http://www.hftreview.com/pg/blog/mike/read/73166/hft-in-russia

Patterson, S., & Hope, B. (6 February 2014). FINRA to provide market surveillance for BATS Global Exchange. *The Wall Street Journal*. Retrieved from http://online.wsj.com/news/articles/SB10001424052702304680904579366790217684548

Pearce, R. (18 June 2013). High-frequency trading fears overblown: ASIC. Retrieved from http://www.computerworld.com.au/article/465164/high-frequency_trading_fears_overblown_asic/

Penny, T. (24 July 2013). U.K. lawmakers urge tax on high-frequency trading. *Bloomberg*. Retrieved from http://www.bloomberg.com/news/2013-07-24/u-k-lawmakers-urge-tax-on-high-frequency-trading.html

Pinnington, V. (May 2013). *Market quality in a rapidly changing environment*. Presented at OSC-IIROC Conference, Toronto, Ontario. Retrieved from http://www.iiroc.ca/Documents/2013/03603d99-c3ef-4fb6-8b94-a6b6aa857cf3_en.pdf

Polansek, T. (11 July 2013). CME group resubmits plan to update rules blocking wash trades. *Reuters*. Retrieved from http://www.reuters.com/article/2013/07/11/cme-washtrades-resubmit-idUSL1N0FH11N20130711

PROTECT Act, S. 1, 113th Cong. (2013). Retrieved from http://beta.congress.gov/bill/113th-congress/house-bill/2292

Puaar, A. (14 August 2013). Russia embraces high-frequency trading. *Financial News*. Retrieved from http://www.efinancialnews.com/story/2013-08-14/russia-embraces-high-frequency-trading?ea9c8a2de0ee111045601ab04d673622

Reuters. (18 September 2008). China: Government ends stamp tax. *The New York Times*. Retrieved from http://www.nytimes.com/2008/09/19/business/worldbusiness/19fobriefs-GOVERNMENTEN_BRF.html?_r=0

Robinson, K., Egbert, K., Tao, J., & Louvel, G. (2013). The qualified foreign institutional investor program in China—Recent developments, new opportunities and ongoing challenges. *Investment Lawyer, 20*(2), 1–8.

Rodier, M. (18 November 2011). Mexico takes huge steps to boost its position in high-speed trading market. *Wall Street & Technology*. Retrieved from http://www.wallstreetandtech.com/exchanges/mexico-takes-huge-steps-to-boost-its-pos/231903373

Rogow, G. (13 February 2013). Mexican exchanges to HFT: Bring us your business. *The Wall Street Journal*. Retrieved from http://blogs.wsj.com/marketbeat/2013/02/13/mexican-exchange-to-hft-bring-us-your-business/

Rosenman, K. M. (2012). France releases details of financial transaction tax. *HFT Review*. Retrieved from http://www.hftreview.com/pg/blog/kattenlaw/read/38536/france-releases-details-of-financial-transaction-tax

Rosenthal, S. (9 August 2012). In France, high-frequency traders now get taxed for fictitious orders. *The Christian Science Monitor* [online edition]. Retrieved from http://www.csmonitor.com/Business/Tax-VOX/2012/0809/In-France-high-frequency-traders-now-get-taxed-for-fictitious-orders

Ross, A. K., Fitzgibbon, W., & Mathiason, N. (16 September 2012). Britain opposes MEPs seeking ban on high-frequency trading. *The Guardian*. Retrieved from http://www.theguardian.com/business/2012/sep/16/meps-ban-high-frequency-trading?view=mobile

Schuster, G., & Dreibus, A. (2 June 2013). Germany: New regulatory requirements for algorithmic and high frequency trading. Retrieved from http://www.mondaq.com/x/238494/Commodities+Derivatives+Stock+Exchanges/New+Regulatory+Requirements+For+Algorithmic+And+High+Frequency

Securities and Exchange Commission. (2013). Regulation systems compliance and integrity. Retrieved from http://www.sec.gov/rules/proposed/2013/34-69077.pdf

Securities and Futures Commission. (2012). Consultation paper on the regulation of electronic trading. Retrieved from http://www.sfc.hk/edistributionWeb/gateway/EN/consultation/openFile?refNo=12CP3

Securities and Futures Commission. (2013). Consultations & conclusions. Retrieved from http://www.sfc.hk/edistributionWeb/gateway/EN/consultation/

Séparation des Activités Utiles au Financement de L'économie des Activités Spéculatives. (2013). *Journal Officiel de la République Française*. Retrieved from http://www.legifrance.gouv.fr/jopdf/common/jo_pdf.jsp?numJO=0&dateJO=20130727&numTexte=1&pageDebut=12530&pageFin=12556

Sharp, A. (16 January 2014). Canadian stock exchange start-up Aequitas tweaks launce plan. *Reuters*. Retrieved from http://www.reuters.com/article/2014/01/16/canada-exchange-idUSL2N0KQ1CW20140116

Sharp, A., & Rocha, E. (25 June 2013). UPDATE 2—New Canadian stock exchange seeks to challenge dominant TMX. *Reuters*. Retrieved from http://uk.reuters.com/article/2013/06/25/canada-exchange-aequitas-idUKL3N0F12WU20130625

Shecter, B. (21 November 2013). High-frequency trading activity in Canada appears to have declined: IIROC. *Financial Post*. Retrieved from http://business.financialpost.com/2013/11/21/high-frequency-trading-activity-in-canada-appears-to-have-declined-iiroc/

Sussman, A. (26 September 2013). HFT: A regulatory work in progress. *TabbFORUM*. Retrieved from http://tabbforum.com/channels/equities/opinions/hft-a-regulatory-work-in-progress

Tabb, L. (31 March 2014). No, Michael Lewis, the US equities market is not rigged. Retrieved from http://tabbforum.com/opinions/no-michael-lewis-the-us-equities-market-is-not-rigged

Taxation. (26 July 2013a). Transaction tax proposed for in UK. Retrieved from http://www.taxationinfonews.com/2013/07/transaction-tax-proposed-for-high-frequency-trading-in-uk/

Taxation and investment in China 2013: Reach relevance and reliability. (2013b). New York: Deloitte Touche Tohmatsu Limited. Retrieved from http://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/Tax/Taxation%20and%20Investment%20Guides/2013/dttl_tax_guide_2013_China.pdf

Timms, A. (2013). Emerging markets look to attract high frequency traders. *Institutional Investor*. Retrieved from http://www.institutionalinvestor.com/Article/3239889/Emerging-Markets-Look-to-Attract-High-Frequency-Traders.html?ArticleId=3239889&p=1#.UhawMFOE6iY

The Trade. (3 September 2013). Liquidity dries up in FTT countries-report. Retrieved from http://www.thetradenews.com/news/Asset_Classes/Equities/Liquidity_dries_up_in_FTT_countries_-_report.aspx

Trindle, J., & Bunge, J. (24 June 2013). Regulator criticizes exchange efforts on 'wash trades.' *The Wall Street Journal* [blog]. Retrieved from http://blogs.wsj.com/moneybeat/2013/06/24/regulator-criticizes-exchange-efforts-on-wash-trades/

Voigt, C. (2013). Regulatory front-running. *Finextra*. Retrieved from http://www.finextra.com/community/FullBlog.aspx?blogid=7991

Wall Street Trading and Speculators Act, S. 1, 113th Cong. (2013). Retrieved from http://www.govtrack.us/congress/bills/113/hr880

Walter, E. (2013a). Opening statement at the SEC Open Meeting. Retrieved from http://www.sec.gov/News/Speech/Detail/Speech/1365171515104#.UgLdf1OE6iY

Walter, E. (2013b). Harnessing tomorrow's technology for today's investors and markets. Retrieved from http://www.sec.gov/News/Speech/Detail/Speech/1365171492300#.UgQrIFOE6iY

Watts, W. L., & Reklaitis, V. (23 August 2013). Critics say flash freeze shows Nasdaq shouldn't run industry's price processor.

Webb, A. (2010). Bullseye! Tokyo Stock Exchange hits the mark with "arrowhead." *Automated Trader*. Retrieved from http://www.automatedtrader.net/articles/exchange-views/40926/bullseye--tokyo-stock-exchange-hits-the-mark-with-arrowhead

Wessing, T. (2013). Wave of action against high-frequency traders hits home. *The Lawyer*. Retrieved from http://www.thelawyer.com/briefings/wave-of-action-against-high-frequency-traders-hits-home/3007951.article

World Federation of Exchanges. (2013). Understanding high frequency trading (HFT). Retrieved from http://media.futuresmag.com/futuresmag/article/2013/05/31/WFE_Understanding%20HFT_May%202013.pdf

Ye, M., Yao, C., & Gai, J. (2013). The externalities of high-frequency trading. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2066839

Yu, X. (22 August 2013). Regulator to check trading systems. *China Daily*. Retrieved from http://www.chinadaily.com.cn/business/2013-08/22/content_16914484.htm

Ziliak, Z. J., & Brown, M. (2013). Regulation ahead: Advice and options for automated and high-frequency traders. *Bloomberg Law*. Retrieved from http://about.bloomberglaw.com/practitioner-contributions/regulation-ahead-advice-and-options-for-automated-and-high-frequency-traders/