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A PRINCIPLED AND COORDINATED APPROACH

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REGULATING SECONDARY MARKETS IN THE HIGH FREQUENCY AGE: A PRINCIPLED AND COORDINATED APPROACH

Michael Morelli[*]

Technological developments in securities markets, most notably high frequency trading, have fundamentally changed the structure and nature of trading over the past 50 years. Policymakers both domestically and abroad now face many new challenges impacting the secondary market's effectiveness as a generator of economic growth and stability. Faced with these rapid structural changes, many are quick to denounce high frequency trading as opportunistic and parasitic. This article, however, instead argues that while high frequency trading presents certain general risks to secondary market efficiency, liquidity, stability, and integrity, the practice encompasses a wide variety of strategies, many of which can enhance, not inhibit, the secondary trading market's core goals.

This article proposes a regulatory model aimed at maximizing high frequency trading's beneficial effects on secondary market functions. The model's foundation, however, requires information. By analyzing more data on how high frequency traders interact with markets, regulators can assess the viability and scope of other potentially worthwhile measures targeting more general market threats. Likewise, regulators can determine who is in the best position to bear supervisory responsibility for particular trading activities: agencies, exchanges, traders, or some combination thereof. Crucially, the model also calls on regulators to share information on a global scale: trading no longer only affects a single exchange, a single asset class, or even a single country. By sharing information, global regulations become more informed, secondary market stability is enhanced, and regulatory arbitrage is minimized. In short, high frequency trading can be a force for good, but a principled and coordinated effort is required to ensure it fulfills that potential.

INTRODUCTION

High frequency trading (HFT) evokes strong emotions on both sides of the political aisle.[1] New York State Attorney General Eric Schneiderman

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[1] *Compare* Sam Mamudi and Dave Michaels, *Hillary Clinton Steps Into High-Frequency Debate with Tax Plan*, BLOOMBERG (Oct. 8, 2015), *available at* http://www.bloomberg.com/politics/articles/2015-10-08/hillary-clinton-steps-into-hft-controversy-with-tax-proposal; *with* Press Release, Senator John McCain, Statement by Senator John McCain on High-Frequency Trading Controversy (Apr. 1, 2014), *available at* http://www.mccain.senate.gov/public/index.cfm/2014/4/statement-by-senator-john-mccain-on-high-frequency-trading-controversy.

has called HFT "Insider Trading 2.0" [2] while Senator Elizabeth Warren simply labeled it as "wrong."[3] CFTC Commissioner Scott O'Malia, a Republican, also expressed a concern that regulators do not have the tools necessary to supervise modern markets.[4] Given the structural revolution that has taken place in secondary markets over the past 25 years, these reactions are expected. HFT has caused volumes to swell[5] and spreads[6], average trade sizes,[7] and average holding periods[8] to decrease just as dramatically. Investors can buy or sell securities at astounding speeds on trading platforms all across the globe, spurred by technological advancements that have brought market participants closer together than ever before.[9] As HFT firms spend millions of dollars every year to increase the speed at which they can trade,[10] one may worry that trading has become an end in itself, separating itself from the goods-and-services producing economy.

Yet many politicians and regulators forget that algorithmic trading, HFT's predecessor, grew out of perceived necessity. In deciding to

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[2] N.Y. State Att'y Gen. Eric Schneiderman, Remarks on High-Frequency Trading & Insider Trading 2.0, *available at* http://www.ag.ny.gov/pdfs/HFT_and_market_structure.

[3] U.S. Senate, Subcommittee on Securities, Insurance, and Investment, *High Frequency Trading's Impact on the Economy*, Hearing, June 18, 2014 (Serial No. 91-299. Washington: Government Printing Office, 2014 (Senator Warren stating HFT reminded her of "the scam in Office Space" by skimming some money on every trade and hoping one will complain).

[4] *See, e.g.,* Silla Brush, *High-Speed Trades Outpace CFTC's Oversight, O'Malia Says*, BLOOMBERG (May 7, 2014), *available at* http://www.bloomberg.com/news/articles/2014-05-06/high-speed-trades-outpace-cftc-s-oversight-o-malia-says.

[5] *Compare Market Turmoil; Averting Blizzard of Paper*, N.Y. TIMES (Oct. 25, 1987) (observing that trading volumes exceed 20 million shares for the first time) *with* Charles M. Jones, *What Do We Know About High Frequency Trading?* 45 (Mar. 20, 2013) (stating today's markets routinely have a daily volume exceeding one billion orders).

[6] *See* "Equity Market Structure Literature Review Part II: High Frequency Trading by Staff of the Division of Trading and Markets," SEC, March 18, 2014, *available at* https://www.sec.gov/marketstructure/research/hft_lit_review_march_2014.pdf.

[7] *See, e.g.*, Jeremy Grant; *Smaller orders breed dark pools and higher post-trade costs*, FIN. TIMES (Feb. 22, 2010), *available at* http://www.ft.com/intl/cms/s/0/768b4e12-1f52-11df-9584-00144feab49a.html#axzz42Qnky213 (noting average order sizes on the New York Stock Exchange decreased from $19,400 in 2005 to $6,400 in 2010).

[8] *See* SCOTT PATTERSON, DARK POOLS 46 (2012).

[9] At the end of the 1990s, it took 20 seconds to complete a trade. By 2011, that number fell to under 200 microseconds. Now, most trades can be executed in 10 microseconds or less, with further enhancements sure to follow. *See* Andrew G. Haldane, Exec. Dir. Fin. Stability, The Race to Zero, Speech Given at International Economic Association Sixteenth World Congress 4-5 (July 8, 2011).

[10] For instance, in 2010 twenty HFT firms paid an average of $140 million to access an ultra-fast fiber-optic cable connection between exchange servers in New Jersey and Chicago. *See* Alan Tovey, *High-frequency trading: when milliseconds mean millions*, Telegraph (Apr. 2, 2014), http://www.telegraph.co.uk/finance/newsbysector/banksand finance/10736960/High-frequency-trading-when-milliseconds-mean-millions.html.

automate markets, regulators aimed to create and enhance price competition on and between market centers, remedying technological issues that actively inhibited securities exchanges' operations.[11] Regulators viewed algorithmic trading as the glue holding these new markets together, serving to both connect and protect investors in ways human market-makers could not.[12]

In many respects, regulators accomplished these goals. Empirical evidence suggests that HFT, by placing competitive pressure on brokerage fees and spreads, is at least partly responsible for reducing transaction costs.[13] Other studies find that HFT also improves pricing accuracy in secondary markets.[14] By paying constant attention to all order flow in a given security, these studies suggest, HFT can form better estimates of that security's price than can traditional human market-makers. Similarly, there is evidence indicating that HFT's constant buying and selling in the market has bolstered liquidity[15] and reduced overall volatility levels.[16] Taken as a whole, these studies suggest that HFT benefits the broader economy by lowering many issuers' costs of capital.[17]

Not all HFT-related concerns, however, are ill-founded. It is contestable, for instance, that HFT irrefutably improves asset pricing. Many HFT strategies trade based only on short-term, non-fundamental information, meaning they contribute little, if anything, to security price accuracy and allocative efficiency.[18] Meanwhile, HFT's purported liquidity

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[11] *See infra* Part I.A.

[12] *Id.*

[13] *See* Equity Market Structure, *supra* note 6.

[14] *See, e.g.*, Jonathan Brogaard, Terrence Hendershott, & Ryan Riordan, *High-Frequency Trading and Price Discovery*, 27 REV. FIN. STUD. 2267 (2014); Ray Riordan & Andreas Storkenmaier, Latency, Liquidity and Price Discovery, 20-21, 15 J. FIN. MKTS. 416 (2012).

[15] Liquidity refers to the extent the secondary market allows securities to be bought and sold at stable prices. *See* Terrence Hendershott, Charles M. Jones, & Albert Menkveld, *Does Algorithmic Trading Improve Liquidity?*, SSRN (August 30, 2010), *available at* http://pages.stern.nyu.edu/~jhasbrou/Teaching/2014%20Winter%20Markets/Readings/HFT0 324.pdf.

[16] Volatility refers to the frequency and magnitude of stock price fluctuations. Many HFT strategies risk trading with counterparties that possess more or better knowledge about a given security. This threat, known as adverse selection risk, means HFT is generally incentivized to update its orders often to reflect the most current information. In theory, more frequent quoting allows investors to successfully trade at more accurate and stable prices, reducing volatility. *See* Christina McEachern Gibbs, *HFT Does Not Create Volatility*, ADVANCED TRADING (Aug. 6, 2009), *available at* http://www.advancedtrading.com/algorithms/show Article.jhtml? articleID=219500116.

[17] *Id.*

[18] Andrei A. Kirilenko et al., *The Flash Crash: The Impact of High Frequency Trading on an Electronic Market* 37-38 (May 26, 2011) (unpublished manuscript), available at

enhancements are often selective, fleeting, and even illusory. Most HFT firms have no obligation to maintain "fair and orderly markets."[19] Unlike market-makers of the past, HFT firms can withdraw from the market during periods of market stress, causing a dearth of liquidity when most needed.[20] Likewise, studies show that HFT only boosts the liquidity of stocks that were generally liquid to begin with, leaving other securities frustratingly illiquid.[21] Equally concerning, there is a widespread belief that HFT runs unchecked as exchanges cater to its needs at the expense of other investors.[22] This belief has undermined investor confidence, driving some retail investors out of the market entirely.[23]

On a more general level, HFT poses substantial risks to secondary market stability. Regulation National Market System (Reg. NMS), enacted in 2005, purported to establish a single national market system where the shares of any company could trade on any exchange.[24] The new system tried to strengthen, not weaken, markets by increasing transparency, efficiency, and fairness.[25] But as severe market swings, or "flash crashes," become an increasingly regular occurrence, markets appear more interconnected and prone to disruptions than ever before.[26] The effects of these disruptions are not limited to domestic trading, either: as more issuers' cross-list their stocks in multiple countries and more HFT firms establish operations in various jurisdictions, these risks can only increase.

Given how little regulators know about how HFT strategies actually work in practice, addressing these risks is hugely important. But this article argues that this information deficit is also why regulators must proceed cautiously. Though policymakers have made significant efforts to address

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http://papers.ssrn.com/sol3/papers.cfmabstract-id=1686004.

[19] *See, e.g.*, Terrence Hendershott et al., *Does Algorithmic Trading Improve Liquidity?*, 66 J. Fin. 30, 30-31 (2011), *available at* http://faculty.haas.berkeley.edu/hender/Algo.pdf.

[20] *Id.*

[21] *See, e.g.*, Elvis Picardo, *Top Stocks High-Frequecy Traders (HFTs)* Pick, INVESTOPEDIA (June 2, 2014), *available at* http://www.investopedia.com/articles/active-trading/053010/top-stocks-high-frequency-traders-hfts-pick.asp.

[22] *See* Merrin, High Frequency Trading, The Economist (Mar. 7, 2012), http://www.economist.com/debate/days/view/816.

[23] *Id.*

[24] Regulation NMS, Exchange Act Release No. 51,808, 70 Fed. Reg. 37,496 (June 29, 2005) (adopting release).

[25] *See supra* Part I.A.

[26] *See, e.g.*, Dave Michaels, *Exchanges, Regulators Scramble to Fix ETFs After August Rout*, BLOOMBERG (Sept. 17, 2015), *available at* http://www.bloomberg.com/news/articles/2015-09-17/exchanges-regulators-scramble-to-fix-etfs-after-august-rout; Scott Paterson, *Breakdown: A Glimpse Inside the 'Flash Crash'*, WALL ST. J. (June 10, 2012), *available at* http://www.wsj.com/articles/SB100014240 5270230329660457745433006039896.

HFT-related issues already, many are overbroad, target the wrong problems, or overlook ways to harness HFT to improve key secondary market functions. All HFT is not created equal; many HFT strategies, like market-making,[27] improve market stability and benefit investors while other strategies, like momentum ignition and spoofing,[28] are aggressive, predatory, and value-diminishing. Regulators must encourage the former and discourage the latter.

As a first step, regulators must expand their knowledge base. These agencies, as primary market supervisors, must capably and reliably distinguish good HFT from bad. Registering HFT firms, collecting and analyzing more complete trading data, imposing disclosure requirements, and stress-testing HFT strategies are all useful measures that will shed light on increasingly opaque and complex secondary markets. Using this information, regulators can then assess the viability and scope of other potentially worthwhile measures, like adopting on-demand batch auction systems, altering minimum stock tick sizes, dynamically setting maker-taker liquidity rebates, and setting order message limits. Likewise, regulators will be able to determine who can best bear supervisory responsibility for particular HFT activities: agencies, exchanges, other non-HFT traders, HFT firms, or some combination thereof.

U.S. regulators must not hoard this information. It is no coincidence that HFT firms trade cross-listed stocks far more actively than non-cross-listed stocks.[29] As the globalization of secondary markets continues, regulators would be wise coordinate their data-gathering and registration processes, fostering a more comprehensive understanding of exactly how HFT strategies affect investors and global markets. Sharing data will have other beneficial effects as well, like facilitating the quick and effective resolution of cross-border enforcement issues and informing more consistent, high-quality regulations that reduce potential regulatory gaps. Such coordination could also include synchronized responses to severe secondary market disruptions, promoting cross-market stability and reducing systemic risk.

This article proceeds as follows. Part I lays out basic information about markets and HFT for those unfamiliar with the topic, explaining at a high level HFT's historical origins, how modern securities markets work, and how common strategies employed by HFT operate. Part II explains why secondary markets are beneficial to the economy. Based on this discussion,

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[27] *See infra* Part I.C.1.

[28] *See infra* Part I.C.3.

[29] Kiril Alampieski & Andrew Lepone, *High Frequency Trading in UK Equity Markets: Evidence Surrounding the US Market Open*, Working Paper, University of Sydney (2013).

the article establishes principles that should guide regulators as they think through the existing secondary market regulatory framework as it applies to HFT. The article then presents several HFT-related issues implicating these principles. Part III offers critical analyses of current initiatives regulators are considering that try to address each of these issues. Part IV concludes by stressing that regulators will not achieve many of these initiatives absent some level of domestic and international coordination.

I. HIGH FREQUENCY TRADING AND SECONDARY MARKETS

From the outset, it is important to understand how secondary markets work and how HFT fits into their structure. Although the following examples involve stocks, HFT is prevalent in secondary markets for most other asset classes as well.[30] This section demonstrates that regulators viewed algorithmic trading, of which HFT is a subset, as a tool capable of fixing significant market infrastructure issues. Following that, this section describes how modern secondary markets currently function and examines how several commonly employed HFT strategies operate.[31]

A. *Historical Origins of High Frequency Trading*

Before 1975, most equity trading in the United States took place on the New York Stock Exchange (NYSE). The NYSE was composed of brokerage firms who upon joining the exchange as members agreed to trade assigned stocks on commission. These firms employed "specialists" who in turn fulfilled these firms' agreed-on obligation to "maintain fair and orderly" markets, standing ready to buy or sell these stocks throughout the trading day.[32] To this effect, specialists maintained stock inventories and continuously posted quotes of prices at which they were willing to buy or sell.[33] Working as intermediaries, these firms pocketed the spread, or the difference between the prices at which they were willing to buy or sell the

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[30] *See, e.g.*, John Rennison, *High-frequency traders: bond market scourge or saviour?*, Fin. Times (Sept. 1, 2015), *available at* http://www.ft.com/intl/cms/s/0/ab70bdf2-4507-11e5-b3b2-1672f710807b.html#axzz42Qnky213.

[31] For a helpful discussion of some basic vocabulary describing different types of orders and specific services offered by trading venues to these traders, *see* Merritt B. Fox, Lawrence R. Glosten, and Gabriel V. Rauterberg, *The New Stock Market: Sense and Nonsense*, 65 DUKE L. J. [] (2015).

[32] *See, e.g.*, Nan S. Ellis, Lisa M. Fairchild, and Harold D. Fletcher, *The NYSE Response to Specialist Misconduct: An Example of the Failure of Self-Regulation*, 7 BERKELY BUS. L.J. 102, 109 (2010).

[33] *Id.*

stock, as profit.[34]

As members, these firms also agreed to abide by certain operating restraints. One restraint involved fixing minimum commission rates. In the Buttonwood Tree Agreement of 1792, the original pact from which NYSE emerged, members agreed to "not buy or sell from this day for any person whatsoever, any kind of Public Stock at a less rate than one-quarter percent Commission."[35] This structure aimed to reduce competition among its members, although brokers still engaged in other forms of non-price competition like free research or services.[36] Nonetheless, commissions on NYSE remained non-competitive for nearly two centuries.

Starting in the late 1960s, societal and technological forces began exerting pressure on the NYSE business model and pricing structure. First, trading volumes increased exponentially. In 1968, daily trading volume on the NYSE exceeded twenty million shares for the first time.[37] Unfortunately, at that time the NYSE still operated on a paper-based system, meaning traders had to transport physical stock certificates (along with an average of thirty-three administrative forms) from one investor to another after every trade.[38] In the resulting chaos, traders piled documents "halfway to the ceiling"[39] and "stock certificates [were] found everywhere from the women's bathroom to the trash bins."[40] Not surprisingly, stock certificates were often misplaced, resulting in failed orders and lost shares.[41] Eventually, these logistical problems forced traders to end their trading early just to catch up on paperwork.[42]

Second, institutions became the largest owners of equities in the

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[34] *Id.*

[35] *See Gordon v. NYSE*, 422 U.S. 659 (1975) (quoting the agreement).

[36] Over the years, NYSE took aggressive steps to stave off competition amongst its members. For instance, in response to declining trading volumes during the late 1930s, NYSE adopted a rule prohibiting its members from trading in its securities on another exchange. The SEC later issued an order eliminating this rule, maintaining at least some minimal level of price competition with regional exchanges. Re Rules of the New York Stock Exchange 1941 10 SEC 270, 272–3.

[37] *Market Turmoil; Averting Blizzard of Paper*, N.Y. TIMES (Oct. 25, 1987), http://www.nytimes.com/1987/10/25/us/market-turmoil-averting-blizzard-of-paper.html.

[38] David C. Donald, *Heart of Darkness: The Problem at the Core of the U.S. Proxy System and its Solution*, 6 VA. L. & BUS. REV. 41, 50 (2011).

[39] Joel Seligman, *Cautious Evolution or Perennial Irresolution: Stock Market Self-Regulation During the First Seventy Years of the Securities and Exchange Commission*, 59 Bus. Law. 1347, 1366 (2004).

[40] *Market Turmoil*, *supra* note 37.

[41] SEC. & EXCH. COMM'N, STUDY OF UNSAFE AND UNSOUND PRACTICES OF BROKERS AND DEALERS, H.R. DOC. NO. 92-231, at 13 (1971).

[42] Donald, *supra* note 38, at 52 (noting that for the second half of 1968, the NYSE closed on Wednesdays); Seligman, *supra* note 39, at 1366 (stating that in 1968 NYSE ended trading early every day of the week).

United States and began seeking ways to avoid paying NYSE's high fixed commission rates.[43] To meet this demand, "third-market" firms started conducting off-exchange block trades in NYSE securities at discounted commissions.[44] In 1969, Instinet established the world's first electronic market trading platform, allowing brokers to post offers to buy and sell stocks off-exchange and after regular market hours.[45] And in 1971, the National Association of Securities Dealers opened NASDAQ, the world's first electronic exchange. Discarding NYSE's specialist model, NASDAQ embraced competition by creating a system pitting market-makers against each another in an electronic quotation system.[46]

The SEC noted these developments with apprehension. An estimated $4 billion worth of securities had been lost in the NYSE's paperwork turmoil.[47] Ironically, many firms went out of business after they lost too many shares, overburdened by the weight of their own success.[48] While the SEC acknowledged the benefits of price competition, increasing market fragmentation meant that most investors lacked effective access to quote information on emerging trading platforms.[49] As a result, quotes across the market for the same security varied considerably.[50]

Ultimately, the SEC decided to investigate ways it could stimulate competition while also ensuring investors had access to information from all markets. After reviewing the situation, the SEC concluded that a drastic restructuring of markets was necessary. In its 1971 Institutional Investor Study, the SEC recommended to Congress that it "creat[e] of a strong central market system for securities of national importance, in which all buying and selling interest in these securities could participate and be

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[43] INSTITUTIONAL INVESTOR STUDY REPORT OF THE SEC. AND EXCH. COMM'N, H.R. Doc. No.64, 92d Cong., 1st Sess. IX (1971).

[44] Nancy L. Rose, ECONOMIC REGULATION AND ITS REFORM – WHAT HAVE WE LEARNED? 576 (2014).

[45] *See* SCOTT PATTERSON, DARK POOLS 109-11 (2012).

[46] Jerry W. Markham & Daniel J. Harty, *For Whom the Bell Tolls: The Demise of Exchange Trading Floors and the Growth of ECNs*, 33 IOWA J. CORP. L. 865, 899 (2008).

[47] Study of Unsafe and Unsound Practices, *supra* note 37; Donald, *supra* note 2, at 52.

[48] Seligman, *supra* note 39, at 1366 ("SEC Chairman Budge testified, 'brokerage firms [paradoxically were] being forced out of business by having too much business.'"). Approximately 160 firms went out of business from 1969 to 1970. Seligman, *supra* note 35, at 1376.

[49] *See, e.g.*, William J. Casey, Chairman, Sec. & Exch. Comm'n, The Changing Environment for Private Pension Plans, Address at American Pension Conference (Oct. 7, 1971) ("There has been an erosion of the central market. Institutional trading, as it increased in volume, has drifted to the regional and OTC markets and to the third market . . . If you like this, you call it competition. If you don't, you call it fragmentation.").

[50] *See* Institutional Investor Study, *supra* note 43.

represented under a competitive regime."[51] The next year, the SEC again advocated for "[a] system of communications by which the various elements of the marketplace, be they exchanges or over-the-counter markets, are tied together."[52] The SEC soon after issued a detailed policy statement describing how its proposed consolidated transaction system would work. In it, the agency called for the market-wide disclosure of price quotations by exchanges via electronic data feeds.[53] The policy went on to propose an "auction trading rule" that would give price priority protections for all public orders entered into a proposed central electronic repository and a "public preference rule" where public orders entering the repository would have preferential treatment over orders by professionals acting in a principal capacity.[54]

The SEC's efforts culminated in 1975 when Congress amended the 1934 Securities Exchange Act.[55] The amendments, among other things, banned fixed commissions, thus instilling intra-exchange competition on NYSE, and authorized the SEC to develop a national market system akin to the one proposed in its 1973 Policy Statement.[56] The House Report noted that markets were "stunted and distorted" by various practices that "unnecessarily erected barriers to competition [and] insulated markets."[57] Decrying exchanges' outmoded technological setups, the House Report acknowledged a need to correct past practices that had led to "misallocations of capital, widespread inefficiencies, and potentially harmful fragmentation."[58] The Senate Report similarly felt that "new legislation [was] necessary in order to assure investors . . . that our securities markets [remain] vigorous and efficient."[59] The Senate believed "many types of market makers [were] necessary and that encouragement should be given to all dealers to make simultaneous competing markets within the new national system."[60]

NYSE, for its part, begrudgingly accepted the new electronic paradigm. In 1976, the exchange introduced its "designated order turnaround" system (DOT), which delivered orders to trading posts

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[51] *Id.*

[52] SEC, STATEMENT ON THE FUTURE STRUCTURE OF THE SECURITIES MARKET, 7-9 (1972).

[53] SEC, POLICY STATEMENT ON THE STRUCTURE OF A CENTRAL MARKET SYSTEM, 8 (1973).

[54] *Id.*

[55] Exchange Act § 11A(a)(2), 15 U.S.C. § 78k-1(a)(2) (2012).

[56] Exchange Act § 11A(a)(1)(C)(ii), 15 U.S.C. § 78k-1(a)(1)(C)(ii) (2012).

[57] H. Rep. No. 94-123, 94th Cong., 1st Sess. (April 7, 1975) at 49.

[58] *Id.*

[59] S. Rep. No. 94-75, 94th Cong., 1st Sess. (April 14, 1975).

[60] *Id.*

electronically, although physical stock trading still took place on the exchange floor. [61] And in 1978, the SEC approved the NYSE-proposed Intermarket Trading System (ITS) plan that routed orders between various exchange floors.[62] Critically, the ITS plan also included a rudimentary "trade-through" rule prohibiting a participant from trading at an inferior price to that quoted on another participant market without first routing an order to the better market and giving it a minute to respond.[63]

By the 1990s, both NYSE and NASDAQ faced new sources of competitive pressure from novel trading venues called electronic trading communications networks (ECNs). ECNs were computer systems that facilitated trading outside of traditional exchanges or markets.[64] Traders liked ECNs because they provided another source of liquidity, allowed investors to trade after-hours, and generally reduced their costs.[65] The SEC recognized that ECNs acted like markets but was wary of stifling innovation and price competition by forcing them to register as exchanges. Thus, the SEC passed Regulation Alternative Trading System (Reg. ATS) in 1999, subjecting these platforms to certain operating and disclosure requirements, but ones less stringent than those imposed on exchanges.[66] Algorithmic traders, and later high frequency traders, flourished. Spurred by Reg. ATS and the decimalization of stock prices, algorithmic traders began trading more often and in smaller increments, achieving better overall average prices on their large trades. [67]

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[61] FRANK J. FABOZZI, HANDBOOK OF FINANCE, FINANCIAL MARKETS AND INSTRUMENTS 131 (2008).

[62] Exchange Act Releases Nos. 14661 (14 April 1978) and 15058 (11 August 1978).

[63] *Id.*

[64] *See supra* Part I(B)(2).

[65] Michael J. McGowan, *The Rise of Computerized High Frequency Trading: Use and Controversy*, 16 DUKE L. & TECH. REV. 1, 6 (2010).

[66] 17 C.F.R. § 242.300 (1999); *see also* Liz Moyer & Emily Lambert, *Wall Street's New Masters*, Forbes, Sept. 21, 2009 at 40-46, *available at* http://www.forbes.com/forbes/2009/0921/revolutionaries-stocks-getco-new-masters-of-wall-street.html. In 2015, the SEC proposed amendments to Reg. ATS that would dramatically increase the regulatory burdens associated with operating an ATS. If adopted, these trading platforms would be subjected to extensive disclosure requirements and heightened oversight with respect to the design and operations of an ATS by the SEC. *See* Regulation of NMS Stock Alternative Trading Systems, 80 Fed. Reg. 80,998 (proposed Dec. 28, 2015). Regardless of the new amendments, these trading platforms remain an integral part of the modern marketplace: the system has adapted to them, not the other way around.

[67] Before decimalization, stock markets operated on a fractional pricing system. For example, a stock price might be quoted in fractions (e.g., $10 1/8) as opposed to decimals (e.g., $10.12). The SEC expressed concern that fractional pricing caused artificially wide spreads and hindered quote competition. The Commission ordered the exchanges and NASDAQ to implement decimal pricing in 2000, and it was fully implemented in April

The SEC embraced algorithmic trading with enthusiasm, as several exchange-related scandals cast doubt on the integrity of traditional market-maker system. The Odd-Eighths controversy, for instance, developed after two finance professors discovered that NASDAQ dealers were collusively maintaining artificially wide bid-ask spreads on NASDAQ stocks.[68] By only quoting at certain intervals but not others, these market-makers increased the amount they kept as profit on each purchase or sale. In response, regulators passed the Order Handling Rules, which required all brokers to post quotes from competing firms alongside quotes from market-makers on the national system, including those from algorithmic traders.[69] The rules sent a clear message: algorithmic traders could be an effective source of competition for market-makers and could instill more discipline in the overall market system.

The 1975 amendments' vision of was fully realized in 2005 once the SEC approved Regulation NMS (Reg. NMS).[70] Aimed at creating and enhancing competition on and between market centers for order flow, Reg. NMS established an electronic network between all national, or "protected," markets.[71] Reg. NMS included a trade-through prohibition similar to the one enacted in 1978, but now only with respect to automated, as opposed to manual, quotes.[72] Thus, algorithmic traders were essential to Reg. NMS' regulatory design: regulators depended on these traders to submit competing quotes to exchanges across the country. In their mind, these traders would help consolidate order flow, reduce trading and execution costs, and increase market liquidity.[73] Despite its laudatory goals, Reg. NMS also substantially increased market complexity, as shown in the next section.

B. How Modern Securities Markets Work

2001. Commission Notice: Decimals Implementation Plan for the Equities and Options Markets (July 24, 2000), *available at* http://www.sec.gov/rules/other/decimalp.htm.

[68] For more information on this controversy, see *In re NASDAQ Market-Makers Antitrust Litig.*, 169 F.R.D. 493 (S.D.N.Y. 1996); Report Pursuant to Section 21(a) of the Securities Exchange Act of 1934 Regarding the NASD and the NASDAQ Market, Exchange Act Release No. 37,542, 52 S.E.C. 882 (Aug. 8, 1996).

[69] *See* Thomas H. McInish, *The Effect of the SEC's Order-Handling Rules on NASDAQ*, J. FIN. RESEARCH (Sept. 22, 1998). Since NASDAQ market makers routinely dealt with ECNs in private transactions, the rules effectively mandated that NASDAQ display quotes from ECNs, thereby increasing price competition.

[70] Regulation NMS, Exchange Act Release No. 51,808, 70 Fed. Reg. 37,496 (June 29, 2005) (adopting release).

[71] *Id.*

[72] Regulation NMS Rule 611, 17 C.F.R. § 242.611 (2006).

[73] Paul S. Atkins, Commissioner, SEC. & EXCH. COMM'N, Enhancement and Modernization of the National Market System (April 2005).

Three major types of trading venues exist in the United States: registered exchanges, Electronic Communication Networks (ECNs), and Dark Pools. All three types must operate in accordance with Reg. NMS.[74] From a business perspective, a trading platform's profitability largely depends on its ability to attract customer order flow; the more transactions that take place, the more transaction fees they can collect. Advances in telecommunications technology and increasing globalization of capital markets have intensified competition among trading venues for these customers.[75] Consequently, many trading venues view HFT firms as business targets, adjusting their services accordingly.

1. Registered Exchange Trading

As stated, Reg. NMS governs modern exchange-based trading. For current purposes, Rules 603 and 611 are its two most important provisions. Under Rule 603, exchanges must send their best-priced quotations and trade reports detailing the price and size of their latest executed transactions to consolidated data feeds.[76] The data feeds consolidate the data and disseminate it to the public. Put another way, Rule 603 creates a single, national order book that combines all the best quotes across exchanges.

To make this national order book operable, Rule 611 requires that sell orders–regardless of the trading venue to which it was originally sent– execute at a price equal to the national best bid (NBB), or highest available price a buyer is willing to pay, across all registered exchanges.[77] Similarly, a buy order must execute at the national best offer (NBO), or lowest available price a seller is willing to accept. When this does not happen, a "trade-through" occurs.[78]

Most markets are organized as *electronic limit order books*. In these order books, traders provide liquidity by submitting limit orders to buy or sell specific quantities of stock at a specified price, or remove liquidity by sending market orders to buy or sell at the best available prices.[79] When a

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[74] Concept Release on Equity Market Structure, Exchange Act Release No. 34- 61,358, 75 Fed. Reg. 3594, 3606 (Jan. 21, 2010).

[75] Russell, I.C.W., Waitzer, E., March 2, 2012. Should exchanges retain regulatory role in a New Age. Natl. Post. Financ. Post.

[76] 17 C.F.R. § 242.603

[77] *See* 17 C.F.R. § 242.611(a)(1); 17 C.F.R. § 242.600(b) (defining relevant terms).

[78] Rule 611(a)(1) specifically requires a "trading center" to implement policies and procedures that are reasonably designed to prevent these trade-throughs unless such trades fall within one of the exceptions set forth in paragraph (b) of the Rule. *Id.*

[79] Market orders are unconditional orders to buy or sell a security at the best price currently available. Limit orders, in contrast, are conditional orders to buy or sell a security at a given price or better. For example, an investor could submit an order to buy 100 shares

market order arrives, the exchange matches it against a resting limit order. The exchange first prioritizes these orders by price and then, within each price level, by their time of arrival.

For example, imagine John wants to buy 1000 shares of IBM and submits a market order. Gathering all resting limit orders in IBM from all registered exchanges, the Rule 603 order book appears as follows:

BIDS		OFFERS	
PRICE	SHARES	PRICE	SHARES
$40.41	NYSE 200 NASDAQ 200 BATS 100	$40.42	NYSE 300 NASDAQ 200 BATS 100
$40.39	NYSE 200 NASDAQ 100	$40.44	NYSE 300
$40.37	NYSE 300	$40.45	NASDAQ 600
$40.36	NASDAQ 200	$40.46	NASDAQ 200

Here, the NBB is $40.41 for a total of 500 shares and the NBO is $40.42 for a total of 600 shares. Let's assume John submits his order to the NYSE. His order would initially execute for 300 shares at $40.42. Under Rule 611, NYSE would then forward orders for 200 shares to NASDAQ and 100 shares to BATS since shares are available on those exchanges at $40.42. These orders would then execute on those venues at this price. Afterward, NYSE would execute 300 shares at the next price level, $40.44, and forward another order to NASDAQ for the remaining 100 shares at the third price level, $40.45. John's average price would thus be $40.426.

Data latency, however, creates complications. It takes time for quote and execution data submitted by an exchange to reach the consolidated data feed. Thus, quote changes on the national reporting system can lag slightly behind the actual activities on a given exchange. Under Rule 603(a), however, exchanges can distribute customized market data products directly to customers.[80] HFT firms can, by purchasing these products and co-locating their servers close to exchange processing systems, get notice of changes in bids, offers, or executions slightly before the consolidated data feed publically disseminates the information. Given their technological sophistication, HFT firms act on this information before someone like John could even see, let alone react, to it.

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of IBM so long as the price at which they buy is $40 or less. Once the market price reaches $40, the limit order becomes "marketable" and will act just like a market order.

[80] *See supra* note 76.

2. Off-Exchange Trading

ECNs are automated systems that match buyers and sellers directly rather than going through a registered exchange. ECNs, like exchanges, must abide by Rule 611. For instance, in the example from the previous section, let's say John actually wants to buy 10,000 shares of IBM and is willing, given the large size of the order, to execute his trade at $40.52–a price worse than all other quotes currently in the order book. If John is trading on an ECN, the ECN would route limit orders to NYSE, NASDAQ, and BATS to buy at $40.50 or better, which would then execute all 1,700 shares quoted for sale on the exchanges with better prices. The remaining 8,300 shares could then execute against contra-side orders in the ECN at $40.52, bringing John's average price to $40.505.

Dark pools are similar to ECNs except they do not send their best-priced orders for inclusion in the consolidated data feed (thus the "dark" moniker). Dark pools originally drew large institutional investors because of this quote opacity: they could trade large stock positions anonymously, minimizing possible price movements against their trading interests.[81] Current dark pools, however, vary with respect to both who their customers are and what services they offer. Some dark pools, like block crossing networks, offer specialized size discovery mechanisms that focus on bringing large buyers and sellers together.[82] These dark pools are extremely discerning in whom they allow into their systems. Most dark pools, however, primarily execute trades with small sizes comparable to public markets.[83] These dark pools generally match smaller "child" orders that are part of larger "parent" orders and are less discerning as to whom they allow into the pool.[84]

HFT firms like ECNs and dark pools because they often achieve swifter trade execution and lower transaction costs as compared to many exchanges. Specifically with respect to dark pools, HFT firms like their lower fees and pre-trade anonymity. These features put them in better positions to detect large institutional orders and trade against them.[85]

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[81] Concept Release on Equity Market Structure, Exch. Act Release No. 61358 (January 21, 2010).

[82] *Id.*

[83] *Id.*

[84] *Id.*

[85] New York Attorney General Eric Schneiderman filed a civil suit against one of the largest dark pool operators, Barclays, under New York State law. A central allegation was that Barclays misrepresented the level of aggressive HFT activity in its dark pool. One industry observer noted that "[t]he problem [wasn't] that high-frequency trading firms [were] participating in dark pools. That's pretty widely known, it's not necessarily bad and it's happening in most of the major ones. . . . [The] troubling . . . allegation [was] that the

C. Commonly Employed High Frequency Strategies

Although many HFT strategies share common characteristics, HFT has no official definition.[86] Since many of these strategies have different goals and disparate market effects, this is not surprising. As the International Organization of Securities Commissions (IOSCO) recently pointed out, "determining a precise definition may not even be practical for regulatory purposes as it could easily become obsolete or the object of regulatory arbitrage."[87]

Nonetheless, "regulators can find it difficult to draw the line between acceptable trading strategies and manipulation because of the complexity of the strategies."[88] This section clarifies these difficulties by identifying the four most common types of HFT strategies. The first strategy, market-making, is often labeled a *passive* strategy while the latter three are labeled *aggressive* strategies.[89] Passive strategies generally involve injecting liquidity into the secondary market i.e. where HFT

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broker lied to clients about the presence of a big HFT firm." *See* Nicole Bullock, *Momentum Builds for Dark Pool Reform*, Fin. Times (June 26, 2014), *available at* www.ft.com/intl/cms/s/0/6ec5f93efd47-11e3-96a9-00144feab7de.html.

[86] For its part, the SEC offered a characteristics-based description of HFT in 2010:

"[HFT] typically is used to refer to professional traders acting in a proprietary capacity that engage in strategies that generate a large number of trades on a daily basis . . . [o]ther characteristics [include] (1) the use of extraordinarily high-speed and sophisticated computer programs for generating, routing, and executing orders; (2) use of co-location services and individual data feeds offered by exchanges and others to minimize network and other types of latencies; (3) very short time-frames for establishing and liquidating positions; (4) the submission of numerous orders that are cancelled shortly after submission; and (5) ending the trading day in as close to a flat position as possible."

Concept Release on Equity Market Structure, Exchange Act Release No. 34- 61,358, 75 Fed. Reg. 3594, 3606 (Jan. 21, 2010).

[87] IOSCO, July 2011, Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency.

[88] Peter J. Henning, *Why High-Frequency Trading Is So Hard to Regulate*, N.Y. Times (Oct. 20, 2014).

[89] Matthew Baron, Jonathan Brogaard, and Andrei Kirilenko, "Risk and Return in High Frequency Trading," SOCIAL SCIENCE RESEARCH NETWORK, April 2014, *available at* http://dx.doi.org/10.2139/ssrn.2433118 (stating that "Aggressive HFTs earn substantially higher returns than [p]assive HFTs—the average [a]ggressive HFTs earns an annualized alpha of 90.67%, while the average passive firm earns 23.22%—suggesting that there is a stronger profit motive for liquidity taking compared to liquidity provision").

actively posts limit orders.[90] Aggressive strategies, in contrast, involve taking liquidity out of the market i.e. sending orders into the secondary market that are immediately executable.[91]

1. Market-Making Strategies

Market-making strategies inject liquidity into the market by regularly offering to buy or sell a security and then pocketing the difference between the bid and ask prices. These strategies also profit from liquidity-provision rebates offered by trading venues under the "maker-taker" system.[92] Although only amounting to fractions of a cent per share, the cumulative value of these rebates can be substantial.

A market-making strategy's success depends on how fast it can react to new information. As this information arrives, market-makers incur adverse selection risk, or the risk of trading with better-informed market participants and losing money as a result. To mitigate this risk, HFT market-makers expend significant resources to ensure they can consistently position their orders at the top of an order book, often canceling and replacing their resting limit orders in rapid fashion. This also explains why HFT market-makers like specialized order types that allow them to maintain their position toward the front of the order book without directly canceling and replacing their orders.[93]

HFT market-makers often claim their actions are positive because they act as liquidity providers, reducing bid-ask spreads and market

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[90] *Id.*

[91] *Id.*

[92] In the past, many exchanges charged a small fee to both buyers and sellers. Now, most charge a relatively high fee to those traders who submit market orders that execute against resting limit orders (which provide liquidity). These exchanges then rebate most of these fees back to those traders that submit standing limit orders. Some argue the maker-taker pricing system contributes to growing market complexity. *See, e.g.*, Stanislaw Dolgopolov, *The Maker-Taker Pricing Model and its Impact on the Securities Market Structure: A Can of Worms for Securities Fraud?*, 8 VA. L. & BUS. REV. 231, 270 (2014).

[93] One controversial example involves the "Hide-Not-Slide" limit order. Imagine that the NBBO for IBM is again $40.41-$40.42 on NYSE. Further suppose that, for whatever strategic reason, an HFT market-maker wants to put a standing buy order at 2:00 PM at $40.42 on another exchange, such as BATS, and wait until someone hits it. Rule 611 prevents this; it is called "locking" the market. If the order submitted to BATS was a regular limit order, the exchange would "slide" the price back to $40.41. But assume that one minute later the NBBO shifts to $40.42-$40.43. BATS would "slide" the regular limit order price back up to $40.42 and give it a time-stamp of 2:01 PM. A Hide-Not-Slide limit order would work in a similar way, except that the order would have a time-stamp of 2:00 PM, thus giving that order time-based priority in the order book. In 2015, Direct Edge was fined by the SEC for selectively disclosing information about how these orders operated to its members. *In the Matter of EDGA Exchange*, Exch. Act. Rel. No. 74032 (Jan. 12, 2015).

volatility levels. The article discusses these claims in more depth in Part II.B.

2. Arbitrage Strategies

Arbitrage strategies take advantage of price discrepancies between identical or related securities on different markets. *Statistical arbitrage* strategies have always been a common practice and are relatively straightforward: traders try to exploit price differentials between correlated securities across markets. If two securities exhibit consistent trading patterns, statistical arbitrageurs will assess whether an observed divergence is only temporary. If so, then the statistical arbitrageur will trade against the temporary price change and capture the pricing difference once the security reverts to its historical relationship.[94]

Structural arbitrage strategies are a more recent phenomenon. Sometimes called *latency arbitrage*, a simplified example best explains how these strategies work. Revisiting John's quest to buy IBM stock, assume the NBB and NBO remain $40.41 and $40.42, respectively. Next, assume that the NYSE receives a buy order for 300 shares at $40.42 that executes. At the same time, a new limit order boosts the NYSE's best bid to $40.43, meaning its best bid-ask quote is now actually $40.43-$40.44. HFT firms, with their fast connection speeds and sophisticated algorithms, will quickly perceive and react to this new order. They will buy all the shares on NASDAQ and BATS at $40.42 and immediately sell them on NYSE for $40.43. Traders quickly exploit these price differentials, which usually only last for fractions of a second.[95] Estimates calculate that trading on these advantages accounts for upwards of $21 billion in profit per year[96], although competition has reduced that number significantly.[97]

Statistical arbitrage is relatively uncontroversial. Such arbitrage is generally considered beneficial because they fight pricing discrepancies, facilitate price discovery, and improve market efficiency. Commentators, however, have criticized latency arbitrage as having only a mixed effect on market liquidity and market efficiency[98] and spurring unnecessary and undesirable investment in faster connectivity and order processing

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[94] Jonathan Brogaard et al., *High Frequency Trading and Price Discovery*, European Central Bank Working Paper Series 1, 5 (Nov. 2013).

[95] Diego Leis, *High Frequency Trading: Market Manipulation and Systemic Risks from an EU Perspective* 76 (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2108344.

[96] Matt Prewitt, *High-Frequency Trading: Should Regulators Do More*, 19 MICH. TELECOMM. & TECH. L. REV. 131 (2012).

[97] *Id.*

[98] *Id.*

technology.[99]

3.   Directional/Predatory Strategies

Directional strategies look to profit from anticipated securities price movements. One type of directional strategy called *momentum ignition* consists of entering orders or a series of orders, perhaps combined with spreading false rumors in the marketplace, to get other market participants to trade. These orders ignite rapid price movements up or down. Another type of directional strategy, called *spoofing* or *layering*, involves submitting a series of orders also intended to induce a rapid directional price movement. If successful, the HFT firm will establish an early position in the security, profiting when the price of the security moves in the desired direction and the firm liquidates its position.

A related third strategy, called *quote stuffing*, places many orders and then cancels them almost immediately.[100] These strategies aim to slow down the market, giving the HFT firm a speed advantage. The sheer number of orders slows down the national limit order book, creating an artificial arbitrage opportunity.[101] The HFT firm's position also gains a functional speed boost relative to other HFT firms that need to sort through and analyze all the fake quotes.[102] In some egregious cases, an HFT firm may try to quote-stuff an entire exchange to have more time to capitalize on cross-exchange price differences.[103]

These strategies are all heavily criticized for their rapid trading, short holding periods, and generally non-beneficial effects on market liquidity or price discovery. The difficulty, from a practical standpoint, is

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[99] Larry Harris, *Stop the high-frequency trader arms race*, FIN. TIMES (Dec. 27, 2012), http://www.ft.com/cms/s/0/618c60de-4b80-11e288b500144feab49a.html#axzz42b H3x6JS.

[100] Adam Adler, *High Frequency Regulation: A New Model for Market Monitoring*, 39 VM. L. REV. 161, 172-73 (2014).

[101] *Id.*

[102] *Id.*

[103] The CFTC and Department of Justice recently charged an HFT firm for violations involving a quote stuffing strategy. The firm, Panther Energy Trading, had an algorithm that would send "ping," or test, orders into the market to see if its strategy would work. The algorithm would then place several layers of orders on the opposite side of the market from the targeted trade to create the illusion of market interest. The quote orders would typically be placed near, but not at, the prevailing market price. The illusion of interest created, the price of the stock would then move toward the targeted price. *U.S. Commodity Futures Trading Commission v. Eric Moncada et al.*, Case No. 12 CV 8791 (S.D. New York Dec. 4, 2012); *United States v. Coscia*, No. 14-CR-00551 (N.D. Ill. Oct. 1, 2014).

distinguishing manipulative patterns from legitimate ones when the volume and frequency of trading is so high.

4. Liquidity Detection Strategies

Liquidity detection strategies try to find and trade against large institutional orders. HFT firms will repeatedly submit small-sized orders intended to detect large orders from institutional investors. Based on intelligence gathered from this process, these strategies can then trade ahead of large orders under the assumption that the large order will move the market's pricing of the security to their benefit.

One particularly contentious application of the strategy involves "flash orders." Flash orders act as an exception to Rule 611 of Reg. NMS: instead of immediately rerouting an unmatched order, an exchange can "flash" the order at the NBBO price to participating traders for a brief period, usually between 30 and 500 milliseconds, who then can choose whether they want to trade against it before it is routed.[104] Some traders and industry observers believe flash orders constitute a form of illegal front-running, arguing that it gives a small subset of traders with non-public information and thus giving them an unfair opportunity to act on that information.[105] Others counter that these traders are only trading on public information and thus should remain legal.[106]

D. High Frequency Trading in Global Markets

HFT is not a U.S.-specific phenomenon. With their sophisticated order processing and communications systems, HFT firms can trade in almost any market across the globe. Driven by competitive and technological pressure from off-exchange trading platforms, many exchanges converted from quasi-public entities to for-profit companies. This process, known as demutualization, allowed exchanges to merge with domestic and foreign counterparts to get more companies to list securities

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[104] Lawrence Harris & Ethan Namvar, The Economics of Flash Orders and Trading 4 (Jan. 15, 2011) (unpublished manuscript) (on file with the Medoza College of Business, University of Notre Dame), *available at* http://business.nd.edu/uploaded Files/Academic_ Centers/Study_of_Financial_Regulation/pdf_and_documents/SSRN-id1953524.pdf.

[105] *See* Elimination of Flash Order Exception from Rule 602 of Regulation NMS, 74 Fed. Reg. 48,632, 48,636 (proposed Sept. 23, 2009) ("The Commission also is concerned that flash orders may create a two-tiered market in which the public does not have access, through the consolidated quotation data streams, to information about the best available prices for listed securities.").

[106] Committee on Capital Markets Regulation, *What is High Frequency Trading* (Dec. 12, 2014).

on their exchanges, increase order flow, and generate more transaction fees.[107]

At the same time, trading in cross-listed securities has increased. Many jurisdictions and exchanges allow companies to list their securities on exchanges in multiple countries so long as the issuer meets certain listing standards and adheres to each country's relevant regulations. In the United States, the most common way of doing so is through American Depository Receipts (ADRs). Simply put, U.S. banks buy foreign shares in bulk from a foreign company, bundle them into groups, and then reissue them as negotiable interests on a U.S. exchange. ADRs and their foreign analogs offer HFT firms arbitrage opportunities. Cross-listed stock prices on a foreign exchange might diverge from the home exchange price for a variety of technical reasons. Exchange price ADRs, for instance, in U.S. dollars. The dollar price of the ADR will usually differ from the home market price due to exchange rates. Because the strategy is so simple, these opportunities disappear quickly. These reasons incentivize HFT firms to continue investing substantial resources toward bolstering the speed and adaptability of their trading systems.

Issuers, investors, and exchanges have flocked to cross-listed securities. As of January 2016, NYSE lists 513 foreign companies from 46 different countries, with trading in those securities accounting for approximately 17% of total volume.[108] HFT firms have shown a particular propensity to target these securities, with one study finding that HFT participation at the start of U.S. trading was 10% greater in cross-listed than non-cross-listed stocks.[109] Consequently, many exchanges now have extended hours to account for trading in cross-listed securities.[110]

II. ESTABLISHING AN EVALUATIVE FRAMEWORK

A. Guiding Principles

Now that the reader has a basic understanding of the history and structure of secondary markets, we can establish guiding principles regulators can consider as they grapple with HFT-related issues. In doing so, it is important to consider, as an initial matter, why secondary markets

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[107] *E.g.*, Nina Mehta and Nandini Sukumar, *Intercontinental Exchange to Acquire NYSE for $8.2 Billion*, BLOOMBERG (Dec. 20, 2012), http://www.bloomberg.com/news/articles/2012-12-20/intercontinentalexchange-said-in-merger-talks-with-nyse-euronext.

[108] Daily NYSE Group Volume in NYSE Listed 2016, NYSE (Feb. 29, 2016), http://www.nyxdata.com/nysedata/asp/factbook/viewer_edition.asp?mode=table&key=3141&category=3.

[109] *See* Alampieski, *supra* note 29.

[110] *Overview of Major World Exchanges' Trading Hours*, HK EXCH. (July 2011).

exist to begin and what functions they perform.

Secondary markets are essential tools for promoting economic growth, namely by pricing and re-pricing new assets quickly, accurately, and fairly.[111] Secondary markets lower transaction costs by establishing a forum where investors can trade their securities on-demand. Thus, established secondary markets should induce investors to make more trades, thereby generating prices that are more accurate. In turn, more accurate stock prices should lower issuers' costs of capital since investors, assured that they can resell their investments at these prices, will demand lower rates of return.[112] Consequently, investors can readily determine the value of their investments and creditors to evaluate the creditworthiness of their borrowers.

Secondary markets also serve as important liquidity mechanisms.[113] Primary market investors are less willing to contribute capital if it is difficult to exit their positions in the future. Secondary markets alleviate this issue by reducing the costs that every investor would otherwise incur finding contra-parties to their later securities transactions. In this sense, liquidity promotes allocative efficiency: more liquidity makes it less costly to sell securities in the future, meaning investors demand a lower return when initially purchasing the securities.[114] Similarly, liquidity reduces volatility: the more available shares there are, the lower the risk that severe price swings will occur during periods of market stress. This is important because a security's price reflects the market's confidence in the issuer's management. Higher volatility, therefore, may indicate higher riskiness, possibly translating to higher costs of capital.[115]

Secondary markets also protect investors. Capital from investors encourages innovation, promotes competition, and spurs job creation throughout the economy. If assured markets will treat their later transactions fairly, investors will be more willing to make these contributions. Organized secondary markets help investors achieve this peace of mind through rules prohibiting fraudulent trading and banning manipulation of securities prices.[116] Other rules target other aspects of fairness, like requiring trade executions at fair prices, mandating market participants keep records of their activities, and demanding prompt dissemination of pricing information.[117]

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[111] Merritt B. Fox, Lawrence R. Glosten, and Gabriel V. Rauterberg, *The New Stock Market: Sense and Nonsense*, 65 DUKE L. J. [] (2015).

[112] *Id.*

[113] *See* Hendershott, *supra* note 15.

[114] LAWRENCE E. HARRIS, TRADING AND EXCHANGES 214-15 (2002).

[115] *Supra* Fox at note 111.

[116] *See, e.g.*, Securities Exchange Act § 9, 15 U.S.C. § 87 (2012).

[117] *See* Regulation NMS, *supra* note 25.

Two major developments underscore investor protection's importance. First, more Americans are putting their personal wealth and retirement savings into securities. Between the mid-1970s and the late 1990s, the share of household financial assets held in bank deposits fell, while that in mutual funds and securities jumped from 22% in 1975 to 42% in 1999.[118] Consequently, rising ownership rates expose more households to large market swings. Second, while many recent technological innovations in markets have been pro-investor, they also created new risks.[119] As the nature of securities trading continues to change, we must assure investors that the market protects their interests.

HFT has advanced each of these functions. Research shows that some HFT strategies, such as market-making and arbitrage, help detect pricing anomalies and therefore stabilize markets.[120] Other studies suggest that HFT has lowered transaction costs and increased certain measures of liquidity.[121] And with respect to investor protection, abuses akin to the Odd-Eighths controversy have all but disappeared.

But HFT also risks inhibiting these functions if not properly managed. Accordingly, regulatory responses should focus on how to harness HFT to improve these functions without sacrificing market integrity or stability. In doing so, HFT regulation should pursue three primary goals:

1. Promote the secondary market's performance of its key functions, recognizing that HFT is a broad and diverse category of trading that many historically thought benefitted secondary markets in key ways;
2. Foster confidence in the secondary market by protecting participants from emerging risks associated with HFT;
3. Minimize the chance that systemic, HFT-induced events interrupt the market's performance of these functions.

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[118] To a large extent, this shift stemmed from several financial innovations, like money market mutual funds and Individual Retirement Accounts, which opened up previously closed-off investing opportunities to Main Street America. *See* John V. Duca, *The Democratization of America's Capital Markets*, FED. RES. BANK (2007), https://www.dallasfed.org/assets/documents/research/efr/2001/efr0102b.pdf.

[119] *See* Staff of the Division of Trading and Markets, U.S. Securities and Exchange Commission, "Equity Market Structure Literature Review, Part I: Market Fragmentation," at 7 (October 7, 2013) (discussing risks associated with increasing market fragmentation).

[120] "U.S. Department of the Treasury, Office of Financial Research 2013 Annual Report," December 2013, *available at* http://www/treasury.gov/initiatives/ofr/about/Documents/OFR_Annual Report2013_FINAL_12-17-2013_Accessible.pdf.

[121] "Equity Market Structure Literature Review Part II: High Frequency Trading by Staff of the Division of Trading and Markets," SEC, March 18, 2014, *available at* https://www.sec.gov/marketstructure/research/hft_lit_review_march_2014.pdf.

B. Problematic Issues with High Frequency Trading

Applying these principles, HFT raises important issues. While this article separates these concerns into four broad (and overlapping) categories, in a sense they are all indicative of a more general dissociative problem. Exchanges serve to promote business investment by assuring investors that they can always sell their shares at a published price. Today, however, the act of trading is increasingly becoming an end in itself, operating to separate itself from the goods-and-services producing part of the economy.[122] Officials worry that trading volume is "unrelated to the fundamentals of the company that's being traded."[123] As Professor Harris astutely points out, HFT trading profits persistently and disproportionally accumulate to a handful of HFT firms, creating what many consider a winner-takes-all industry.[124] Decreasing competition means that trading costs and the average cost of capital will rise.[125] We must question whether the increasingly large sums spent by HFT firms to boost their trading speeds produce worthwhile social benefits.[126]

1. Price Accuracy and Allocative Efficiency Concerns

One worry is that HFT harms the secondary market's pricing function by trading based on short-term statistics unrelated to the fundamental value of a given security.[127] At the end of World War II, investors held a US stock, on average, for four years. In 2008, that average time had fallen to two months. By 2011 – 22 seconds.[128] These trading patterns, officials fear, obfuscate rather than clarify the financial health of the issuer in the eyes of investors.[129] Rather than contributing new information to stock prices, HFT might actually drive it further away from its fundamentals-based price

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[122] *See* Tor Brunzell, *High-Frequency Trading–To Regulate Or Not to Regulate–That Is the Question*, 2 J. Bus. & Fin. Aff., no. 1 (2013) (noting that in October 2008, one HFT firm traded over 2 billion shares in a single day).

[123] *See* David S. Hilzenrath, *High-Frequency trading raises concerns at SEC*, Wash. Post (Feb. 22, 2012), *available at* https://www.washingtonpost.com/business/ economy/ high-frequency-trading-raises-concerns-at-sec/2012/02/22/gIQAfpLdTR_story.html.

[124] Larry Harris, *Stop the high-frequency trader arms race*, FIN. TIMES (Dec. 27, 2012), http://www.ft.com/cms/s/0/618c60de-4b80-11e288b500144feab49a.html#axzz42b H3x6JS.

[125] *Id.*

[126] In the HFT world, these sums are worth it: a one millisecond advantage in trading could be worth an extra $100 million in annual profit. Patterson, DARK POOLS 287-8 (2012).

[127] Kirilenko et al., *supra* note 18.

[128] Patterson, DARK POOLS 46 (2012)

[129] *See, e.g.*, Hilzenrath, *supra* note 123.

(unlike long-term investors who analyze and trade based on the underlying value of the stock), ultimately impeding allocative efficiency.

Evidence provides mixed support for these claims. On an intraday basis, HFT arbitrage strategies, with their rapid execution speed, respond to news ahead of other investors and potentially make stock prices reflect new information more quickly.[130] HFT's long-term effect on price accuracy is less clear. Some studies suggest that HFT-initiated price movements often have more lasting, long-term effects than price movements initiated by non-HFT traders.[131] Other research, however, shows that HFT activity hampers price discovery by making markets "too efficient," causing stock prices to move excessively in the direction of fundamentals-related news and ultimately harming longer-term price discovery.[132]

These studies, however, do not distinguish between the many types of HFT strategies and their differing effects on price discovery. Market-making strategies, for instance, tend to benefit price discovery more than other, more aggressive strategies.[133] And while arbitrage strategies trading a single security across multiple markets can help price discovery, other arbitrage strategies, like latency arbitrage, may instead be harmful.[134] Similarly, one study found that many HFT strategies tend to place buy (sell) market orders just before an increase (a decrease) in the market valuation of assets, suggesting HFT strategies that use market orders possess and act on fundamentals-related information.[135] In contrast, HFT firms buy (sell) limit orders tend to execute when market valuations are falling (increasing), suggesting that HFT strategies relying on limit orders are trading based on more speculative, non-fundamentals-related information. At least with respect to price discovery, these types of trading patterns are less socially beneficial.[136]

The better question, therefore, asks to what extent HFT firms use these latter parasitic strategies, since such trading could result in prolonged deviations from fundamental values and undermine conditions necessary for

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[130] *See* Concept Release on Equity Market Structure, Exchange Act Release No. 34-61,358, 75 Fed. Reg. 3594, 3608 (Jan. 21, 2010) (stating HFT arbitrage activity "often may contribute to the quality of price discovery in a stock").

[131] Jonathan Brogaard et al., *High Frequency Trading and Price Discovery* 26-28 (July 30, 2012) (unpublished manuscript), *available at* http://ssm.comlabstract=1928510.

[132] *See* X. Frank Zhang, High Frequency Trading, Stock Volatility, and Price Discovery 33-35 (2010) (unpublished manuscript), available at http://papers.ssrn.com/sol3/papers.cfm?abstractid=1691679.

[133] *See* Tech. Comm. Of the Int'l Ord. of Sec. Comm'ns, Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency 26 (2011), at 25.

[134] *See* Prewitt, *supra* note 96.

[135] *See* Brogaard, *supra* note 131.

[136] *Id.*

markets to generate and synthesize information.[137] Specifically, if HFT reduces information-based trading's profitability, traders have no incentive to generate it. Consequently, if large traders are unable to hide their trades from parasitic HFT strategies, this trading harms long-term market efficiency by repressing the market's information-generation function.[138]

2.   Selective Liquidity and Volatility Concerns

While it is generally undisputed that HFT has contributed to narrower bid-ask spreads and lower transaction costs for many securities and investors,[139] evidence suggests that HFT-provided liquidity is often selective and fleeting. As an example, HFT firms may simply stop providing liquidity or suddenly engage in liquidity-taking trades, especially during periods of market stress.[140] Even if HFT remains in the market, HFT contributes deceptively little to the depth of shares available. Many HFT strategies submit quotes for relatively small amounts of shares, rapidly canceling and replacing them with new ones in order to adapt to changing market conditions and maintain favorable positions in order books.[141] When spreads were wider, average trade sizes used to be in the thousands. In 2015, the average trade size was only 160-180 shares.[142] Put another way, Rule 611 enables situations where HFT market-makers may quote narrow spreads but remain unwilling to buy or sell sizeable quantities at those prices. HFT exacerbates these issues by displacing other kinds of liquidity suppliers, like traditional market-makers, who might have been willing to effect larger transactions.[143]

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[137] *See* Charles R. Korsmo, *High-Frequency Trading: A Regulatory Strategy*, 48 UNI. RICH. L. REV. 523, 573 (2014).

[138] *Id.*; *see also* Daniel R. Fischel & David J. Ross, *Should the Law Prohibit "Manipulation" in Financial Markets?*, 105 HARV. L. REV. 503, 509-10 (1991) ("Traders must be allowed to disguise their trades to avoid disclosing the information they possess to other traders.").

[139] *See, e.g.*, Terrence Hendershott et al., *Does Algorithmic Trading Improve Liquidity?*, 66 J. FIN. 30, 30-31 (2011).

[140] Albert J. Menkveld, *High Frequency Trading and the New-Market Makers* 27 (Feb. 6, 2012) (unpublished manuscript), *available at* http://ssm.com/abstract=1722924.

[141] Gary Stone & Sanghyun Park, *As Odd-Lots Report to Tape, Average Trade Size Declines Again*, BLOOMBERG (Mar. 4, 2014), http://www.bloombergtradebook.com/blog /odd-lots-average-trade-size-declines-again/.

[142] *Id.*

[143] Because of their speed advantage, HFTs can supply liquidity on better terms than slower traders. This creates an adverse selection problem for slow liquidity suppliers, who can be crowded out of the market by HFTs. *See* Jonathan Brogaard, *High Frequency Trading and its Impact on Market Quality*, Working Paper, NORTHWESTERN UNI. (2010).

Moreover, HFT-driven liquidity gains are generally limited to certain blue-chip stocks that already had relatively high liquidity levels.[144] HFT firms, like all traders, prefer securities with narrow spreads and heavy trading volumes since these characteristics reduce their own liquidity risk. However, while aggressive traders typically like to trade in securities with high volatilities (large price swings mean more profit opportunities), most HFT actually prefers *lower* volatility securities because their strategies depend on making small profits with near certainty. Similarly, while a typical trader might be indifferent to a security's price, the maker-taker rebate system incentivizes HFT firms to trade in lower-priced securities since rebates are based on the *number of shares traded*, not the *total amount traded*. In short, any liquidity gains are likely isolated to securities least in need of the boost. Empirical evidence supports these claims. One study found that while standard measures of market liquidity improved after the introduction of HFT strategies for stocks with large capitalizations, there was no significant effect on market liquidity for stocks with small capitalizations.[145] Another study, examining algorithmic more generally, similarly found that its beneficial effects on liquidity accrued mainly to stocks with large capitalizations and low volatility.[146] In contrast, algorithmic trading appeared to decrease liquidity for small cap stocks and not affect the liquidity of high-volatility stocks.[147]

On the other hand, it is unclear whether HFT-provided liquidity actually increases or decreases volatility. One study, looking at the foreign exchange market, found that despite high correlations among HFT strategies, no causal relationship existed between HFT trading and exchange rate volatility.[148] In another study, researchers found HFT was in fact associated with higher levels of volatility. Analyzing the trading activity of thirteen NASDAQ stocks subject to a ban on short-selling for three weeks in September and October 2008, the study found that HFT-associated trading volume fell sharply for those stocks compared to unaffected stocks.[149] Generalizing the short-sale ban as a negative shock to HFT activity, the study concluded that stocks in which short-sales by HFT firms were most affected (relative to other stocks) experienced relatively

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[144] *See* Picardo, *supra* note 21.

[145] *Id.*

[146] Ekkehart Boehmer, Kingsley Fong, and Juan Wu, *International Evidence on Algorithmic Trading*, Working Paper, EDHEC (2012).

[147] *Id.*

[148] Alain Chaboud, et al, *Rise of the Machines: Algorithmic Trading in the Foreign Exchange Market*, 69 J. FIN. 2045, 2084 (2009).

[149] Jonathan Brogaard, Terrence Hendershott, and Ryan Riordan, *High Frequency Trading and Price Discovery*, Working Paper (2013).

greater increases in volatility, consistent with HFT's general negative effect on volatility overall.[150]

Even if we assume that HFT has generally reduced volatility at the individual security level, it likely increased volatility at the macro level.[151] One study found that higher trading volumes could destabilize market conditions and produce "volatility above and beyond that based on fundamentals."[152] Interestingly, the study also suggested that there was an inflection point at which an increase in trading volume increases volatility such that only a small circle of investors benefit.[153] Instead, overall benefits to investors "dominate at low to medium levels of trading."[154] In a similar vein, Andrew Haldane recently pointed to the danger of normalizing deviance at the micro level, concluding that "thinner technological slices may make for fatter market tails. Flash Crashes, like car crashes, may be more severe the greater the velocity."[155] That the 2010 Flash Crash started in the E-Mini S&P 500 futures market, one of the most liquid in the world, seems only to add force to Mr. Haldane's argument.

3.   Market Stability and Systemic Risk Concerns

Systemic risk can refer to many things, but in this article, it refers to the possibility that a certain contingency, event, or series of events could severely disrupt market operations. Using this definition, HFT increases systemic risk by making markets less resilient to serious market shocks. First, Reg. NMS has made stock markets more interdependent and correlated.[156] Many HFT firms employ similar strategies, suggesting that shocks hitting a few active HFT firms can have knock-on effects detrimentally affecting multiple exchanges, trading platforms, and investors.[157] The effects may not be limited to one particular asset class: HFT also exacerbates price shocks between derivatives and their underlying assets, between stocks and their ETFs, or between foreign stocks and their

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[150] *Id.*

[151] Didier Sornette and Susanne von der Becke, *Crashes and High Frequency Trading*, Swiss Fin. Inst. Research Paper No. 11-63 (2011).

[152] Ilia Dichev, Kelly Huang, and Dexin Zhou, *The Dark Side of Trading*, Emory L. & Econ. Research Paper No. 11-95 (2011).

[153] *Id.*

[154] *Id.*

[155] Andrew Haldane, *Race to Zero*, Speech at Int. Econ. Ass'n Sixteenth World Congress, Beijing, China (2011), http://www.bankofengland.co.uk/publications/speeches /2011/speech509.pdf.

[156] Kristin Forbes and Roberto Rigobon, *No Contagion, Only Interdependence: Measuring Stock Market Co-Movements*, 57 J. FIN. 2223 (2002).

[157] Brogaard finds that NASDAQ HFTs tend to place market and limit orders in the same direction over various time intervals. *See* Brogaard, *supra* note 149.

corresponding ADRs. This makes markets co-move together, implying higher levels of systemic risk.[158]

Second, HFT firms rely on pre-programmed algorithms to make thousands of trading decisions every second based on many assumed market conditions. Small programmatic errors or changes in trading conditions can affect HFT algorithms in unexpected ways, leading to potentially significant trading errors and major disruptions across multiple markets.[159] This is a particular worry with algorithms interpreting qualitative data since it is harder for them to determine whether it contains mistakes or errors. Again, it is extremely difficult for HFT firms, let alone regulators, to isolate and correct their strategies on a real-time basis since these strategies can place orders in multiple venues across different markets.[160]

Third, even if HFT does not cause a particular market disruption, these strategies can still exacerbate its effects. HFT firms have no market-making obligation to maintain "fair and orderly markets."[161] Consequently, HFT firms, especially those using aggressive or predatory strategies, can freely withdraw from the market during periods of stress, resulting in a dearth of liquidity at critical junctures. These market exits in turn risk transmitting illiquidity across markets, increasing systemic risk.[162]

4. Investor Protection and Market Integrity Concerns

The directional strategies outlined in Part I.C.3 illustrate how certain HFT strategies can exploit and harm other traders.[163] It is an open debate, however, as to exactly which investors these strategies harm the most. One study found that on a per contract basis, traders who focused on company-specific events when determining whether to buy or sell a stock (i.e. fundamentals traders) incurred the least cost to HFT whereas small traders incurred the most.[164] The study also noted that the fundamentals traders were more likely to be large institutions while the small traders were more likely to be retail investors.[165] Blackrock, in contrast, asserted that HFT generally does not affect retail investors since their orders are small and

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[158] *See* Forbes & Rigobon, *supra* note 156.

[159] *See* Bernard S. Donefer, *Algos Gone Wild: Risk in the World of Automated Trading Strategies*, 5 J. TRADING 31 (2010).

[160] *Id.*

[161] *See* Patterson, DARK POOLS 260-77 (2012).

[162] Kirilenko, *supra* note 18.

[163] *See Moncada, supra* note 103.

[164] *See* Baron, *supra* note 89.

[165] *Id.*

usually filled completely and immediately at the NBBO.[166] In a similar vein, other studies concluded that institutional investors, at least when trading against *order anticipation* and *momentum ignition strategies*, incurred higher transaction costs than retail investors.[167] Another framing of the issue differentiates between fundamentals and non-fundamentals traders. Short-term HFT strategies are more prone to herd to the same information, driving a security's price further away from the price dictated by its fundamentals.[168] Put differently, the more momentum traders there are, the more likely it is a security's price will diverge from its fundamentals and the less likely it is that fundamentals trader will be successful.

Despite this mixed empirical evidence, the widespread belief that HFT operates unchecked has decreased investor confidence. Fear of manipulative HFT has driven some retail investors out of the market. For instance, a recent poll of consumer confidence found that only 15% of respondents "trust[ed]" stock markets.[169] Alarmingly, many also feel that HFT is responsible for creating a "two-tiered" secondary market.[170] HFT firms often pay exchanges huge sums to get direct access to their trade data and place their servers near to their order processing servers, known as colocation.[171] Many market centers also give HFTs customized order types that help these trading strategies work more effectively.[172] Several of these order types, harm market transparency, increase market complexity, and create situations where certain HFT strategies can unfairly exploit non-HFT investors.

Professor Korsmo has defended the current market structure by pointing to its more "democratic" virtues. Anyone can get open access to co-location, data feeds, and specialized order types if they are willing to pay for them, resulting in a system which is "far more 'democratic' than what came before."[173] He further points to decreasing HFT profits as markets

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[166] Blackrock, "US Equity Market Structure: An Investor Perspective," at http://www.blackrock.com/corporate/en-es/literature/whitepaper/viewpoint-us-equity-market-structure-april-2014.pdf.

[167] Lin Tong, *A Blessing or a Curse? The Impact of High Frequency Trading on Institutional Investors*, Euro. Fin. Ass'n 2014 Paper Series (Oct. 13, 2015).

[168] Ken Froot, David Scharfstein, & Jeremy Stein, *Herd on the Street: Informational Inefficiencies in a Market with Short-Term Speculation*, 47 J. FIN. 1461 (1992).

[169] Merrin, *supra* note 22.

[170] *See* Bullock, *supra* note 85.

[171] *See, e.g.*, Keri Geiger and Sam Mamudi, *High-Speed Trading Faces New York Probe Into Fairness*, BLOOMBERG (Mar. 18, 2014), http://www.bloomberg.com/news/articles/2014-03-18/high-speed-trading-said-to-face-n-y-probe-into-fairness

[172] Patterson, DARK POOLS 48-49

[173] *See* Korsmo, *supra* note 137.

adapt to its presence.[174] These arguments, however, do not negate the need to boost investor confidence. Policymakers must root out remnants of unfairness to ensure investors continue participating in the capital-raising process.

III. HFT REGULATION GOING FORWARD

The landscape surrounding HFT is fluid. Global regulators have enacted, proposed, or considered a wide range of measures targeting several of the problems discussed in Section II, with more now under consideration. This section describes several of the measures in-depth, identifying whether they adequately address HFT-related issues and recommending which ones policymakers should keep, adopt, alter, or discard going forward.

A. Measures Addressing Price Accuracy and Efficiency Issues

Any plan to regulate HFT must encourage those HFT strategies that promote effective price discovery and discourage those that do not. As a starting point, HFT strategies primarily relying on market orders will impute more information into securities' prices than those primarily relying on limit orders. Nonetheless, HFT strategies that heavily rely on market orders may damage the market in other ways, such as by trading against standing limit orders and decreasing overall liquidity levels. In short, any solution needs to maximize the market order's benefits while minimizing its potential costs, thus ensuring that securities' trading continues to be based on fundamentals analysis rather than pure speed. Put another way, HFT strategies that depress investment in generating and acting on new information should be discouraged, while those boosting such investment should be encouraged.

1. Minimum Resting Times

Minimum resting times specify a time that a limit order must remain in force. Theoretically, these delays increase the likelihood that a viewed quote is available to trade and provide better estimates of current market prices. Similarly, by making the limit order more risky from an adverse selection standpoint, minimum resting times reduce manipulative strategies' profitability while simultaneously incentivizing HFT firms to submit orders reflecting more fundamentals-based information. SEC Chair Mary Jo White has expressed qualified support for minimum resting times, arguing they

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[174] *Id.*

would curb the excessive use of canceled orders by HFT firms.[175]

The broadness of these proposals present certain dangers. Professors Fox, Glosten, and Rauterberg for instance, chastise minimum resting times for ignoring the many legitimate reasons why HFT strategies rapidly cancel orders beyond electronic front-running.[176] Beyond this, it is unclear that minimum resting times would achieve regulator's desired effects. These limits inhibit arbitrage between markets and products at least to some extent, diminishing efficient price discovery. Similarly, instead of receding to the background, new types of manipulative strategies would operate at slower, but just as harmful, intervals.

Minimum resting times would have other harmful effects as well. For instance, preventing limit orders from being canceled means that such orders are in constant danger of becoming stale and subject to adverse selection. Aggressive HFT strategies would submit market orders to execute against stale standing limit order and immediately sell the shares at a higher price. The aggressive market order thus profits at the expense of the limit order, leading liquidity providers to increase spreads to hedge this additional risk. Since market orders are typically more impactful with respect to price, decreased liquidity leads to larger price changes when a particularly aggressive market order hits the market. Thus, it is not surprising that other jurisdictions, like Australia and Europe, have rejected minimum order resting times.[177]

2. Minimum Order-to-Execution Ratios

Minimum order-to-execution ratios impose limits on a trader's ability to send orders to the market. Once they hit the ratio's limit, these traders would need to participate in a trade before submitting any new orders. The potential benefits of these ratios mirror those of minimum resting times: the limit order book would be more stable since it would be harder to cancel orders, providing the market with better, more accurate

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[175] "Enhancing Our Equity Market Structure. Speech by SEC Chair Mary Jo White before Sandler O'Neill & Partners, L.P. Global Exchange and Brokerage Conference," June 5, 2014, *available at* http://www.sec.gov/News/Speech/Detail/Speech/137054200431 2#.U5hzaihCw40.

[176] *See* Merritt B. Fox, Lawrence R. Glosten, and Gabriel V. Rauterberg, *The New Stock Market: Sense and Nonsense*, 65 DUKE L. J. [], 51 (2015).

[177] Adam Haigh, *ASIC Scraps Minimum-Resting-Time Plan for Equity Trade Orders*, BLOOMBERG (May 29, 2013), http://www.bloomberg.com/news/articles/2013-05-30/asic-scraps-minimum-resting-time-plan-for-equity-trade-orders; Philip Stafford and Alex Barker, *EU Clampdown on 'flash boy' traders turns* technical, FIN. TIMES (Apr. 14, 2014), http://www.ft.com/intl/cms/s/0/40afcd9c-c3e3-11e3-870b00144feabdc0.html#axzz41r4Gr RSS.

price estimates. But unlike minimum resting times, traders wishing to submit limit orders are not forced into a situation where they face adverse selection risk. So long as the trader remains below the ratio, they can cancel these orders at any time, meaning there is a smaller windfall to predatory HFT strategies using market orders.[178]

One concern is that these ratios would also affect other beneficial HFT trading strategies. Again, Fox et al note that HFT firms revise quotes for many non-manipulative purposes.[179] Statistical arbitrage strategies, for example, naturally trigger cancellations and resubmissions to reduce price discrepancies, and a restrictive minimum order-to-execution ratio would be stifling. And as with minimum resting times, certain order-to-execution ratios could cause ETF and derivatives valuations to become unaligned due to this decreased arbitrage activity, resulting in less accurate prices and efficiency losses.

Similarly, an overly restrictive ratio would undermine other market functions. Many algorithmic trading strategies seek to reduce trade execution costs by splitting large orders into smaller pieces and sending orders both spatially and temporally to markets.[180] As orders execute or languish, the execution strategy recalibrates, leading to cancellations and resubmissions. This trading approach reduces costs for traders and leads to greater efficiency in execution; improperly restricting its use would likely lead to higher spreads. More generally, too low a ratio will result in traders sending fewer limit orders to the market, reducing overall liquidity.

Thus, regulators can choose between two approaches. First, the ratio could be set relatively high. This reduces the likelihood that the ratio improperly inhibits good HFT, though any efficiency gain would be relatively inconsequential. Second, regulators could differentiate order-to-trade ratios based on strategy and historical trading activity. This option would depend on regulators getting more information from HFT firms through registration, discussed in Part III.C.3. Fox et al do not consider whether more HFT-related trade data would lead to more informed ratios.[181] But it seems that, after gathering this data, regulators could effectively charge both exchanges and HFT firms with setting and enforcing reasonable and appropriate order-to-execution ratios during various market conditions based on trading patterns and strategy. Such an obligation would result in

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[178]J. Doyne Farmer and Spyros Skouras, "Minimum resting times and transaction-to-order ratios: review of Amendment 2.3.f and Question 20," U.K. GOV'T OFF. SCI. (2012), *available at* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289047/12-1064-eia2-minimum-resting-times-and-transaction-order-ratios.pdf.

[179] *See* Fox, et al, *supra* note 176.

[180] *Id.*

[181] *Id.*

more tailored regulation, preserve regulatory resources, and ensure beneficial HFT strategies can continue to operate freely.

3. Frequent and On-Demand Batch Auctions

One of the more intriguing proposals being considering involves replacing the current continuous trading system with frequent batch auctions. Professors Budish, Cramton, and Shim, for instance, recently produced a plan whereby trading would consist of sealed-bid auctions conducted at discrete time intervals, e.g. every second.[182] They argue that continuous time auctions consistently create opportunities for latency arbitrage since there will always be a benefit to being at the top of the order book.[183] As a result, the status quo rewards HFT firms that continuously flood securities markets with orders because the emphasis is on speed and not price. In contrast, batch auctions would process orders received during a fixed time interval simultaneously, meaning "if multiple traders observe the same information at the same time, they are forced to compete on price instead of speed."[184] Similarly, since batch auctions make it more difficult for HFT strategies to determine if the trading venue will execute their order, each trade would be slightly riskier. Thus, batch auctions would incentivize HFT firms to make more trades based on information related to a security's fundamentals and dissuaded from engaging in other aggressive strategies that add little to price discovery. Perhaps most importantly, the market structure would no longer incentivize HFT firms to invest as many resources in speed-focused technologies that contribute little social benefit.

Many jurisdictions are seriously considering similar versions of these frequent batch auctions. The London Stock Exchange, for instance, tested a midday auction program in its most liquid securities.[185] The SEC recently also approved the Chicago Stock Exchange's plan to launch a batch-auction platform called CHX SNAP.[186] At least in the U.S., these auctions face significant implementation hurdles. Specifically, it is unclear how multiple discrete batch auctions would interact with each other under existing U.S. law. The United States, like most equity markets, imposes an obligation on broker-dealers to obtain "best execution" for their clients.[187]

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[182] *See* Eric B. Budish, Peter Cramton, & John J. Shim, *The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response*, Fama-Miller Working Paper; Chicago Booth Research Paper No. 14-03 (December 23, 2013).

[183] *Id.*

[184] *Id.*

[185] Press Release, London Stock Exch., London Stock Exchange To Launch Midday Auction (Nov. 11, 2014) (on file with author).

[186] *See* Securities Exchange Act Release No. 75346 (July 1, 2015), 80 FR 39172.

[187] Best execution refers to the responsibility of brokers to provide the most

Rule 611 of Reg. NMS forces broker-dealers to first route an order to an exchange providing the NBBO, partially assuring best execution. Exchanges post quotes in continuous limit order books, making it possible for broker-dealers to make sure they submit an order to the venue with the best price at a particular time. In contrast, a multiple exchange, frequent batch auction system would determine prices only at the end of a batch interval, meaning a broker-dealer cannot know in advance which venue will yield the best price.[188]

Even assuming the SEC could modify Reg. NMS, every exchange would need to run its auctions simultaneously to completely shift HFT competition from speed to price. Absent such coordination, idiosyncratic latency arbitrage opportunities across markets and products could still arise. For instance, a stock's batch auction processing time would need to be synchronized with the processing times of its associated derivatives. Similarly, latency arbitrage could still occur with respect to ETFs. Every ETF's batch auction would also need to be synchronized with each of its component stocks, an almost impossible feat.

Synchronized batch times would not be desirable from an efficiency standpoint, either: optimal batch trading intervals, at least with respect to liquidity, vary by security. [189]   And from a systemic risk standpoint, synchronized markets would be more interconnected and more susceptible to system-wide disruptions than ever before. Disruptions in one market (e.g. the equities market) could spill over into other markets (e.g. the options or futures market) with more rapidity and frequency.

Nonetheless, variations on the Budish et al auction model could complement and improve continuous trading dynamics. One possible solution would involve making batch auctions an on-demand function limited to large trades. PDQ, an alternative trading system, currently uses a trader-initiated auction system for orders of 2,500 shares or more.[190] The system negates synchronization problems and protects large institutional orders from predatory, latency-exploitive HFT strategies. As an example, John submits a market or marketable limit order to PDQ to buy 4,000 IBM

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advantageous order execution for their customers. *See* Securities Exchange Act Release No. 34902 (Oct. 27, 1994), 59 FR55006, 55007 at n.15 (Nov. 2, 1994).

[188] Markus Baldauf and Joshua Mollner, *Competition among Exchanges*, Working Paper (Jan. 8, 2014), *available at* https://www.owen.vanderbilt.edu/faculty-and-research/upload/JMP_baldauf.pdf.

[189] Daniel Fricke and Austin Gerig, *Too Fast or Too Slow? Determining the Optimal Speed of Financial Markets*, DERA Working Paper Series (2013), *available at* http://www.sec.gov.edgekey-staging.net/dera/staff-papers/working-papers/dera-wp-optimal-speed.pdf.

[190] *Auction1 On-Demand Auctions from PDQ ATS*, PDQ (Dec. 17, 2014), http://www.pdqats.com/wp-content/uploads/2013/10/Auction1_2014_WEB.pdf.

shares. Over the next five to 20 milliseconds, depending on how fast John wishes his execution to be, PDQ solicits liquidity for the trade by sharing only the stock's name with liquidity providers, keeping order direction, size, and price hidden. The trading venue would aggregate contra-side orders submitted by HFT liquidity providers in response to the solicitation at specific price levels at or within the NBBO. The auction is then processed, and 3,500 shares execute at these prices. The remaining order for 500 shares, depending on John's preferences, will either remain on the order book until the next IBM auction, be routed to another exchange for execution, or cancelled.

Expanding these auctions to exchanges would present significant, but not insurmountable, technical obstacles. On-demand batch auctions assume this order book's existence to determine at what prices these auctions can clear. But under current rules, on-demand auction runners would need to disseminate auction orders to the national limit order book and include them in the NBBO, despite these quotes not being immediately executable or available to everyone. In response, crafty HFT strategies might send orders to both the auction and the continuous order book to shift the NBBO in a particular direction.

To fix the latter problem, auction orders should have to meet minimum size thresholds (e.g., 500 shares) and be un-cancelable. If the auction time is short enough, these restrictions make it extremely risky for traders to try to manipulate the NBBO, especially without knowing the size or direction of the auction trade. With respect to the former problem, exchanges should still transmit these quotes to the market but tag them as auction orders. The SEC could then establish a Rule 611 exception exempting these orders from inclusion in the NBBO calculation.[191]

This proposed exemption would be appropriate because on-demand auctions have characteristics of a slow market. A slow market occurs when an exchange does not execute trades in a particular security at the fastest possible speed. Currently, Rule 611 only protects quotations that are at the top of the book and immediately accessible electronically, meaning slow market quotes are not included in the NBBO.[192] Since auction orders are also not immediately accessible or executable, it makes sense to exclude these submitted quotes from the NBBO as well. The NBBO would still protect auction execution prices and eliminating the reverse fear of trading through the rest of the market.

The SEC originally enacted Rule 611 to incentivize exchanges to become electronic and automated, ensuring investors always received the

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[191] 17 C.F.R. § 242.611(d).
[192] 17 C.F.R. § 242.611(a).

best possible price.[193] While on-demand auctions detract from Reg. NMS' historical vision of universal "fast" markets to some extent, they give HFT liquidity providers more incentives to compete based on price, while the continuing availability of a continuous market ensures that traders can still get immediate execution when needed. They also ensure that markets for different but related securities like equities, derivatives, futures, and ETFs can continue to operate independently. Regulators would not need to make any radical changes to Reg. NMS either, since the national limit order book would still drive trading both inside and outside of these auctions. In short, on-demand auctions promote Rule 611's true purposes, price protection and increased competition.

Admittedly, getting HFT firms to engage with these systems might be challenging so long as continuous order systems exist. This would be undesirable because non-aggressive HFT order flow benefits non-HFT traders via liquidity promotion and price competition. Auction-runners can address this problem in two ways. First, auction runners could give HFT firms with higher liquidity rebates when their orders execute in a batch auction. This solution is not entirely satisfactory; it would increase market complexity, skew broker-dealer incentives with respect to best execution, and fail to discourage HFT firms from inundating the auction platform with quotes (although restricting their ability to cancel submitted orders might). A better approach would piggyback off an HFT algorithm registration proposal, discussed later in the article, whereby firms would register specific algorithms with a regulator. As part of this process, the regulator would only allow passive market-making HFT algorithms to enter these auctions. If enough institutional trading activity migrates to on-demand auctions, research suggests HFT will follow.[194]

B. Measures Addressing Liquidity and Volatility Issues

As discussed, evidence suggests that HFT's benefits are limited to certain measures of liquidity and volatility in particular trading environments, and even then only with respect to specific types of securities.[195] Regulators must determine how HFT can best increase liquidity and reduce volatility when and where it is most needed.

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[193] *See supra*, Parts I.A & B.

[194] Elaine Wah, Dylan Hurd, and Michael Wellman, *Strategic Market Choice: Frequent Call Markets vs. Continuous Double Auctions for Fast and Slow Traders* (Aug. 2015), *available at* https://web.eecs.umich.edu/srg/?page_id=1666.

[195] *Supra* Part II.B.2.

1. Financial Transaction Taxes

Many scholars and government officials of note, including Joseph Stiglitz and Hillary Clinton, have suggested that regulators should consider imposing a small tax on every order.[196] Financial transaction taxes, just like other taxes, reduce the amount of the taxed activity. Thus, a financial transaction tax would theoretically discourage frivolous orders and encourage traders to base their trades on a stock's fundamentals, not their short-term price movements.[197] Proponents say the tax would limit the effectiveness of manipulative HFT strategies, discourages excessive investment in financial market infrastructure, and encourages market participants to shift towards longer-term investment strategies where the tax consequences will be inconsequential.[198] As of 2014, 11 of the 28 European Union countries had agreed to adopt a version of these taxes, joining many other jurisdictions in Asia, Africa, and North America.[199]

Financial transaction taxes can generate, however, substantial economic distortions and unintended consequences, the most obvious being that they could increase the cost of funding for the real economy.[200] Similarly, market actors might simply pass these costs to consumers, meaning the financial transaction tax is essentially a tax on consumers. Even if jurisdictions pass targeted taxes imposed only on firms that have excessively high order-trade ratios, HFT firms could avoid the tax by relocating their operations to another exchange in another jurisdiction.[201] In short, policymakers should shelve the financial transaction tax given the practical and political difficulties involved in setting up a global tax and the availability of other effective but less contentious policy options.

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[196] *See, e.g.,* Jennifer Epstein, *Hillary Clinton to Propose High-Frequency Trading Tax, Volcker Rule Changes*, BLOOMBERG (Oct. 7, 2015), http://www.bloomberg.com /politics/articles/2015-10-08/hillary-clinton-to-propose-high-frequency-trading-tax-volcker-rule-changes; Steve Matthews, *Stigliz Calls High-Speed Trading "Front Running," Suggests Tax*, BLOOMBERG (Apr. 15, 2014), http://www.bloomberg.com/news/2014-04-15/stigliz-calls-high-speed-trading-front-running-suggests-tax.html.

[197] *See, e.g.,* John Fullerton, *High-frequency trading is a blight on markets that the Tobin tax can cure*, The Guardian (Apr. 4, 2014), http://www.theguardian.com/business/economics-blog/2014/apr/04/high-frequency-trading-markets-tobin-tax-financial-transactions-algorithms.

[198] *Id.*

[199] *Id.*

[200] Zsolt Darvas and Jakob Von Weizsacker, *Financial Transaction Tax: Small is Beautiful*, BRUEGEL POL. CONTRIBUTION (Feb. 2010), *available at* http://aei.pitt.edu/12885/1/pc_tobintax_080210.pdf.

[201] *See infra* Part IV.

2. Small-Cap Tick Size Pilot Program

Since evidence shows that HFT has only boosted liquidity for certain securities, regulators are considering ways to harness HFT to increase liquidity on a broader basis. The SEC's Small-Cap Tick Size Pilot Program is one such experiment. Starting in May 2016, the SEC will run a test program to see whether trading small cap stocks in wider increments would improve liquidity for these stocks. The test will temporarily undo the effects of "decimalization," or trading in penny increments, for this part of the market.[202]

The pilot program will include stocks of companies that have market capitalizations of $3 billion or less, average daily trading volumes of one million shares or less, and a volume weighted average price of at least $2.00.[203] The SEC will place 1,400 stocks in a control group that will still trade in penny increments. One separate test group will include stocks quoted in $0.05 increments but capable of being traded at any price, while a second control group will include stocks that will be both quoted and traded in $0.05 increments. A final test group will test the "trade-at" rule, requiring trades be executed on an exchange unless other non-exchange venues (e.g., dark pools and ECNs) offer a "meaningfully" better price.[204]

The conceptual foundation of the rule is quite clear. The current one-size-fits-all tick size regime subjects small issuers to the same trading framework as large, multinational companies with much higher trading volumes and market caps. Instead, regulators and exchanges should tailor trading regimes to the liquidity needs of the issuer. Wider tick sizes result in wider spreads, making it more costly to trade. At least with respect to small cap stocks, higher costs might lead to increased efforts by both human and high frequency traders to capture the spread, in turn adding more bids and offers to the order book. Deeper books increase liquidity, incentivizing investment banks to underwrite more IPOs and fund more research coverage. Of course, if regulators set the minimum tick size too high, trading activity could migrate towards off-exchange trading venues. The trade-at rule, however, ensures that more trading in these securities happens on exchanges, improving transparency and price discovery.

Most existing literature examining the effect of tick sizes on trading

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[202] *See* Plan to Implement a Tick Size Pilot Program Submitted to the Securities and Exchange Commission Pursuant to Rule 608 of Regulation NMS under the Securities Exchange Act of 1934 (as modified by the Commission), *available at* http://www.sec.gov/rules/sro/nms/2015/34-74892-exa.pdf.

[203] *Id.*

[204] *Id.*

pre-dates HFT's rise in the marketplace.[205] Theoretically, however, HFT firms are attracted to stocks with smaller tick sizes because there are more increments in which a share can move, thus producing more trading opportunities. Wider tick sizes make it more expensive for HFT firms to enter and exit a given trading position, meaning HFT strategies dealing in these stocks would likely slow down: HFT would send fewer quotes to the market, but HFT would likely not cancel and replace these quotes as often.[206] Whether this would improve or hurt liquidity in these securities is an empirical question, one pilot program data might help answer.

But why limit the pilot program to small-cap stocks? Many large cap stocks rarely, if ever, trade at penny increments. Why not explore different tick sizes for these stocks as well? For that matter, why base tick-sizes off capitalization at all? Exchange-led self-regulatory initiatives in Europe, for instance, have largely harmonized tick sizes based on price levels.[207] The European Commission's MiFID II proposal formalizes this framework by basing tick size on share price and other liquidity factors based on the average number of trades per day.[208] The system's aim is to find a better compromise between the liquidity pooling in tick-size buckets while maintaining enough granularity to avoid long trading queues. Since evidence suggests that HFT's liquidity benefits do not extend to high volatility stocks regardless of their capitalization, the SEC should at least investigate a similar approach.[209]

3. Market-Making Obligations

These obligations would require a trader acting as a market-maker to post prices to buy and sell at competitive levels at all times a trading venue is open regardless of market conditions.[210] HFT firms currently have no regulatory obligation to make markets.[211] Exchanges have some market-

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[205] For one of the few empirical studies on the topic, *see* Alex Frino, Vito Mollica, and Shunquan Zhang, *The Impact of Tick Size on High Frequency Trading: Evidence from Stock Splits*, MACQUARIE GRAD. SCHOOL MGMT. (2015), http://sfm.finance.nsysu.edu.tw/php/Papers/CompletePaper/051-827862218.pdf.

[206] *Id.*

[207] Sviatoslav Rosov, *2 Fast 2 MiFID: What Does Brussels Have in Store for HFT*, CFA INST. (Oct. 19, 2015), https://blogs.cfainstitute.org/marketintegrity/2015/10/19/too-fast-to-mifid-ii-what-does-brussels-have-in-store-for-hft/.

[208] *Id.*

[209] *See* Brogaard, et. al, *supra* note 149.

[210] Oliver Linton, Maureen O'Hara, and J.P. Zigrand, "Economic impact assessments on MiFID II policy measures related to computer trading in financial markets," U.K. GOV'T OFF. SCI. (2012), *available at* https://secure.fia.org/epta-downloads/Economic-Impact-assessments-on-MiFID-2-policy-measures_083012.pdf.

[211] Liz Moyer, *High-Frequency Firms Urge SEC to Add to Market-Makers'*

making rules but "no true affirmative quoting or trading requirements."[212] Even in the limited circumstances where market participants had to enter quotes, "the current system led to practices like 'stub-quoting,' in which a trader quotes way outside the price range of a particular stock just to meet minimal market making requirements."[213]

An obligation could take multiple forms: HFT market-makers could be required to remain in the market for a certain length of time during the trading day, quote securities of a minimum market capitalization, and/or quote prices that are at or within an exchanges best bid and offer for a minimum percentage of the trading day.[214] Obligations to set competitive prices could help reduce volatility, both on an individual and system-wide level. Requirements to stay in the market continuously, meanwhile, could improve liquidity provision by ensuring security prices remain actively quoted during periods of market stress. To the extent that these obligations improve the depth of the market through minimum quote size requirements, traders will also find it easier to buy and sell, lowering transaction costs and bolstering liquidity.

Nonetheless, market-making is not a costless enterprise. All market-makers face a variety of situations where posting quotes exposes them to the risk of large losses. These costs are exacerbated for HFT strategies that conduct cross-market and cross-product trading. Historically, market-maker rules aimed to give market-makers certain economic and market structure benefits to compensate them for the risk inherent in their market-making obligation. To the extent that rules impose market-making obligations without corresponding compensation, at least some market makers will exit, reducing liquidity.

Similarly, market-making during stressful conditions is extremely risky. Requiring HFT market-makers to buy when prices are crashing may also result in them exiting the market, but this time not on their own accord.[215] More significantly, any HFT market-making obligations face

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Obligations, Forbes (Jul. 13, 2010), http://www.forbes.com/sites/streettalk/2010/07/13/high-frequency-firms-urge-sec-to-add-to-market-makers-obligations/#775bc43e29bb

[212] *Id.*

[213] *Id.*

[214] As an example, the European Commission's MiFID II proposal requires member states to guarantee its regulated markets have in place written agreements with all investment firms pursuing a market-making strategy. Under the proposal, these obligations will be triggered when firms dealing in their own account post simultaneous two-way quotes of comparable size and competitive prices in at least one security on one trading venue for at least 50% of daily trading hours. These agreements must obligate the market-maker to continue quoting in this manner, although they can also state that market-makers may exit the market during "exceptional circumstances," which are left up to individual trading venues to determine.

[215] The MiFID II proposal wisely allows market-makers to exit the markets during

significant definitional issues. What exactly would it mean to maintain "quotes" in the market? If the definition is too vague, HFT firms could simply evade the requirements by posting one quote on the side of the market on which it wishes to take a position and posting another on the other side away from competitive prices (called "stub quotes"). In other words, the quality of liquidity would not improve. And finally, as Fox et al note, "historical evidence suggests that strong paper obligations have proved insufficient in the past to motivate market makers to continue supplying liquidity during periods of extreme volatility," suggesting that any obligation would be near impossible to enforce.[216]

It is telling, however, that major HFT firms have urged the SEC to impose stricter market-making obligations.[217] These firms acknowledge that "additional market maker obligations will significantly reduce the chance of another destabilizing event," suggesting the costs of a well-defined obligation would not be prohibitively high.[218] To that effect, regulators should require HFT firms qualifying as market-makers to quote at or inside the NBBO for a certain percentage of the trading day based on the price, liquidity, and volatility characteristics of the security. These characteristics should also be used to set minimum quote size (e.g. 200, 500, or 1000 shares) and market depth obligations (e.g. 3-5 price levels below the applicable price obligation). There should similarly be a maximum quote length requirement to fix issues with stub quotes. Finally, to remedy Fox et al's enforcement concerns, trading venues could compensate HFT firms for their increased market-making by modifying their maker-taker systems, discussed below.

4. Dynamic Maker-Taker Fees

Another intriguing option involves altering the existing maker-taker fee programs offered by most trading venues.[219] Many have criticized the

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"exceptional circumstances" as determined by individual trading venues. *See* Tony Katz and Puesan Lam, *MiFID II: Microstructural Issues*, DLA Piper (Oct. 2015), *available at* https://www.dlapiper.com/~/media/Files/Insights/Publications/2015/10/DLA%20Piper_MiFID%20II_Microstructural%20Issues_October%202015.ashx.

[216] *See* Fox, et. al, *supra* note 176.

[217] *See* Moyer, *supra* note 211.

[218] *Id.*

[219] *See* Joe Ratterman, Chief Executive Officer, & Chris Concannon, President, BATS, "Open Letter to U.S. Securities Industry Participants Re: Market Structure Reform Discussion," at 3-4 (Jan. 6, 2015), *available at* http://cdn.batstrading.com/resoureces/newsletters/OpenLetter010615.pdf (discussing BATS' suggested tiered approach to access fees).

current maker-taker system on conflict of interest,[220] market transparency,[221] and market complexity[222] grounds. Accordingly, most calls for reform in this area either propose lowering the maker-taker fee cap,[223] currently set at $0.003 per share,[224] or outright prohibiting the payment of rebates altogether.[225] Both sets of proposals, however, overlook the potential of dynamically-set fees. By making them more customizable, exchanges could incentivize liquidity provision at key times. For instance, Blackrock, the world's largest asset manager, recently suggested that highly-liquid securities might not need as high a rebate compared to less liquid securities, and therefore fees should be limited to thinly-traded securities.[226] Similarly, allowing larger maker-taker fees for categories of illiquid, small-cap stocks, like the pilot small-cap tick-size program, will make capital raising easier for small businesses, benefitting the overall economy. Still, trading platforms would need to take care when considering the appropriate maker-taker fee tiers. For example, BATS recently proposed segmenting maker-taker fees based on a variety of security-specific and factors, including its average daily volume, market capitalization, inclusion in certain broad market indices, security type, or some combination thereof.[227] For its part, the SEC is also considering a pilot program aimed at assessing the effect of maker-taker fees and their alternatives on certain stocks.[228]

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[220] *See, e.g.*, Letter from Sen. Carl Levin (D-MI), to Mary Jo White, Chair, SEC (July 9, 2014), *available at* www.hsgac.senate.gov/download/levin-letter-to-sec-chairman-mary-jo-white-re-equity-market-structure-july-15_2014; Letter from Charles Schumer (D-NY), to Mary Schapiro, Chair, SEC (May 10, 2012), *available at* http://www.schumer.senate.gov/record.cfm?id=336748&.

[221] *See, e.g.*, Stanislav Dolgopolov, *The Maker-Taker Pricing Model and its Impact on the Securities Market Structure: A Can of Worms for Securities Fraud?*, 8 VA. L. & BUS. REV. 231, 270 (2014).

[222] *Id.*

[223] *See* Larry Tabb, "The Grand Bargain: A Great Start, But Don't Hold Your Breath," Tabb Forum (Jan. 6, 2015), *available at* http://tabbforum.com/opinions/the-grand-bargain-a-great-start-but-don't-hold-your-breath.

[224] *See* 17 C.F.R. 242.610(c).

[225] *See, e.g.*, Robert Battalio, Shane A. Corwin, and Robert Jennings, "Can Brokers Have it All? On the Relation Between Make-Take Fees and Limit Order Execution Quality," at 2 (Mar. 31, 2015), *available at* papers.ssrn.com/sol3/papers.cfm?abstract_id=2367462&download=yes.

[226] *See, e.g.,* BlackRock Inc. Viewpoint, U.S. Equity Market Structure: An Investor Perspective, at 7 (Apr. 2014), *available at* https://www.blackrock.com/corporate/en-us/literature/whitepaper/viewpoint-us-equity-market-structure-april-2014.pdf ("The value of liquidity and therefore the need for incentives andrebates is not the same across all stocks. Regulators should review whether highly liquid stocks require any rebates at all.").

[227] *See supra* at note 201.

[228] U.S. Senate, Subcommittee on Securities, Insurance and Investment, *Regulatory*

Unfortunately, the BATS model would substantially increase market complexity.[229] A recent study by the Royal Bank of Canada found that there already were 839 different fee schedules across U.S. exchanges.[230] Even assuming that regulators or exchanges could determine an optimal fee structure, a dynamic fee structure requires vigilant monitoring by trading venues, which would be costly. Regardless of the cost, a dynamic system does not necessarily alleviate fears that certain HFT strategies will game these systems, causing periodic artificial drops in liquidity. Part of the problem is that markets have gotten so complex so quickly, they left regulators in the rearview mirror. At this stage, allowing exchanges to tier their fees would only complicate matters further.

Nonetheless, commentators have paid relatively little attention toward altering the maker-taker system during periods of high volatility and low liquidity. The structure could give exchanges the choice of increasing the size of these fees after, say, trading trips a circuit breaker or exceeds a limit-up limit-down band.[231] If the maker rebates were high enough, they would incentivize HFTs to make markets instead of fleeing markets entirely. Although still increasing market complexity somewhat, exchanges would retain discretion as to whether to activate the altered fees, meaning regulators would control the complexity instead of the other way around. Over time, as regulators and exchanges learn more about how HFT operates, they can set an optimal level of fees, harnessing HFT's benefits while minimizing its detrimental effects. For these reasons, a maker-taker fee pilot program would be a useful step in the right direction.

C. Measures Addressing Market Stability Issues

To deal with issues related to market stability and systemic risk, regulators must focus their efforts on maintaining HFT's presence in the market. The market-making obligations and dynamic maker-taker fees discussed above would go a long way towards accomplishing this. Still,

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Reforms to Improve Equity Market Structure, Hearing, March 3, 2016 (Serial No. FILL IN). Washington: Government Printing Office, 2016 (SEC Director of Trading and Markets Stephen Luparello indicating that the SEC would implement a maker-taker fee pilot program if its Equity Market Structure Advisory Committee recommended such action).

[229] *See* Jeffrey Sprecher, Chairman and Chief Executive Officer, ICE, Statement to the U.S. Senate Banking, Housing and Urban Affairs Committee, Hearing on "The Role of Regulation in Shaping Equity Market Structure and Electronic Trading," (Jul. 8, 2014) (stating that maker-taker pricing should be banned because it adds to market complexity).

[230] *See* Nathaniel Popper, *Stock Exchange Prices Grow So Convoluted Even Traders are Confused, Study Finds*, N.Y. Times (Mar. 1, 2016).

[231] *See infra* notes 232 and 233.

regulators must gather more details regarding how HFT designs their strategies and under what conditions they are most vulnerable to malfunctions. Regulators must also investigate ways in which they can effectively manage HFT-induced market interdependence and correlations without unduly hampering the benefits of inter-exchange price competition.

The SEC has already taken several steps in this area, most notably by revamping single-stock circuit breakers[232] and instituting the Limit-Up Limit-Down Rule.[233] The SEC also passed Regulation Systems and Compliance and Integrity (Reg. SCI) in 2014, imposing stringent compliance and monitoring requirements on most trading platforms.[234]

Observers like Professor Korsmo place great faith in these measures' effectiveness, noting "circuit breakers [and the limit-up limit-down mechanism] are the most straightforward way[s] to prevent a repeat of the major dislocations of the Flash Crash."[235] Similarly, Professors Fox, Golsten, and Rauterberg enthusiastically endorse both measures as "moderate proposals which should have salutary effects in moderating future crashes."[236]

Yet despite their seemingly simple and uncontroversial natures, both measures have significant shortcomings. Circuit breakers are blunt tools that are artificially set and often overly broad.[237] The Limit-Up Limit-Down

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[232] Under these circuit breakers, trading in most stocks is paused across U.S. equity markets for a five-minute period if that the stock experiences a significant price decline over the preceding five minutes (10%, 20%, or 30%, depending on the stock). In 2012, the SEC altered the program by, among other things, decreasing the market decline thresholds and extending the length of the trading halt. *See* Order Granting Accelerated Approval to Proposed Rule Changes Relating to Trading Pauses Due to Extraordinary Market Volatility, Exchange Act Release No. 34-62,252, 98 SEC Docket 2160 (June 10, 2010).

[233] Under the rule, these price bands are calculated (and recalculated at throughout the trading day) for each security at a percentage above and below the security's average price over the prior five minutes of trading. Trading cannot occur outside of these price bands. For more liquid stocks, the percentage level for the price band is five percent while the percentage level for most other stocks is 10%. The rule includes several exceptions, the most notable of which is the doubling these price bands during the opening and closing periods of the trading day. *Id.*

[234] The regulations also require these trading venues to promptly disclose technology problems to the SEC when they occur. Regulation SCI does not impact HFT directly but does force trading venues to watch HFT activity with a more watchful eye. Regulation Systems Compliance and Integrity, Exchange Act Release No. 73639 (Nov. 19, 2014), 79 Fed. Reg. 72252 (Dec. 5, 2014).

[235] Charles R. Korsmo, *High-Frequency Trading: A Regulatory Strategy*, 48 UNI. RICH. L. REV. 523, 608 (2014).

[236] *See* Fox, et. al, *supra* note 176 at 53-4.

[237] *See, e.g.*, Lee Chyen Yee and Samuel Shen, *China suspends market circuit breaker mechanism after stock market rout*, REUTERS (Jan. 7, 2016) (describing China's difficulties with successfully implementing stock circuit breakers).

rule, meanwhile, has also exhibited significant shortcomings when faced with extreme market volatility.[238] In a 2014 speech, SEC Chair Mary Jo White acknowledged that technology had "transformed the nature of trading" such that substantial regulatory efforts targeting market stability were needed to address problems posed by modern trading practices.[239] While accepting that HFT was an inevitable consequence of technological advancement, she stressed that the SEC was "assessing the extent to which specific elements of the computer-driven trading environment may be working against investors" and imposing distinctive, systematic risks to secondary markets more generally.[240] Indeed, HFT firms, with their large trading footprints, can uniquely affect broader secondary market activities both domestically and abroad. This section details other measures regulators can pursue to manage these risks.

1. Anti-Disruptive Trading Rules

The SEC is currently considering an anti-disruptive trading rule that would "apply to active proprietary traders in short time periods when liquidity is most vulnerable and the risk of price disruption caused by aggressive, short-term trading strategies is highest."[241] Although the SEC has not released a formal rule proposal, Chair White indicated the new rule would likely include "affirmative or negative obligations for high-frequency trading firms that employ the fastest, most sophisticated trading tools."[242]

The rule might bear similarities to the CFTC's anti-disruptive trading practices rule, which makes it unlawful in the futures and

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[238] On August 24, 2015, US markets fell sharply due to worries over economic troubles in China and other commodity-dependent emerging markets. Pre-market volatility levels were high. Ten minutes after the opening bell, nearly half of NYSE-listed equities had yet to begin trading. It was not until almost 10:00 AM that all S&P 500 securities opened. Wild price swings resulted, triggering nearly 1,300 trading halts as required by the Limit-Up Limit-Down bands. The trading halts caused so much disruption that market could not completely stabilize until well into the afternoon. *See* State Street Global Advisors, *Circuit Breakers and New Market Structure Realities* (Jan. 13, 2016), *available at* https://www.ssga.com/investment-topics/general-investing/2016/circuit-breakers-and-new-market-structure-realities.pdf.

[239] Mary Jo White, "Enhancing Our Equity Market Structure," Sandler O'Neill & Partners, Global Exchange and Brokerage Conference, June 5, 2014.

[240] *Id.*

[241] *Id.*

[242] *Id.* However, Stephen Luparello, the head of the SEC's Trading and Markets division, suggested that the rule might instead resemble NYSE's requirements for specialists, which impose an obligation to act as a liquidity provider of last resort. *See* Emmanuel Olaoye, *Anti-disruptive trading rule will look like old specialist rules, says senior SEC official*, COMPLIANCE COMPLETE (Oct. 3, 2014), http://www.conatum.com /presscites/AntiDisruptive.pdf.

commodities space for any person to engage in any trading, practice, or conduct that (i) violates bids or offers; (ii) demonstrates an intentional or reckless disregard for the orderly execution of transactions during the closing period; or (iii) constitutes spoofing.[243] Exchanges have also experimented with anti-disruptive trading rules. For instance, the SEC recently approved a BATS-proposed rule prohibiting exchange members from engaging in or facilitating disruptive quoting and trading activity.[244] The rule built off the exchange's existing anti-manipulation authority, but defined and prohibited disruptive trading with more specificity.[245] The rule also gives BATS more authority to cut off-exchange access when a client engages in such activity.[246]

An anti-disruptive trading rule along the lines proposed would benefit market stability in several ways. Markets are often subject to extreme volatility, so a rule restricting aggressive HFT strategies from removing large amounts of liquidity during those times would dampen HFT's amplificatory effect on severe market swings. But the rule will only be effective if it is targeted and well-defined. Regulators need to identify not only which activities are disruptive, but "which traders should be restricted" and "during which time periods" these restrictions should apply.[247] Too broad a definition will inappropriately capture legitimate trading activity, potentially chilling it and impeding HFT firms that can and want to provide liquidity from doing so. On the other hand, too narrow a definition would prevent the SEC from evaluating the facts and circumstances of each case, an equally undesirable outcome. In response, Chair White has claimed that the rule would be "tailored to apply to active proprietary traders" in short time periods.[248] Yet as other regulatory efforts have shown, these definitions are sometimes hard to pin down.[249]

As with other measures, successful implementation of an anti-disruptive trading rule depends on accurately parsing out good HFT from the bad. The SEC's ongoing data-driven approach to regulation, detailed

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[243] 7 U.S.C. § 4(c)(a)(5) (2012).

[244] Order Approving BATS Proposed Rule Changes Relating to Disruptive Quoting and Trading Activity, Release No. 34-77171 (Feb. 18, 2016) (to be codified at 17 C.F.R. 240.19b-4.

[245] *Id.*

[246] *Id.*

[247] *High Frequency Trading's Impact on The Economy: Hearing Before the Subcomm. On Securities, Insurance, and Investment*, 113th Cong. 477 (2014) (statement of Hal S. Scott, Director, Comm. on Capital Markets Regulation).

[248] See Mary Jo White, Chair, U.S. Sec. and Exch. Comm., *Enhancing Our Equity Market Structure*, Speech at Sandler O'Neill & Partners, L.P. Global Exchange and Brokerage Conference (Jun. 5, 2014).

[249] *Cf.* 12 U.S.C. § 1851 ("Volcker Rule") (2012).

more thoroughly below, should continue and help the agency inform what exactly is disruptive trading, who does it, and when do they do it. To get a good rule, regulators must quantify disruptive trading and identify instances of it in market data. Despite the SEC's best efforts, there will always be false positives. But if the SEC takes enough care in developing the rule and adjusting it going forward, detection and market stability should improve.

2. Order Message Limits

Many exchanges already limit the number of messages its members can send on a per second basis. Traders can submit four types of messages to an order book: to *add* a limit order, to *cancel* a limit order, to *cancel and replace* one limit order with another, and to place a *market order*.[250] HFT strategies often send hundreds of these messages every second, but a trading platform can limit the number of messages that a market participant can send to it by either rejecting messages sent in excess of the limit or cutting the market participant off completely.[251] Other exchanges have a message pricing system that imposes further monetary penalties for excessive ordering strategies.[252]

These "throttles", when tripped, can aid in the rapid detection of malfunctioning algorithms while reducing the damage and monetary losses caused by manipulative algorithms, like quote stuffing strategies.[253] Throttles improve market stability in several ways: they protect the stability of a trading venue's order processing system, give these trading venues and market participants' flexibility in responding to questionable trading patterns as they arise, and automatically cut off problematic trading activity before its effects spread to other trading platforms or asset classes. Throttles also represent a beacon of simplicity in a sea of complexity. These limits apply to everyone, and if designed correctly can easily adapt to changing

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[250] *See* David Kane, Andrew Liu, and Khanh Nguyen*, Analyzing an Electronic Limit Order Book*, 3 R. J. 64 (June 1, 2011).

[251] For example, the Eurex exchange will automatically "throttle," or cut off, messaging after 150 messages are sent in a second and automatically disconnect the member entirely should messaging exceed 450 messages a second. Megan Morgan, *What's the Best Way to Regulate HFT*, Tabb Forum (Feb. 12, 2014), http://tabbforum.com/opinions/what's-the-best-way-to-regulate-hft.

[252] Oliver Linton & Maureen O'Hara, "Economic impact assessments on MiFID II policy measures related to computer trading in financial markets," U.K. Gov't Off. for Sci. (Aug. 2012).

[253] *See* Regulation Automated Trading (proposed Nov. 24, 2015) (to be codified at 17 C.F.R. pts. 1, 38, 40, 170); *see also* Concept Release on Risk Controls and System Safeguards for Automated Trading Environments, 78 Fed. Reg. 56542 (Sept. 12, 2013), http://www.cftc.gov/ucm/groups/public/@lrfederalregister/documents/file/2015-30533a.pdf.

market conditions.

In the futures and commodities space, the CFTC recently proposed Regulation AT that, among other things, mandates that algorithmic traders and exchanges establish maximum message limits as part of its pre-trade risk control process.[254] The regulation does not prescribe particular limits or thresholds, giving these traders and exchanges the discretion to set levels reasonably designed to prevent Algorithmic Trading Events, defined as either an algorithmic trading compliance issue or an algorithmic trading disruption.[255]

Regulators should apply this approach more generally across all secondary markets. Allowing HFT firms to set their own message limits, limits informed by specific information including the strategy being employed and that system's speed, avoids any under or over-inclusiveness problems of a strict message limit. Exchanges, meanwhile, can vary message limits as appropriate based on factors like the time of day, type of security, and market conditions. More generally, shifting the onus onto algorithmic traders and exchanges should make them more sensitive to market stability issues, encouraging more dialogue between the industry and regulators and spurring cultures of compliance within HFT firms. Importantly, overall market complexity would not increase much; if anything, complexity might decrease as exchanges and market participants come to consensuses about what the most appropriate message limits for particular types of strategies should be.

3. HFT Registration and Disclosure Requirements

The SEC recently proposed an amendment to Rule 15b9-1 that would require many HFT firms to register with FINRA.[256] While many HFT firms are already subject to SEC oversight as brokers, the rule change would boost the SEC's ability to monitor for fraud across multiple markets since firms would also be subject to more examinations and enforcement actions from FINRA.

The amendment's registration, reporting, and transparency objectives significantly further important security and fairness goals. These mechanisms convey important information about individual firm and systemic risk to regulators. Under a more comprehensive registration regime, regulators would be able to identify HFT strategies that pose systemic risks more quickly. Regulators would also be able to isolate and

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[254] *Id.*

[255] *Id.*

[256] Securities Exchange Act Release No. 74581 (March 25, 2015), 80 FR 18036 (Apr. 2, 2015).

investigate HFT firms contributing to severe market disruptions in a more cost and time-efficient manner. Consequently, regulators could also implement necessary market infrastructure changes more quickly and effectively. Moreover, information about how and where these strategies operate as well as what securities they deal in will lead to a better mapping of secondary markets, giving regulators more insight into where these markets are most apt to transmit the effects of disruptive trading to other markets. Similarly, registration would substantially improve the effectiveness of other proposed measures offered in this article, including on-demand auctions and order messaging limits.

Markets will likely also become more transparent. Under the proposed amendment, HFT firms would not need to join FINRA if they limit their trading to exchanges of which they are members. Thus, some firms could decide to stop their off-exchange trading while others opt to reduce their off-exchange activity in dark pools or ECNs to curb the increased costs of trading associated with FINRA membership.

While off-exchange trading undoubtedly has its benefits, including smaller bid-ask spreads and more market depth, current proportions are too lopsided.[257] So much trading now happens away from exchanges that publicly quoted prices may no longer properly reflect where the market is.[258] Given that Dark Pools and ECNs price their transactions off the published prices on the exchanges, these inaccurate exchange prices will also skew off-exchange pricing.[259] In short, more on-exchange trading will lead to more informed pricing that, all things equal, will make market prices more stable. Since more stable secondary markets make it easier for listed companies to raise capital, the cost of capital will fall, increasing efficiency.[260]

The amendment is a useful first step, but the SEC should consider incorporating aspects of similar, more detailed registration requirements pioneered by its foreign counterparts. For instance, the proposed revision of the European Commission's Markets in Financial Instruments Directive (MiFID II) requires significant disclosures.[261] HFT firms must give their home state regulators descriptions of their algorithmic trading strategies,

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[257] *See* Rhodri Preece, *Dark Pools, Internalization, and Equity Market Quality*, CFA INSTITUTE (Oct. 2012), *available at* http://www.cfapubs.org/doi/pdf/10.2469/ccb.v20 12.n5.1.

[258] John McCrank, *Dark markets may be more harmful than high frequency trading*, REUTERS (Apr. 7, 2014), http://www.reuters.com/article/us-markets-darkpools-analysis-idUSBREA3605M20140407.

[259] *Id.*

[260] Nicholas Economides and Robert Schwartz, *Electronic Call Market Trading*, 21 J. PORT. MGMT. 10 (1995).

[261] *See* Katz & Lam, *supra* note 215.

details of the trading parameters or limits to which the system is subject, and the key compliance and risk controls that it has in place.[262] Registered HFT firms and trading venues must also establish effective systems and risk controls to ensure trading systems are resilient and have enough capacity.[263] As part of these risk controls, HFT firm senior management must designate a "responsible party" to sign off on the initial deployment or a substantial update to an algorithmic trading system or strategy.[264] The directive further mandates that firms test their algorithms to ensure they work effectively in stressed market conditions and, if necessary, can switch these algorithms off.[265] In turn, trading venues that allow algorithmic trading will also be required to perform a due diligence and conformance testing on the users of its systems.[266]

Imposing more specific registration requirements is a path worth considering. The long-term effects of, for instance, requiring descriptions and periodic testing of algorithms alongside registration would improve market stability tremendously. HFT algorithms will become more resilient, and regulators more competent at supervising them. Of course, too stringent requirements might cause HFT firms to flee to less regulated trading platforms or jurisdictions. Coming up with conditions to test these algorithms will also, at least initially, be difficult and costly. Regulatory coordination and information sharing, however, can mitigate these concerns, discussed more thoroughly in Part IV.

D. Measures Addressing Investor Protection Issues

Regulators must restore the public's faith that the secondary market protects their interests. First, regulators must make the secondary market more transparent. The issues discussed in Part II.B.4 primarily revolve around opacity: only the most sophisticated investors know the ins-and-outs of how HFT and trading dynamics work. Second, regulators must assure investors they are protected from predatory HFT strategies. To accomplish this, regulators must increase their surveillance capabilities and aggressively pursue enforcement actions against manipulative HFT strategies. However, regulators must also make sure not to demonize HFT strategies that add value to secondary markets. As previously discussed, electronic trading developed, at least to some extent, to curb certain abusive practices of manual traders. Regulation must maintain HFT's competitive benefits.

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[262] *Id.*
[263] *Id.*
[264] *Id.*
[265] *Id.*
[266] *Id.*

Finally, regulators must enhance the perceived fairness of secondary markets in the eyes of the public. Competitive pressure to increase order flow pushed trading venues to cater to HFT demands, creating what many perceived as a "two-tiered" market. Co-location, proprietary data feeds, and specialized order types all animate claims that the market is rigged.[267] Regulators need to revisit each of these developments to see if they actually serve the public interest.

Despite this, the SEC has taken several positive steps to make secondary markets more transparent and manageable. In 2011, the SEC passed the Large Trader Reporting Rule, imposing registration and reporting requirements on certain traders that exceed defined volume thresholds.[268] The rule gives the SEC more insight into how major traders interact with securities markets, reconstruct trading activity following periods of extreme market volatility, and apply the data gained from the reporting system for regulatory purposes going forward.

Similarly, in 2012 the SEC adopted Rule 613, requiring national securities exchanges and FINRA to submit plans to create, implement, and maintain a consolidated audit trail (CAT) designed to track the life cycle of all orders and trades.[269] Currently, while exchanges report executed trades to the consolidated market data system, there is no database that logs records of all order activity, including canceled orders.[270] If CAT is implemented on-budget and regulators take steps to ensure the data given to it is accurate, it will allow regulators to track secondary market activity more accurately and efficiently.[271] Of course, this is a big "if."[272] But by

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[267] *See, e.g.*, Laurie Carver, "Exchange Order Types Prompt Fears of HFT Conspiracy," *Risk Magazine*, April 23, 2013, *available at* http://www.risk.net/risk-magazine/feature/2261626/exchange-order-types-prompt-fears-of-hft-conspiracy.

[268] SEC Release 34-64976 (Jul. 27, 2011), 75 Fed. Reg. 46960 (Aug. 3, 2010). Under the rule, entities who trade either 2 million shares or $20 million during any calendar day, or 20 million shares or $200 million during any calendar month, must register. *Id.*

[269] *See* 17 C.F.R. § 242.613 (2012).

[270] Press Release, SEC, SEC Approves New Rule Requiring Consolidated Audit Trail to Monitor and Analyze Trading Activity (July 11, 2012), *available at* http://www.sec.gov/News/PressRelease/Detail/PressRelease/1365171483188#.UkXTmMi30AM.

[271] FINRA currently operates the Order Audit Trail System (OATS), an analogous system that tracks order and execution data for most U.S.-listed stocks. One recurring issue with the OATS system involves data integrity: the system is useful only to the extent that the data it is provided is accurate and complete. *See, e.g.* Matt Robinson and Sam Mamudi, *Goldman Fined $1.8 Million by FINRA Over Inaccurate Trading Data*, BLOOMBERG (Jul. 27, 2015), http://www.bloomberg.com/news/articles/2015-07-27/goldman-fined-1-8-million-by-finra-over-inaccurate-trading-data.

[272] In March 2016, Senator Michael Crapo of Idaho remarked that it was "beyond frustrating that six years after the Flash Crash we still haven't built the CAT." U.S. Senate, Subcommittee on Securities, Insurance, and Investment, *Regulatory Reforms to Improve Equity Market Structure*, Hearing, March 3, 2016 (Serial No. FILL IN). Washington:

creating a central repository of trading data, the SEC and other regulators can link customer account information to order event data and perform ongoing surveillance while also letting regulators to complete market reconstructions. Equally important, CAT should enable private enforcement as well; it will give private parties another tool with which they can reconstruct HFT manipulation to establish causation and intent in potential market manipulation or contract class action claims.[273]

The SEC also established its Market Information Data Analytics System (MIDAS) in 2013, becoming the agency's official trade monitoring system. Designed to allow the agency to quickly reconstruct trading activity after extreme market events and better detect troublesome or illegal trading behavior, MIDAS collects more than one billion records every day.[274] The SEC regularly posts visual summaries of this market data on its website, making markets seem less opaque to investors.[275]

The SEC has made strides addressing the "two-tiered" market concern as well. For example, in 2010, the agency essentially prohibited "naked access." Naked access describes an agreement where an HFT firm pays an SEC-registered broker to directly access securities exchanges through their order management systems. These systems had direct connections to exchanges and other trading platforms. By accessing these systems, HFT firms could reduce their trade latency and increase the efficacy of their trade strategies without submitting themselves to various risk-management and capital requirements faced by registered brokers. The Naked Access Rule prohibited broker-dealers from providing this access, and required brokers with market access to put in place risk management

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Government Printing Office, 2016.

[273] *See* Tara E. Levens, *Too Fast, Too Frequent? High-Frequency Trading and Securities Class Actions*, U. Chi. L. Rev. 1511, 1526-55 (describing the securities-fraud class action framework as applied to HFT manipulation cases). For examples of prominent class actions in this area, *see* Complaint for Violation of Federal Securities Laws, Civil Action No. 14-2811 (SDNY filed Apr. 18, 2014) ("*City of Providence v. BATS Global Markets, Inc.*) (pending class action brought on behalf of public investors who claimed injury under, among other provisions, §§ 6(b) and 10(b) of the Exchange Act, highlighting manipulative and deceptive conduct in connection with HFT strategies including electronic front running, spoofing, layering, and rebate arbitrage); *and* Class Action Complaint, Civil Action No. 14-3745 (SDNY filed May 23, 2014) (*Lanier v. BATS Exchange, Inc.*) (pending class action on behalf of subscribers who purchased electronic market data from BATS claiming the exchange transmitted market data to their HFT clients first, in violation of their subscription contract).

[274] It took the SEC's investigatory unit approximately four months to reconstruct and analyze the relevant trade data. Frank Konkel, *SEC's MIDAS program highlights how to do big data*, FCW (Mar. 28, 2014), https://fcw.com/articles/2014/03/28/sec-midas-big-data.aspx.

[275] *Id.*

controls and supervisory procedures to help prevent erroneous orders, ensure compliance with regulatory requirements, and enforce pre-set credit or capital thresholds.[276]

Meanwhile, many of the SEC's enforcement efforts have aimed to increase investor knowledge about how secondary markets work. For example, the SEC recently fined Direct Edge for selectively disclosing information about how a certain order type commonly used by HFT firms operated to its members.[277] In its enforcement action, the SEC further suggested that many HFT firms gave Direct Edge input about how these orders should operate, and stated that Direct Edge should have informed exchange members of this fact.[278] In response, exchanges have taken steps to eliminate or simplify their order types, presumably to make their platforms seem fairer to non-HFT traders.[279]

In short, the SEC has done all the right things with respect to developing a more robust regulatory infrastructure. HFT registration will promote transparency while CAT, MIDAS, and its ilk will give the SEC dramatically better surveillance capabilities. Using these tools, the SEC can better parse harmful algorithms from beneficial ones and adjust their enforcement and policy focus accordingly. Though other jurisdictions have placed more emphasis on investor protection issues,[280] there is no immediate need in the U.S. to follow suit beyond ensuring regulators implement and adhere to existing rules and proposals going forward. If anything, U.S. regulators might consider reevaluating trading platform co-location and proprietary data feed distribution practices in the medium-term. Any benefit gained from changing either of these things, however, would not stem directly from equalized access to market data: HFT firms would simply place more emphasis on improving their order processing capabilities. Rather, eliminating these practices could help regulators change the public's perception, right or wrong, that markets are rigged.[281]

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[276] *See* Risk Management Controls for Brokers or Dealers with market Access, Exchange Act Release No. 34-63241, 75 Fed. Reg. 69791 (Nov. 3, 2010).

[277] *In the Matter of EDGA Exchange*, Exch. Act. Rel. No. 74032 (Jan. 12, 2015).

[278] *Id.*

[279] *See, e.g.*, Adam Brown, *NYSE to eliminate several complex order types to rein in HFT*, IR MAG. (May 9, 2014), http://www.irmagazine.com/articles/stock-exchanges-listings/20178/nyse-eliminate-several-complex-order-types-rein-hft/.

[280] For instance, In Australia, the surveillance onus is partially shifted to other traders. Market participants must notify its primary market regulator, the Australian Securities and Investments Commission, if they have "reasonable grounds" to suspect that someone has placed an order or engaged in a transaction which has the effect of creating or maintaining an artificial, false, or misleading price. *See* Aust. Sec. & Inv. Comm'n, *Suspicious Activity Reporting* (Aug. 2013) at 6, *available at* http://download.asic.gov.au/media/1247093/rg238.pdf.

[281] Michael Lewis, FLASH BOYS 109 (2014).

IV. THE IMPORTANCE OF REGULATORY COORDINATION

Secondary markets are growing more complex and interlinked every day. HFT's ability to employ cross-exchange and cross-product arbitrage strategies means that trading is more impactful on a global scale than ever before. Global securities regulations are more interdependent as well; issuers can cross-list their stocks on multiple exchanges while HFT firms can locate themselves and operate in multiple markets. Given HFT's demand for access to more trading opportunities, it is not surprising that exchanges have consolidated. Revenues from equities trading have plunged in the face of fierce competition, pushing stock exchanges to merge with derivatives and international exchanges to boost growth.[282] As one industry commentator noted, "[t]he way the market works is simple: if you're not in the top tier or in the second tier of [global] exchanges, you're finished."[283]

Regulators have noted these trends. For instance, before the Flash Crash, single security circuit breakers were limited to particular venues or assets. Once these circuit breakers were triggered, trading volume could nonetheless migrate off-exchange or to other assets. During the Flash Crash, CME, a derivatives exchange, hit many of these circuit breakers while NYSE did not. This meant that trading in certain derivatives halted, but trading in their associated stocks remained active. NYSE executed these trades, but later canceled and reversed them. However, orders placed after trading resumed on CME, intended to hedge against their perceived stock losses on NYSE, did execute.[284] Paradoxically, these hedge trades lost money. Had both exchanges been subject to the circuit breakers, this state of affairs would not have taken place. Afterward, regulators revamped the circuit breaker system, and securities and futures exchanges must now follow procedures for coordinated market-wide trading halts based on declines in the S&P 500 index.[285] To facilitate more measures like these, the CFTC and SEC formed a Joint Advisory Committee to consider potential

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[282] *See* Eyk Henning and Shayndi Raice, *NYSE Owner ICE, CME Group Mulling Bids for LSE*, WALL ST. J. (Mar. 1, 2016), http://www.wsj.com/articles/nyse-owner-intercontinental-exchange-says-it-is-considering-offer-for-lse-1456821176; Ken Sweet, *Why stock exchanges have merger fever*, CNN MONEY (Feb. 18, 2011), http://money.cnn.com/2011/02/18/markets/exchange_mergers/.

[283] *See* Sweet, *supra* note 282.

[284] Ananth Madhavan, *Exchange-traded funds, market structure, and the Flash Crash* (Blackrock Working Paper, 2011), http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.466.608.

[285] Bulletin, Sec. & Exch. Comm'n, Investor Bulletin: Measures to Address Market Volatility (last updated Jan. 4, 2016), https://www.sec.gov/investor/alerts/circuitbreakersbulletin.htm.

coordinated regulatory responses.[286] Both of the agencies have either taken up or considered many of the committee's recommendations.[287]

Likewise, successful implementation of most policy measures discussed in this article depends on significant regulatory coordination and cooperation. Rolling out on-demand batch auctions, for instance, requires regulators and exchanges to work together to determine eligible securities and traders. Altering tick sizes, maker-taker fees, and order message limits pose similar challenges. And with respect to surveillance tools like CAT, the SEC needs to collaborate with FINRA, broker-dealers, and traders to ensure the data collected is the data desired. In short, exchanges, regulators, and traders all need to work together on an ongoing basis to ensure these measures actually, and not just theoretically, improve market conditions.

Cooperation must extend to the international level as well. Insufficient coordination could result in HFT firms pursuing yet another arbitrage strategy, but this time of the regulatory variety. Downward competitive pressure from jurisdictions that want to attract or retain HFT's order flows might "enhance or debilitate [the] regulatory regime[s]" of other jurisdictions, putting certain investment activity that has profound effects on a given market beyond a state's regulatory reach.[288]

These risks are most acute with respect to financial transaction taxes. Even if these taxes are targeted and limited to aggressive trading strategies, HFT firms could simply avoid the tax by relocating their operations to another exchange in another jurisdiction. For instance, when Sweden began taxing financial transactions in the 1980s, bond trading fell by 85% and futures trading fell by 98%.[289] By 1990, more than 50% of all Swedish trading moved to London. More recently, Italy's financial transaction tax caused trading in Italian stocks to fall by 34.2% the year it introduced the tax.[290] And while the Italian government expected to raise €1 billion via the tax, actual receipts totaled only €200 million.[291] Italian

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[286] JOINT CFTC-SEC ADVISORY COMM. ON EMERGING REGULATORY ISSUES, RECOMMENDATIONS REGARDING REGULATORY RESPONSES TO THE MARKET EVENTS OF MAY 6, 2010, at 2 (2010).

[287] *Id.* at 3-14.

[288] Amir N. Licht, *Regulatory Arbitrage for Real: International Securities Regulation in a World of Interacting Securities Markets*, 38 VA. J. INT'L L. 563, 606-07 (1998).

[289] *Financial Transaction Taxes are Historically Harmful and Unsuccessful*, MODERN MARKETS INITIATIVE, http://modernmarketsinitiative.org/topics/effects-of-a-financial-transacti on-tax/ (last visited Mar. 11, 2016).

[290] *FTT drags down Italian stock trading volumes*, FTSE GLOBAL MARKETS (Apr. 23, 2014), http://www.ftseglobalmarkets.com/news/ftt-drags-down-italian-stock-trading-volu mes.html.

[291] Maria Coelho, *Dodging Robin Hood: Responses to France and Italy's Financial Transaction Taxes*, U.C. BERKELEY (Nov. 3, 2015), *available at* https://www.sbs.ox.ac.uk/sites/default/files/Business_Taxation/Events/conferences/doctoral

traders have felt the effects: studies have found that volatility and bid-ask spreads significantly increased.[292]

Regulators must carefully think through HFT registration requirements and market-making obligations for similar reasons. If not implemented in a coordinated way, these requirements risk alienating both good and bad HFT, pushing both types to jurisdictions with more lenient regulations, fewer registration requirements, and more anonymity with respect to their trading-related information.[293]

Regulatory coordination, of course, is not always easy or desirable. Harmonizing HFT regulation on a global scale would be contentious and often impractical. First, trying to universalize substantive regulation "can quickly devolve into regulatory nationalism as internal political and economic interests clash with international expectations."[294] Coordination may also exacerbate transparency, accountability, and legitimacy issues to the extent that international bodies not accountable to the subjects of the regulation develop universal regulatory principles.[295] Second, market structures can vary dramatically across jurisdictions. Rules established for a jurisdiction with a single trading venue, for instance, should not be the same as those used for highly-fragmented markets.[296] Third, harmonization efforts could create new arbitrage opportunities. Since the pace of enacting legal change will vary across countries, things might get worse before they possibly get better. Finally, uniform regulations risk the converse problem of regulatory arbitrage by inhibiting regulatory competition and

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_meeting/2014/coelho.pdf.

[292] Tobias Ruhl and Michael Stein, *The impact of financial transaction taxes: Evidence from Italy*, 34 ECON. BULLETIN 25 (Jan. 14, 2014).

[293] *See* C.L. Clark, "Controlling Risk in a Lightning-Speed Trading Environment, Essays on Issues," The Federal Reserve Bank of Chicago, Number 27 (March 2010), *available at* https://www.chicagofed.org/digital_assets/publications/chicago_fed_letter /2010/cflmarch2010_272.pdf ("[P]lacing limits on high-frequency algorithmic trading or restricting un-filtered sponsored access and co-location within one jurisdiction might only drive trading firms to another jurisdiction where controls are less stringent."). Several major U.S. HFT players recently expanded their operations to Europe, attracted by diverse trading opportunities, favorable corporate tax rates, and convenient regulatory requirements. Fiona Reddan, *Market Trading in a Flash*, IRISH TIMES, Oct. 2, 2009, at 9.

[294] Annelise Riles, *Managing Regulatory Arbitrage: A Conflict of Laws Approach*, 47 CORNELL INT'L L.J. 63 (2014).

[295] Kathleen Casey, Commissioner, Sec. & Exch. Comm'n, The Role of International Regulatory Cooperation and Coordination in Promoting Efficient Capital Markets (June 12, 2010).

[296] For example, the U.S. has 13 recognized exchanges and over 50 alternative trading systems. In contrast, 90% of trading activity in Japan occurs on the Tokyo Stock Exchange. *See* Yuji Nakamura and Toshiro Hasegawa, *Humans Lose Out as Robots Take Tokyo Stock Exchange*, BLOOMBERG (Mar. 4, 2015), http://www.bloomberg.com/news/articles/2015-03-05/robots-take-tokyo-as-high-frequency-equity-infiltration-hits-70-.

experimentation, potentially leading to stale, inflexible regulatory rules that quickly become outdated.

Even after acknowledging these limits, there is room for at least some level of international coordination in this space. Given the interconnectedness of markets, international securities regulators should at least (1) coordinate their data-gathering and registration processes so as to better understand how HFT strategies impact investors and global markets; (2) share this data to enable quick and effective resolution of cross-border enforcement issues and inform more consistent, high-quality regulations that reduce potential regulatory gaps; and (3) consider synchronized responses to severe secondary market disruptions that promote cross-market stability and reduce systemic risk.

CONCLUSION

Contrary to public opinion, HFT is not a recent phenomenon. Electronic trading has been a fixture in markets since the 1960s; HFT is simply its latest incarnation. Electronic trading arose out of a desire to enhance secondary markets, and in many ways it has: trading opportunities are more diverse, spreads are lower, and price competition is at an all-time high. HFT, if properly managed, can propel these enhancements even further. Although it poses both logistical and philosophical challenges to past market paradigms, HFT can be a force for good. This article states a principled and coordinated approach toward achieving that goal.

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