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THE SYMBIOSIS OF HIGH FREQUENCY TRADERS
AND STOCK EXCHANGES: A MACRO PERSPECTIVE

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INTRODUCTION

High Frequency Trading (HFT) is under attack. Hillary Clinton wanted to tax it.¹ Warren Buffet's business partner Charlie Munger considered it "the functional equivalent of letting rats into a granary."² Bill Gates agreed.³ Notwithstanding an increasingly critical atmosphere, high frequency traders (HFTs) appear destined to remain a fixture in U.S. equity markets for the foreseeable future. They are too profitable, too influential, and too integral to fail.

HFT is the most dominant force in the contemporary equity market. It impacts some of the most significant aspects of

1. See Sam Mamudi & Dave Michaels, *Hillary Clinton Steps Into High-Frequency Debate with Tax Plan*, BLOOMBERG (Oct. 8, 2015), <https://www.bloomberg.com/news/articles/2015-10-08/hillary-clinton-steps-into-hft-controversy-with-tax-proposal>.

2. See Alex Crippen, *Buffett, Gates and Munger criticize high-frequency trading*, CNBC (May 5, 2014), <http://www.cnbc.com/2014/05/05/buffett-gates-and-munger-criticize-high-frequency-trading.html>.

3. *Id.*

market performance.⁴ HFT dramatically increased daily trading volumes and claimed a majority of that increase.⁵ At their 2009 peak, HFTs accounted for only 2% of U.S. stock exchanges' clients, and yet accounted for nearly 75% of daily trading volume in all U.S.-listed equities.⁶ In 2016, HFTs accounted for 55% of such volume.⁷ HFT also initiated decreases in spreads, average trade sizes, and holding periods.⁸ It has also had a controversial impact on liquidity, price discovery, and volatility.⁹ Taken together, this profound market influence translates into significant clout over exchanges—by virtue of their volume and insatiable desire for speed and information, HFTs are exchanges' best clients. This Note explores this relatively new relationship.

In the wake of Regulation National Market System (Reg. NMS) and its attendant market fragmentation, HFTs experienced a meteoric rise in importance by developing highly sophisticated, technologically advanced proprietary algorithmic trading strategies that exploited the new fractured market

4. The U.S. Securities and Exchange Commission (SEC) deemed HFT to be “[o]ne of the most significant market structure developments in recent years.” See SEC Concept Release on Equity Market Structure, 75 Fed. Reg. 3594, 3606 (proposed Jan. 21, 2010) (to be codified at 17 C.F.R. pt. 242) [hereinafter Concept Release].

5. Charles M. Jones, *What Do We Know About High Frequency Trading?* 45 (Columbia Bus. Sch. Research, Paper No. 13–11, 2013), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2236201## (noting that today's securities markets regularly have a daily volume exceeding one billion orders).

6. Jonathan A. Brogaard, *High Frequency Trading and Its Impact on Market Quality* (Sept. 2010) (unpublished research paper) (on file with author) (estimating that HFT made up 74% of dollar trading volume in U.S. equities in 2009).

7. See RENA S. MILLER & GARY SHORTER, CONG. RES. SERV., R44443, HIGH FREQUENCY TRADING: OVERVIEW OF RECENT DEVELOPMENTS i (2016) (claiming that HFTs accounted for 55% of daily trading volume in U.S. equities in 2016). See also World Fed. of Exch., *Understanding High Frequency Trading (HFT)* (2013). See also U.S. SEC. & EXCH. COMM'N, STAFF OF THE DIV. OF TRADING AND MKTS., EQUITY MARKET STRUCTURE LITERATURE REVIEW PART II: HIGH FREQUENCY TRADING (2014) (claiming that HFTs trading volume “typically exceeded 50% of total volume in U.S. equities”), https://www.sec.gov/marketstructure/research/hft_lit_review_march_2014.pdf.

8. See U.S. SEC. & EXCH. COMM'N, STAFF OF THE DIV. OF TRADING AND MKTS., EQUITY MARKET STRUCTURE LITERATURE REVIEW PART II: HIGH FREQUENCY TRADING (2014), https://www.sec.gov/marketstructure/research/hft_lit_review_march_2014.pdf.

9. *Id.*

structure. But HFTs did not develop in a vacuum. By pushing the limits of algorithmic trading, they compelled the venues on which they traded to adapt to their strategies. In the process, HFTs shifted leverage away from exchanges and toward themselves.

Bucking nearly two hundred years of tradition, exchanges now depend on client-tailored products and services for a majority of their revenue. The non-transaction fee revenue (that is, the revenue that does not derive from the difference between the maximum price that a buyer is willing to pay and the minimum price that a seller is willing to accept) for the New York Stock Exchange (NYSE)¹⁰ in 2016 accounted for 56% of net revenues, representing a growth of 13% from 2015 and 21% from 2014.¹¹ Within this non-transaction revenue, data services revenue—comprised of offerings discussed in Part IV that are largely consumed by HFTs—skyrocketed 127% from 2015 to 2016, to a record \$1.97 billion.¹² This figure is over 100 times the NYSE's data services revenue in 2012.¹³ NASDAQ is less transparent with respect to its non-transaction revenue, yet it is clear that between 2014 and 2016 it consistently earned approximately 63% of its total net revenues from non-transaction sources.¹⁴ HFTs are chiefly responsible for these figures. This data reveals that HFTs upended the maxim that market participants are subordinate to exchanges. The exchanges, in response, have thus far embraced this change, seizing the opportunity to profit.

As recently as two decades ago, exchanges did not cater to their clients in the way they now cater to HFTs. Exchange business models were investor-centric, based primarily on transaction revenues (which comprises of the spread between bid and

10. Throughout this Note, "NYSE" refers to the collective operations of the New York Stock Exchange, Euronext, their parent company the Intercontinental Exchange (ICE), as well as ICE affiliates.

11. INTERCONTINENTAL EXCH., ILLUMINATING MARKETS: 2016 ANNUAL REPORT 23 (2016), <http://ir.theice.com/~media/Files/I/Ice-IR/annual-reports/2016/2016-annual-report.pdf> [hereinafter "ICE Form 10-K"].

12. The NYSE booked \$871 million in data services revenue in 2015. *Id.* at 39.

13. The NYSE booked \$161 million in data services revenue in 2012. *Id.* at 39.

14. NASDAQ, Inc., Annual Report (Form 10-K) 35 (Mar. 1, 2017), <http://files.shareholder.com/downloads/NDAQ/1826306584x8241384xS1120193-17-3/1120193/filing.pdf>.

ask prices, or the difference between the maximum price that a buyer is willing to pay and the minimum price that a seller is willing to accept). Today, they are trader-centric, based primarily on non-transaction revenues. To a significant extent, HFTs rely on the assistance of exchanges, and exchanges rely on the business of HFTs. This Note argues that, to a certain degree, exchanges and HFTs enjoy a symbiotic relationship. I support this assertion through analysis of HFT strategies and the tools offered by exchanges to assist those strategies. This Note will reveal that HFTs are rational economic actors operating in an environment stacked in their favor. This Note will also argue that exchanges are increasingly parasitic with respect to their HFT clients in the sense that they seek to extract an increasingly significant portion of their revenues from HFT-tailored products and services.

Part I introduces HFT and explores the market and regulatory forces behind its growth. Part II discusses the evolution of the exchange business model. Part III investigates three categories of HFT strategies, and Part IV explores three tools that exchanges provide to assist these strategies. Specifically, I demonstrate how co-location, private data feeds, and novel order types support market making, arbitrage, and predatory strategies. Part V discusses the market manifestations of this relationship, including the impact on bid—ask spreads, liquidity, volatility, and price discovery. Part VI proposes possible responses to address the externalities created by the relationship between HFTs and exchanges, including increased competition, supervision, and regulation. Part VII concludes.

I.

A BRIEF INTRODUCTION TO HIGH FREQUENCY TRADING

In order to understand how exchanges and HFTs operate in cohort, it is important to first understand the phenomenon of HFT and its place in the secondary market. This section defines HFT using a framework adopted by the Securities and Exchange Commission (SEC), and then identifies its objectives. I go on to explore the organic market forces and inorganic regulatory forces behind HFT's growth.

A. *High Frequency Trading Defined*

By virtue of their profitability and claim to a majority of daily trading volume, HFTs wield enormous clout over exchanges and markets. Notwithstanding this influence, HFT and HFTs remain undefined in any express manner. The SEC has never proffered a formal definition. Indeed, some experts, like the International Organization of Securities Commissions, believe that “determining a precise definition may not even be practical for regulatory purposes as it could easily become obsolete or the object of regulatory arbitrage.”¹⁵

It is generally understood, however, that HFT is a subset of algorithmic trading. Following the industry-wide shift to fully automated trading systems in the 1990s and 2000s, sophisticated market participants like institutional investors now use algorithms to place orders to buy or sell securities in order to maximize the efficiency and accuracy of their order handling and management. HFTs pushed the limits of this evolution and operate at the vanguard of automation by using high-speed trading programs to enter and exit positions thousands of times per day in order to earn small profits on each trade. They often collect mere fractions of a penny per share per transaction, but the sheer volume of their trading activity makes their operations highly lucrative.¹⁶ HFTs initially emerged as independent entities, but many now operate in conjunction with large financial institutions.

Even though there is no discrete legal definition of HFT, the SEC provides a framework against which HFTs may be identified. As a general matter, the SEC considers HFTs to be “professional traders acting in a proprietary capacity that generate a large number of trades on a daily basis.”¹⁷ These traders, the SEC continues, may be “organized in a variety of ways, including as a proprietary trading firm (which may or may not be a registered broker-dealer and a member of the Financial Industry Regulatory Authority (FINRA)), as the proprietary

15. TECHNICAL COMM., INT’L ORG. OF SEC. COMMISSIONS (IOSCO), REGULATORY ISSUES RAISED BY THE IMPACT OF TECHNOLOGICAL CHANGES ON MARKET INTEGRITY AND EFFICIENCY 21 (2011).

16. See *infra* Part I.B.

17. See Concept Release, *supra* note 4, at 3606.

trading desk of a multi-service broker-dealer, or as a hedge fund.”¹⁸

From this definition of “proprietary” traders, HFTs are more clearly distinguishable from other market participants. Specifically, the SEC contends that there are five characteristics often attributable to HFTs. These include: (1) use of extraordinarily high-speed and sophisticated programs for generating, routing, and executing orders—translating into what some commentators deem to be another hallmark of HFTs: large expenditures on software, hardware, and data; (2) use of co-location services and individual data feeds offered by exchanges and others to minimize network and other latencies—again, translating into large expenditures; (3) short time periods for establishing and liquidating positions; (4) submission of numerous orders that are canceled shortly after submission—meaning large order volumes with small average order size; and, (5) ending the trading day in as close to a flat position as possible (that is, not carrying significant, unhedged positions overnight).¹⁹ It is worth noting that the SEC does not require that all five characteristics be present; a combination of some, presumably dependent on their degree of significance, will suffice.

B. *The Profitability of High Frequency Trading*

The importance of affirmatively identifying HFTs rests in large part on the fact that their activities are highly lucrative. If left to operate in a vacuum, HFTs would threaten to constitute a powerful interest group divorced from regulatory and public scrutiny. This is of course not inherently nefarious, however, it is a development worth examining. Baron et al., in an authoritative CFTC-sponsored study, examined 26 HFTs between 2008 and 2010, which were identified with the help of NASDAQ as firms with “high volume, low intraday inventory and low overnight inventory.” They concluded that these HFTs make a collective average of \$20 million per day or \$5 billion per year, assuming 250 trading days per year. This equates to about \$200 million per HFT per year.²⁰ Moreover, other ex-

18. *Id.*

19. *Id.*

20. They go on to disaggregate HFTs based on their trading strategies, finding that: “The average Aggressive HFTs earns \$45,267 in gross trading

perts contend that HFTs trade primarily in Exchange Traded Products (ETPs), like Exchange Traded Funds. Ramaswamy found that ETPs accounted for \$66 billion of trading activity in the year 2000.²¹ In 2010, ETPs accounted for \$1.3 trillion of trading activity. This increased variety and trading of ETPs correlates with an increase in HFT activity, likely because ETPs are amenable to certain HFT arbitrage strategies, which are examined in more detail in Part III.²²

C. *The Market Origins of High Frequency Trading*

To a certain extent, HFTs are the progeny of a general shift toward fully automated markets dependent on algorithmic trading, and are thus classifiable as an organic development. Specifically, HFTs are in part the end product of a market-based trend toward increasingly complex automation, rising from the fringes in the 1990s. Thorough analysis of HFT's evolution is outside the scope of this Note; however, it is important to briefly examine the market forces behind HFT's growth in order to fully grasp the significance of the non-market forces.

In 1969, Instinet established the world's first electronic trading platform and moved the goal posts of consumer expectations for the venerable NYSE—the only public exchange in the United States for nearly 200 years. Instinet was the original electronic communications network, or ECN.²³ ECNs operated as third-party computer systems that attempted to facilitate trading outside of traditional exchanges or markets. They provided another source of liquidity for securities traders seeking to transact at any given time, even after market hours. Indeed, by the late 1960s, it was clear to industry insiders that

profits [per day] in August 2010, while Mixed and Passive HFTs earn significantly less: only \$19,466 and \$2,461 per day, respectively.” “Aggressive” HFTs are defined as such if more than 60% of their trades are liquidity taking; “mixed” if between 20% and 60%; and “Passive” if less than 20%. See MATTHEW BARON, JONATHAN A. BROGAARD & ANDREI KIRILENKO, *THE TRADING PROFITS OF HIGH FREQUENCY TRADERS* 1–5 (Nov. 2012).

21. Srichander Ramaswamy, *Market Structures and Systemic Risks of Exchange-Traded Funds* (Bank for Int'l Settlements, Working Paper No. 343, 2011), <http://www.bis.org/publ/work343.pdf>.

22. See discussion *infra* Part III.B.

23. See SCOTT PATTERSON, *DARK POOLS: THE RISE OF A.I. TRADING MACHINES AND THE LOOMING THREAT TO WALL STREET* 109–11 (2013).

money never sleeps—it no longer needed to. Moreover, commissions offered by ECNs like Instinet were lower because they could afford to charge their clients less. By matching buyers and sellers directly, ECNs eliminated the registered exchange intermediaries and their attendant, profit-draining commissions. In other words, Instinet offered users a cheaper and more streamlined trading experience. ECNs like Instinet demonstrated that trading off the NYSE was both more convenient and more efficient.

After the National Association of Securities Dealers founded NASDAQ as the world's first electronic exchange in 1971, in part out of recognition of Instinet's (and by extension ECNs') superior user experience, the NYSE had no choice but to adapt. In 1976, it introduced its designated order turn-around (DOT) system, which delivered tradable orders to its physical trading posts electronically. Even though the NYSE did not convert into a fully automated exchange like NASDAQ, the implementation of DOT by the world's largest stock exchange was the ultimate signal to the market that automation and the algorithmic trading models that accompanied it were here to stay. By the 1980s, it was clear that no party—from investors to brokers to trading venues—could afford to be an analog player in a digital world.

As the appeal of algorithmic trading broadened into the 1990s, ECNs threatened to undermine the duopoly of NASDAQ and the NYSE. Specifically, ECNs—with their superior speed, convenience, and price—complemented the rise of HFT strategies intent on exploiting the new automated market. Over time, market making, arbitrage, and predatory opportunities grew across trading venues thanks to the rise of competing ECNs, and HFTs were well-situated to exploit these lucrative openings.²⁴ Eventually, many ECNs, including Instinet, became so integral to the new automated market that exchanges and large financial institutions acquired them. Thus, to an extent, modern HFTs represent the conclusion of an endogenous market shift. They exploit externalities created by the burgeoning embrace of automation and attendant algorithmic trading that began with third-party ECNs and spread to exchanges and regulators.

24. See discussion *infra* Part III.A.–D.

D. *The Regulatory Origins of High Frequency Trading*

The growth of HFT is also a product of something else entirely: an inorganic development manufactured, or at least catalyzed—directly or indirectly, purposefully or accidentally—by the hands intent on regulating it. Indeed, the SEC is partially responsible for the pervasiveness of HFT.

The SEC initially remained idle in the face of automation. It recognized that ECNs acted like exchanges, however, the agency was hesitant to regulate them out of fear of stifling innovation and competition.²⁵ Promoting competition is squarely within the SEC's mandate, and requiring ECNs to, for example, register as exchanges would undermine this aspect of the SEC's mission.

Congress did eventually initiate some action to address the rise of automation when it adopted the National Market System amendments to the 1934 Securities Exchange Act in 1975 (the NMS amendments). Policymakers acknowledged that advances in information technology would enable markets to cater to traders more efficiently and transparently. In Congress' view, these possibilities could only be effectuated through a nationally linked, electronic market of competing trading venues. These amendments thus empowered the SEC to endorse and execute a grand vision for a competitive, electronic national market system.²⁶

Progress toward full execution of this vision took a great deal of time. The Order Handling Rules, introduced in 1997 and adopted in 1998, were a substantive first step.²⁷ In an effort to increase transparency and competition, the SEC tightened bid—ask spreads—which were astronomically high compared to today's fractional spreads, regularly exceeding 15

25. Registration as a public exchange is costly, as evidenced by the requirements set forth in Section 6 of the Exchange Act of 1934. *See* Securities Exchange Act of 1934, ch. 404, 48 Stat. 881 (codified as amended at 15 U.S.C. §§ 78a et seq. (2012)).

26. *See* Securities Acts Amendments of 1975, Pub. L. No. 94-29, 89 Stat. 97 (amended June 4, 1975).

27. Nat'l Ass'n of Sec. Dealers, Inc., Order Granting Accelerated Approval of Rule Change Relating to Implementation of the Commission's Order Handling Rules, Exchange Act Release No. 34-38156, File No. SR-NASD-96-43 (Jan. 10, 1997).

cents.²⁸ These rules mandated market makers and specialists (the latter were used by the brokerage member-firms of the NYSE)²⁹ to publicly display any superior prices that they privately offered on ECNs.³⁰ ECNs could fulfill this obligation on behalf of their market maker and specialist clients by submitting their formerly-private quotes for inclusion into public quotation displays (the Securities Information Processor, or SIP). These rules eroded the anonymity and the attendant advantages enjoyed by ECN clients, and were a gentle first step toward federal acceptance and regulation of the newly automated market.³¹

The Order Handling Rules were expanded under the 1998 Regulation of Exchanges and Alternative Trading Systems (Reg. ATS) which, among other mandates, required ECNs handling five percent or more of the aggregate trading volume of national market securities to display *all* their orders, not just those entered by market makers and specialists.³² Consequently, this rule completely eliminated the anonymity of all trading conducted on ECNs and contributed to the growth of competing ECNs, which, in turn, competed with the duopoly of the NYSE and NASDAQ. As the number of ECNs and other forms of alternative trading systems (ATS) increased, HFTs could more easily observe trader behavior and subsequently model it with greater certainty—all orders and quotes, even those from institutional investors, were now public. This infor-

28. Robert Wood & George J. Benston, *Why Effective Spreads on Nasdaq Were Higher than on the New York Stock Exchange in the 1990s* (Univ. of Memphis Working Paper Aug. 13, 2003), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=436640.

29. Through contractual obligations with the exchange, NYSE specialists were entrusted to maintain “fair and orderly markets” by standing ready to buy or sell shares during regular market hours. They were another form of market maker employed by the exchange. See Nan S. Ellis, Lisa M. Fairchild & Harold D. Fletcher, *The NYSE Response to Specialist Misconduct: An Example of the Failure of Self-Regulation*, 7 BERKELEY BUS. L.J. 102, 109 (2010).

30. *Id.* See also SAL ARNUK & JOSEPH SALUZZI, BROKEN MARKETS: HOW HIGH FREQUENCY TRADING AND PREDATORY PRACTICES ON WALL STREET ARE DESTROYING INVESTOR CONFIDENCE AND YOUR PORTFOLIO 68 (2012).

31. It should be noted that Congress amended the 1934 Securities Exchange Act in 1975 in an effort to combat wide spreads and eliminate fixed commissions charged by exchanges in recognition of growing ECN competition. See discussion *infra* Part II.B.

32. Regulation of Exchanges and Alternative Trading Systems, Exchange Act Release No. 40,760, 63 Fed. Reg. 70,844 (Dec. 8, 1998).

mation was and remains extremely valuable to HFTs employing the passive and aggressive strategies discussed in Part III.³³

As an added boon to HFTs, institutional investors that once used ECNs to trade large blocks of shares in private were now pushed by Reg. ATS to use algorithms to execute their trades in pieces in an attempt to shield their activities from prying eyes—or, more literally, prying computers. According to critics, their algorithms were weak and used simple volume weighted average pricing.³⁴ This simplicity made their once-hidden trades easy for HFTs to devour. Not only were the activities of institutional investors now public, they also were targets. Early SEC actions therefore had a dual impact: catalyzing the general market shift toward algorithmic trading and laying the foundation for an explosion of profitable HFT activity.

Upon the foundation laid by the NMS amendments, Order Handling Rules, and Reg. ATS, the SEC approved Regulation National Market System (Reg. NMS) in 2005 in full recognition of market automation.³⁵ Thirty years after the NMS amendments, the SEC finally satisfied Congress' vision of an electronically linked national securities market. Algorithmic trading became the norm by the 2000s, and was used on three main types of trading venues: registered exchanges, ECNs, and Dark Pools.³⁶ Reg. NMS intended to lay the ground rules and processes that could finally establish a well-defined, unified electronic network linking these venues. In the process of unification, however, Reg. NMS actually led to fragmentation and sowed the seeds of HFT.

Specifically, under Rule 603 of Reg. NMS, exchanges must submit their best-priced quotations to a publicly available consolidated data feed (the SIP).³⁷ In effect, this mandated the

33. See discussion *infra* Part III.

34. ARNUK & SALUZZI, *supra* note 30, at 70.

35. Regulation NMS, Exchange Act Release No. 51,808, 70 Fed. Reg. 37,496 (June 25, 2005).

36. Detailed discussion of dark pools remains outside the scope of this Note. See PATTERSON, *supra* note 23.

37. In brief, dark pools are private securities exchanges that flourished as a consequence of the rise of ECNs and attendant market fragmentation discussed in more detail later in this section. One of their main benefits to market participants is anonymity. Dark pools do not reveal the identity of traders or the size of their trades until the trades are executed, thus avoiding any premature impact. 17 C.F.R. § 242.603.

creation of a national order book that combined the best prices available for any publicly listed stock at any given time. The only way this could work would be if algorithmic trading were the norm, underscoring the SEC's acceptance of the unstoppable trend toward automation. Rule 603 works in conjunction with Rule 611 to prevent exchanges from executing orders that can be filled at better (either lower or higher) prices elsewhere, on different exchanges. Moreover, this rule created a National Best Bid (NBB) price for sell orders and a National Best Offer (NBO) price for buy orders.³⁸ Thus, if a venue is unable to fill an order on its own—for example, if a buy order can obtain a lower price elsewhere or a sell order can obtain a higher price elsewhere—then that order must be re-routed to the “away” venue capable of satisfying the conditions of Rules 603 and 611.

This “trade through” or “order protection” rule created the semblance of a national unified market. As will be shown in Parts III and IV, however, HFTs can purchase tools offered by most exchanges, permitted under Rule 603(a), that disseminate customized private data on securities ahead of the public SIP. The system created by Rules 603 and 611, in other words, enables HFTs to construct the NBB and NBO before ordinary retail and institutional investors.

It is worth noting that Reg. NMS also established Rule 610, which instituted a ban on locked markets and mandated that trades cannot be executed by trading venues when the bid and ask prices are equal. The market is “locked” when a bid price for a security equals its ask price.³⁹ This ban essentially defined the conditions under which HFTs can obtain superior placement in an exchange's order book—when their orders do not lock the market.⁴⁰ Thus, this rule enabled certain HFT strategies that aim to get ahead of retail and institutional investors in the queue of orders on exchanges' order books and to obtain a more favorable price. These are strategies that most exchanges assist by providing certain services, which will be discussed in more detail in Parts III and IV. In other words,

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

39. NASDAQ FINANCIAL GLOSSARY, <http://www.nasdaq.com/investing/glossary/1/locked-market>.

40. HAIM BODEK, *THE PROBLEM OF HFT*, 31 (2012).

Rule 610 more closely aligned the interests of exchanges and HFTs going forward: exchanges needed the business of HFTs and HFTs needed concessions from exchanges that would help them profit.

In addition to the opportunities for exchanges to sell new products and services to HFTs that take advantage of the Reg. NMS market structure, Rules 603, 610, and 611 created a prioritization of speed, which in turn promoted market fragmentation. The first to access quotes could lessen or eliminate the risks of trading in one direction or another. Fragmentation along the lines of latency has come to benefit HFT arbitrage and market making strategies. Today, there are over 60 potential destinations for trades to be executed—thirteen exchanges and almost fifty dark pools and similar venues.⁴¹ The NYSE, NASDAQ, and BATS all operate dark venues and their own ATS including dark pools, ECNs, and non-ATS broker-dealer internalization systems. Due largely to the fragmentation created by Reg. NMS, the SEC notes that the NYSE's market share in its listings declined from approximately 79% in 2005 to approximately 25% in 2009, while the total volume in NYSE-listed stocks during this period increased by 181%.⁴² NASDAQ's combined market share in its listings declined from 52% in 2005 to 33% in 2009, while total trading volume in NASDAQ-listed stocks increased by only 30%.⁴³ This data illustrates how market fragmentation generated by Reg. NMS supports HFT arbitrage and market making tactics, discussed in more detail in Parts III and IV.

II.

THE EVOLUTION OF THE EXCHANGE BUSINESS MODEL

Amidst the shift towards fully automated markets, exchanges were not only confronted with the need to evolve their trading platforms—they also needed to transform their business models or else face extinction. This section discusses the original business model of exchanges, before ECNs, frag-

41. LAURA TUTTLE, U.S. SEC. & EXCH. COMM'N, DIV. OF ECON. & RISK ANALYSIS, ALTERNATIVE TRADING SYSTEMS: DESCRIPTION OF ATS TRADING IN NATIONAL MARKET SYSTEM STOCKS 5–6 (2013), <https://www.sec.gov/divisions/riskfin/whitepapers/alternative-trading-systems-10-2013.pdf>.

42. Concept Release, *supra* note 4, at 3595–96.

43. *Id.*

mentation, and HFT. It then discusses the current business model of exchanges. By highlighting the reasons why this evolution occurred, this section sets the stage for a discussion of the products and services that exchanges offer to facilitate HFT strategies. Exchanges would have failed if they neglected to mold their business models in response to the needs of HFTs.

A. *The Traditional Exchange Business Model*

Stock exchanges connect potential buyers and sellers of stock, and prior to fragmentation of the national market almost all stock exchange activity was conducted on either NASDAQ or the NYSE.⁴⁴ In the aftermath of Reg. ATS and Reg. NMS, these traditional exchanges were not structured to compete with ECNs operating in a fractured securities market. Until 2000 for NASDAQ and 2006 for the NYSE, these exchanges were member-owned, non-profit organizations implementing a business model tailored to a non-competitive, unfragmented landscape.

The NYSE, established in 1792, executed the prototypical exchange business model. The exchange was originally composed of brokerage member firms that agreed to buy and sell stocks on commission. These member firms employed “specialists”—actual human beings—for listed stocks who quoted buy and sell prices and facilitated trading for brokers and traders on a physical trading floor.⁴⁵ The member firms were prepared to continuously buy and sell stocks traded on the exchange in order to “maintain fair and orderly” markets.⁴⁶ They were intermediaries acting as liquidity providers and, by extension, as guardians of market stability. As compensation for this burden, they collected the difference between the prices at which they were willing to buy or sell.⁴⁷ As a practical matter, these spreads remained uncompetitively high for nearly two

44. George T. Simon & Kathryn M. Trkla, *The Regulation of Specialists and Implications for the Future*, 61 THE BUS. LAW. 217, 225–27 (2005).

45. LARRY HARRIS, TRADING & EXCHANGES: MARKET MICROSTRUCTURE FOR PRACTITIONERS 48, 89–111 (2003).

46. Nan S. Ellis, Lisa M. Fairchild & Harold D. Fletcher, *The NYSE Response to Specialist Misconduct: An Example of the Failure of Self-Regulation*, 7 BERKELEY BUS. L. J. 102, 111 (2010).

47. *Id.*

hundred years, handicapping this type of business model as it entered the 21st century.

The traditional business model was further ill-suited to compete in the digital world by virtue of its fixed commission structure. For example, the Buttonwood Tree Agreement of 1792, the original contract that governed the relationship between NYSE members, set a mandatory floor on commissions of “one-quarter percent.”⁴⁸ This mandatory commission successfully reduced intra-exchange competition between member firms, but was a fatal constraint on inter-exchange competition when ECNs defined the new status quo by providing more efficient and convenient alternatives to traditional exchanges in a fragmented market.

Non-competitive commissions combined with wide spreads meant that revenues for member firms of the NYSE and later NASDAQ were primarily based on transactions; spreads remained wide enough that every trade netted a handsome profit. Unlike the NYSE specialists, NASDAQ employed dealers—also actual human beings—who bought and sold all shares traded on the exchange. Of course, before ECNs and fragmentation, the NYSE and NASDAQ controlled all trading traffic. This meant that concerns regarding potentially excessive spreads and commissions were theoretical. Exchanges possessed enormous leverage over market participants—they were the only game in town and their business models reflected this absolute advantage.

As competition from ECNs grew, fragmentation took hold, and HFT drove an enormous spike in daily trading volumes, which in turn caused spreads to shrink to fractions of a penny. As a result, exchanges could no longer rely on spreads and commissions to fuel their businesses and placate their member-owners. The simple, anti-competitive business model of exchanges was inevitably rendered obsolete. Their absolute advantage evaporated and a search for some sort of comparative advantage began. Exchanges that once acted as gatekeepers controlling order flow and selling information broadly to all market participants on a one-size-fits-all basis needed to evolve or face extinction.

48. See RICHARD J. TEWELES, EDWARD S. BRADLEY & TED M. TEWELES, *THE STOCK MARKET* 97 (6th ed. 1992). See also *Gordon v. NYSE*, 422 U.S. 659, 663 (1975) (quoting the agreement).

B. *The Modern Exchange Business Model*

Exchanges are no longer the sole primary and secondary market makers. There are no more trading floors of any consequence. The cacophony engulfing the talking heads on CNBC and similar business news networks is a manufactured spectacle that primarily provides entertainment value. Today, all of the more than 60 visible and dark trading venues operate as electronic limit order books where traders post limit orders or firm commitments to buy or sell a certain stock in a certain quantity at a certain quoted price *without human interaction*.⁴⁹ A venue's matching engine—not a human being—then pairs posted buy or sell limit orders with any buy or sell market orders that originate from traders willing to buy or sell at the best available market price. This all takes place electronically on servers locked in buildings miles away from the physical trading floors. The once dramatic and personal process of buying and selling stock has become a prosaic and impersonal exercise in efficiency.

This change not only curtailed any romanticism inherent in securities trading, it also upended the traditional exchange business model.⁵⁰ The NYSE no longer has member-owners or specialists. NASDAQ has no dealers. By the 1990s, the market embraced ECNs that provided relatively more efficient order matching of buyers and sellers, more transparent pricing, and longer trading hours. These lower cost trading platforms were particularly appealing alternatives to the NYSE from the perspective of institutional investors that, as early as the 1960s, had become the largest owners of publicly traded equities in the United States.⁵¹ The explosion of ECN competition forced a transformation of traditional exchanges into their current forms.

Demutualization into shareholder-owned, for-profit corporations enabled exchanges to implement a more profit-

49. The stated price limit of a sell limit order is called an "offer," and for a buy limit order, a "bid."

50. Shamshad Akhtar, *Demutualization of Asian Stock Exchanges—Critical Issues and Challenges*, in DEMUTUALIZATION OF STOCK EXCHANGES 3, 5 (Shamshad Akhtar ed., 2002).

51. U.S. SEC. & EXCH. COMM'N, INSTITUTIONAL INVESTOR STUDY REPORT OF THE SECURITIES AND EXCHANGE COMMISSION, H.R. DOC. NO. 92-64 (1971).

driven and competitive strategy.⁵² The mutual governance model inherent in member-owned firms was no longer sustainable. The decision-making processes of a member-owned exchange were relatively slower, and therefore disadvantageous, in a rapidly evolving market as compared to the processes of a firm that employed a corporate model. By divesting from their member-owners, exchanges could more easily serve the needs of their customers and the exchange itself as a whole—not the factional interests of their member-owners.⁵³ Newfound shareholder accountability therefore created an environment amenable to a more profit-oriented business model.⁵⁴ Furthermore, a for-profit model afforded exchanges greater access to capital resources for investment in new technologies that would help them compete with ECNs.⁵⁵ Thus, by de-coupling the interests of members and their exchanges and aligning the interests of *shareholders* and exchanges, maximization of profits supplanted preservation of the status quo as the primary mission of exchanges.

This evolution to a for-profit shareholder model not only made exchanges competitive with ECNs but it also primed exchanges to take advantage of the explosion in HFT. As HFTs solidified their hold on trading volume, spreads continued to narrow and average order size decreased. Since exchanges could no longer rely on spreads for revenue, securing the business of the highest volume traders was essential, particularly after Reg. NMS further fragmented the market. The need for high volume, however, was only the beginning.⁵⁶ As Part IV will illustrate, exchanges realized that they could court HFTs with other incentives, like products and services for which they would pay handsomely.

52. Roberta S. Karmel, *Motivations, Mechanics and Models for Exchange Demutualizations in the United States*, in DEMUTUALIZATION OF STOCK EXCHANGES 59, 61 (Shamshad Akhtar ed., 2002).

53. Pamela S. Hughes, *Background Information on Demutualization*, in DEMUTUALIZATION OF STOCK EXCHANGES 33, 36 (Shamshad Akhtar ed., 2002).

54. *Id.*

55. *Id.* at 39.

56. Transaction-based revenue, and by extension volume, is still important, though its value has diminished. Thanks to the Electronic Liquidity Provision, much of liquidity “taking” trades get penalized with a small fee. But most of that fee is then “rebated” to liquidity providing trades. See discussion *infra* Part III.A.

Literally and figuratively then, demutualized for-profit exchanges paid their greatest dividends when the profitability of high-priced HFT-oriented products and services came into full relief in the 2000s. NASDAQ now earns 75% of its revenue from non-transaction sources.⁵⁷ The NYSE earns 57%.⁵⁸ These figures underscore the shift to the new business model and the contention that the traditional business model was rendered inadequate and obsolete. The old model was not structured to create non-transaction-based offerings. After exchanges lost their leverage as gatekeepers of the securities markets, they needed to cater to HFTs or they would fail. The NYSE Form 10-K for 2016 reveals as much, stating that “a reduction in trading volumes could . . . result in a corresponding decrease in the demand for [its] market data, which would . . . reduce [its] overall revenue.”⁵⁹

This shift to the new exchange business model was initiated when Congress passed the NMS amendments and banned fixed commissions like those employed by the NYSE, which promoted competition to create a unified electronic national securities market.⁶⁰ Even as early as 1975, both the U.S. House and Senate admonished exchanges for their anti-competitive behavior that, in their view, insulated the public from a potentially more efficient securities market.⁶¹ This criticism indeed demonstrates that the government took into account fundamental market developments to which exchanges neglected to respond. To be sure, by the time the NMS amendments passed, Instinet and other ECNs had already proven that an off-exchange trading platform that charged lower commissions than exchanges fulfilled a market need. Thus, under congressional scrutiny and intense competitive pressure, exchanges needed to evolve their corporate structures to enhance their profit-making abilities if they were to remain rele-

57. *Supra* Part I.

58. *Id.*

59. ICE Form 10-K, *supra* note 11.

60. Securities Exchange Act of 1934, 15 U.S.C. § 78k-1(a)(1)(C)(ii) (2012).

61. *See, e.g.*, H. Rep. No. 94-123, 94th Cong., 1st Sess. (Apr. 7, 1975) at 49. *See also* S. Rep. No. 94-75, 94th Cong., 1st Sess. (Apr. 14, 1975).

vant in a market where a larger proportion of order traffic was redirected off-exchange.⁶²

III.

COMMON HIGH FREQUENCY TRADING STRATEGIES

As discussed in Part I, HFT transcends discrete definition.⁶³ Common characteristics, however, enable classification of HFTs and their key strategies. It is generally understood that there are two categories of HFT strategies: passive and aggressive.⁶⁴ Passive strategies inject liquidity into the market by posting limit orders that are not immediately executable, whereas aggressive strategies take liquidity by entering orders that are immediately executable.⁶⁵ This section identifies three strategies, one passive and two aggressive, that I will later pair with three tools sold by exchanges to facilitate HFT.⁶⁶ A brief introduction into these strategies is necessary in order to best understand how the tools provided by exchanges assist in their execution.

A. *Market Making Strategies*

Market making strategies involve submission of non-marketable resting orders—offers to buy and sell certain amounts of securities at threshold prices that are not immediately available in the market. HFTs profit on the difference between the bid prices that buyers are willing to pay for a security and the ask prices that sellers are willing to accept. In other words, HFTs offer to buy or sell a security and collect the spread—a strategy that the SEC considers “passive.”⁶⁷

The profitability of this strategy is enhanced by the maker—taker model or electronic liquidity provision insti-

62. This process was further justified by a wave of demutualization of stock exchanges around the world. The Helsinki Stock Exchange demutualized in 1995, Copenhagen in 1996, Amsterdam in 1997, Australia in 1998, and Toronto, Hong Kong, and London all in 2000.

63. See discussion *supra* Part I.A.

64. Concept Release, *supra* note 4, at 3602.

65. Matthew Baron, Jonathan Brogaard, Bjorn Hagstromer & Andrei Kirilenko, *Risk and Return in High Frequency Trading*, J. OF FIN. & QUANTITATIVE ANALYSIS (forthcoming).

66. See discussion *infra* Part IV.A–D.

67. Concept Release, *supra* note 4, at 3597. See also MILLER & SHORTER, CONG. RES. SERV., *supra* note 7.

tuted by exchanges to comply with Rule 610 of Reg. NMS's ban on locked markets.⁶⁸ This model rewards traders that add liquidity with a small rebate, and penalizes those that take liquidity with a small fee, with exchanges taking the spread between make and take rates. Exchanges profit by charging a higher taker fee than the amount of their liquidity rebates, and pocketing the difference.⁶⁹ By layering their resting market making orders correctly—a function of price and time—HFTs collect rebates across different venues. This process is called *market maker rebate arbitrage*. Put simply, HFTs compete for these maker rebates by providing—or, more accurately, posting—liquidity across multiple stocks and venues simultaneously.

By chasing spreads and rebates, HFTs in essence morph into de facto market makers, somewhat like the specialists of the NYSE of yesteryear.⁷⁰ HFTs act like market makers in the sense that they stand ready to fill all orders of a certain size that are submitted to an exchange on an automated basis,⁷¹ providing liquidity to those who have a utility for it—a pro-

68. See *supra* Part I. It is worth noting that some observers consider market making strategies the “most constructive” but “least profitable” HFT strategy. See Tyler Durden, *The Problem With HFT Explained In One Chart*, ZEROHEDGE (Apr. 10, 2014, 1:59 PM), <http://www.zerohedge.com/news/2014-04-10/problem-hft-explained-one-chart>.

69. See Jonathan Brogaard, Terrence Hendershott & Ryan Riordan, *High-Frequency Trading and Price Discovery*, 27 REV. FIN. STUD. 2267 (2014) (“Fees for liquidity demanding trades [maker fees] range from \$0.0025 to \$0.00295 per share and [taker] rebates for passive trades from \$0.0025 to \$0.0028 per share.”). Note that this is different from what HFTs profit off of—HFTs receive both the bid-ask spread and the maker rebates. See Concept Release, *supra* note 4, at 3598–99. See also Lawrence E. Harris, *Maker-Taker Pricing Effects on Market Quotations*, 2 (Nov. 14, 2013), http://www.securitiesmosaic.com/gateway/sec/speech/hujibusiness_Maker-taker.pdf.

70. See *supra* Part II.A. See also Concept Release, *supra* note 4, at 3608 (“Proprietary traders are analogous to OTC market makers in that they have considerable flexibility in trading without significant negative or affirmative obligations for overall market quality. But unlike an OTC market maker, a proprietary firm typically does not trade directly with customers. The proprietary firm therefore may not have ongoing relationships with customers that can pressure the proprietary trader to provide liquidity in tough trading conditions or less actively traded stocks.”).

71. RISHI K. NARANG, *INSIDE THE BLACK BOX: THE SIMPLE TRUTH ABOUT QUANTITATIVE TRADING*, 266–68 (2014).

foundly important role in the modern securities market.⁷²⁷³ Their collective ability to compete for and profit from rebates is a function of the tools sold by exchanges that are discussed in Part IV.⁷⁴

B. *Arbitrage or Structural Strategies*

Arbitrage is an aggressive HFT strategy with two main types: *latency* and *statistical arbitrage*. In certain instances, these strategies may also be considered “structural” strategies because they seek to exploit structural vulnerabilities in the market.⁷⁵

Latency arbitrage is relatively straightforward. It aims to exploit fleeting differences in equity prices between exchanges—differences that manifest for mere fractions of a second.⁷⁶ Gaps in pricing may occur when quotes on one trading venue are updated relatively quicker than another. For exam-

72. The SEC considers it worthwhile to support market makers’ interests because they support the market as a whole and “they are an indispensable part of an efficient and liquid market.” See Public Statement from Luis A. Aguilar, Comm’r, U.S. Sec. & Exch. Comm’n, U.S. Equity Market Structure: Making Our Markets Work Better for Investors (May 11, 2015), <http://www.sec.gov/news/statement/us-equity-market-structure.html>.

73. See also HENRY KEYSER, THE LAW RELATING TO TRANSACTIONS ON THE STOCK EXCHANGE 23 (1850) (“Were it not for this intermediary class . . . the public would experience great delay and inconvenience in their sales or purchase of stock.”). Some critics also consider liquidity in securities markets to be a public good. See Stanislav Dolgoplov, *Regulating Merchants of Liquidity: Market Making from Crowded Floors to High-Frequency Trading*, 18 U. PA. J. BUS. L., no. 3, 651, 658 (2016); see also Letter from Brent Robertson, Dir., Trading, Beta Portfolio Mgmt., OMERS Capital Mkts., to Mkt. Regulation Branch, Ont. Sec. Comm’n 5 (Oct. 4, 2013), http://www.osc.gov.on.ca/documents/en/Marketplaces/com_20131004_aequitas_omers-capital.pdf (“[T]he benefits of proper market making will accrue to all investors.”).

74. See *infra* Part IV.

75. Concept Release, *supra* note 4, at 3607. It is important to note that the SEC disaggregates arbitrage and structural strategies. However, even within the SEC’s own explanation of both strategies, significant overlaps exists. For example, exploitation of latency-based externalities is a structural issue. Therefore, for clarity purposes, I collapse these two categories in this Note.

76. See Andrew G. Haldane, Exec. Dir. Fin. Stability, Bank of Eng., Speech Given at Int’l Econ. Assoc. Sixteenth World Cong.: The Race to Zero 4–5 (July 8, 2011) (transcript available at <https://www.bis.org/review/r110720a.pdf>). It took under 200 microseconds to complete a trade in 2011 compared to 20 seconds in the 1990s.

ple, an HFT posts a limit order to buy or sell on the basis of a NBO or NBB on a NYSE affiliated venue, only to learn of a better NBO or NBB on a NASDAQ venue, all before the publicly available SIP is updated with the new quote. If the HFT's order on the NYSE is marketable and executed, then the HFT can turn and transact against the stale quote.⁷⁷ Thus, the crux of this strategy is that the NBO and NBB available on the SIP to a vast majority of retail and institutional investors is not the same as that which is provided to the HFT.⁷⁸ This activity is extremely profitable. Some estimates peg potential profits at \$21 billion,⁷⁹ and a recent class action lawsuit filed against all U.S. exchanges alleging illicit collusion with HFTs claims that latency arbitrage generates billions of dollars per year in profit for HFT.⁸⁰

After Reg. ATS increased ECN competition and Reg. NMS created a fragmented marketplace of nearly 60 visible and dark trading venues, price inefficiencies are more prevalent than ever. Fleeting price differences have practically no impact on retail and institutional investors—they could not see the gaps in pricing even if they tried. HFTs are particularly well-situated to exploit these gaps in pricing because of their superior access to speed and information.⁸¹ This comparative advantage is in part why former CFTC Commissioner Bart Chilton referred to HFTs as “cheetahs.”⁸² To be sure, transformation from a gazelle into a cheetah depends on products and services offered by exchanges that are explored in Part IV.⁸³ Moreover, whether this behavior rises to the level of illegal

77. See Merritt B. Fox et al., *The New Stock Market: Sense and Nonsense*, 65 DUKE L.J. 191, 238 (2015).

78. See *infra* Part IV.A–D.

79. See Matt Prewitt, *High-Frequency Trading: Should Regulators Do More*, 19 MICH. TELECOMM. & TECH. L. REV. 131 (2012); see also Elaine Wah, “How Prevalent and Profitable are Latency Arbitrage Opportunities on U.S. Stock Exchanges?” (Feb. 8, 2016), <http://ssrn.com/abstract=2729109> (using MIDAS stock data, she estimates that there were \$3.03 billion worth of latency arbitrage opportunities in S&P 500 stocks in 2014).

80. Amended Complaint at 6, *City of Providence v. BATS Global Mkts., Inc.*, No. 14-cv-2811-SMF (S.D.N.Y. Sept. 2, 2014).

81. See *infra* Part IV.A–D.

82. Gregory Meyer, *HFT ‘cheetahs’ get Chilton as an adviser*, FIN. TIMES (Aug. 21, 2014), <https://www.ft.com/content/e3e6fae0-2963-11e4-baec-00144feabdc0>.

83. See *infra* Part IV.A–D.

front running—trading ahead of publicly available information—is discussed in more detail in Part IV.B.⁸⁴

Statistical arbitrage is relatively more complex, albeit less controversial. It aims “to identify patterns in information that can be used to guide trading.”⁸⁵ There is an element of game theory inherent in this tactic—anticipating the reaction of other market participants is crucial to its success. Some common characteristics of this strategy include: (1) systematic or rules-based algorithmic trading signals as opposed to fundamentals-based; (2) market neutral trading books with no net exposure upon market close; (3) statistical mechanisms for generating returns; and, (4) creation of a low volatility investment strategy with positive expected returns.⁸⁶

“Pairs-trading” is the most common type of statistical arbitrage. Using algorithmic tools, candidate pairs are formed that match certain stocks with certain historical price and volatility paths. Once a stock and underlying trend are paired, trades in that stock are automatically executed according to a set of rules.⁸⁷ Put most simply, whenever there is a deviation from the “norm”—a trend or pattern determined after forming and studying the pairs and their corresponding historical relationship—an algorithm automatically buys or sells the paired security. Furthermore, pairs can be formed between a stock index and a single underlying stock, or a single stock and other stocks in the same industry. The only necessary criterion is the identification of some underlying historical relationship between the pairs and the ability to execute trades in the opposite direction of deviations from a historical path. Similar to latency arbitrage, the success of statistical arbitrage is a function of speed and information.

84. See *infra* Part IV.B.

85. Tyler Durden, *High Frequency Trading: All You Need to Know*, ZEROHEDGE, (Apr. 7, 2014, 09:23 AM), <http://www.zerohedge.com/news/2014-04-06/high-frequency-trading-all-you-need-know>.

86. Marco Avellaneda & Jeong-Hyun Lee, *Statistical Arbitrage in the U.S. Equities Market*, (July 11, 2008), <https://ssrn.com/abstract=1153505>.

87. Evan Gatev, William N. Goetzmann & K. Geert Rouwenhorst, *Pairs Trading: Performance of a Relative-Value Arbitrage Rule*, 19 REV. FIN. STUD. 797 (2006), <https://pdfs.semanticscholar.org/e5f1/b9530a587c5910ceea57ed80270ee22c73b4.pdf>.

C. *Predatory or Directional Strategies*

Directional strategies seek to anticipate price movements (the “direction”) of securities—shifts that HFTs themselves may initiate. With respect to such strategies, regulators and many market participants and academics consider them to be closely related and within the same analytical framework.⁸⁸ It is clear, however, that a key difference between them is that pure directional strategies seek to exploit price movements that occur independent of HFT activity. HFTs that implement more explicit predatory strategies create such price movements on their own. I disaggregate my analysis of the forthcoming strategies along this functional distinction.

Order anticipation or *liquidity detection* is one of the most common directional strategies. It is relatively less aggressive than related predatory strategies because trading is not actually initiated by the HFTs themselves. The strategy functions as it sounds: knowledge of an incoming order to buy or sell permits HFTs to *detect* it and to trade in the opposite direction of the *anticipated* price movement.⁸⁹ HFTs often use this strategy to trade ahead of large institutional purchases—orders that will inject liquidity into or remove liquidity from the market and significantly move the price of a particular stock.

Though one of the more benign predatory strategies, order anticipation generates controversy due to its use of “flash orders.” As an exception to Rule 611 of Reg. NMS, which requires orders executable at better prices on different exchanges to “trade through” to that exchange, flash orders are visible only to those traders (like HFTs) who have access to them—more specifically, those who paid for them. Instead of immediately rerouting a trade as Reg. NMS requires, exchanges “flash” the NBBO to subscribed traders for milliseconds, upon which that trader can choose to trade against it *before* it is sent to an “away” exchange.⁹⁰ Rule 602 of Reg. NMS exempts these flash orders from incorporation into the

88. See generally *infra* Part IV.B.

89. SEC Div. of Trading & Markets, *Equity Market Structure Literature Review Part II: High Frequency Trading*, 31–32 (Mar. 18, 2014), https://www.sec.gov/marketsstructure/research/hft_lit_review_march_2014.pdf.

90. SEC, *Fact Sheet: Banning Marketable Flash Orders* (Sept. 17, 2009), <https://www.sec.gov/news/press/2009/2009-201-factsheet.htm>.

NBBO.⁹¹ Similar to the debate surrounding latency arbitrage, some argue that this constitutes illegal front running.⁹² Others disagree because access to flash orders is available to the public, for a price.⁹³ Flash orders may also have liquidity enhancing value according to some.⁹⁴ Regardless of its merits, this strategy is commonly used by HFTs to anticipate and act on the orders of other market participants.⁹⁵

It is worth noting that this active predatory strategy may work in conjunction with passive market making strategies because it can serve as a signal detector for HFTs. For example, if an expected market-maker rebate morphs into a taker fee, HFTs can consider whether predatory strategies should be used. Using private data feeds to acquire as much information on incoming orders as possible,⁹⁶ HFTs may detect a large institutional order responsible for changing a stock's bid—ask spread and flipping the rebate into a fee. To extract alpha from this new information, HFTs can take a position opposite the institutional order and liquidate the position for a profit shortly thereafter. Passive strategies are thus combined with aggressive ones.

Momentum ignition is another predatory strategy. It attempts to trigger market participants to trade in order to cause rapid price movement, enabling the triggering firm to buy or sell for a guaranteed profit. HFTs employ this strategy by ei-

91. *Id.* The exception to Rule 602 was adopted in 1978, before the use of automated trading.

92. See Elimination of Flash Order Exception from Rule 602 of Regulation NMS, 74 Fed. Reg. 48632, 48636 (proposed Sept. 23, 2009); see also David Silver, *A Short History of Fast Times on Wall Street*, N.Y. TIMES (Sept. 17, 2009), <http://www.nytimes.com/2009/09/18/opinion/18silver.html?bl>.

93. Comm on Capital Mkts Regulation, *What is High Frequency Trading?*, MODERN MARKETS INITIATIVE, 8 (Dec. 29, 2014), https://modernmarketsinitiative.org/wp-content/uploads/2015/01/2014-12-29_CCMR-What_Is_High_Frequency_Trading.pdf.

94. Troy A. Paredes, Commissioner, SEC, Statement at Open Meeting to Propose Amendments to Eliminate Flash Orders (Sept. 17, 2009), <https://www.sec.gov/news/speech/2009/spch091709tap-flash.htm>.

95. See Nicholas Hirschey, *Do High-Frequency Traders Anticipate Buying and Selling Pressure?*, LONDON BUS. SCH. (July, 2017), <https://ssrn.com/abstract=2238516> (the author uses a NASDAQ dataset to examine order anticipation and finds that “HFT [can] identify a pattern, for example a series of marketable buy orders, that indicates that a large mutual fund will be purchasing shares of the same stock in the near future.”).

96. See *infra* Part IV.B.

ther taking a pre-position in a target security or “laddering the book”—since HFTs know that the target’s share price will likely revert back to the pre-ignition price (due to the artificial nature of the price movement), HFTs can profit on both the price rise and fall. Though momentum ignition is not always effective in instigating large price shifts, significant swings in volume can generate significant profits for HFTs that initiated it.⁹⁷ This is indeed one of the more profitable HFT strategies according to a BlackRock report.⁹⁸ Moreover, this strategy is similar to *spoofing* or *layering*, where HFTs establish positions and then submit numerous resting “test” orders that will shift the price of the target security, which are then immediately canceled, allowing the HFTs to profit thereafter when they liquidate their pre-spoofing position.⁹⁹

Quote stuffing or *spam and cancel* is a predatory strategy that often works in conjunction with structural strategies. The objective is to place a large number of orders that are immediately canceled.¹⁰⁰ To be sure, HFTs may cancel orders for legitimate reasons, for example, when algorithms detect a drop in demand, which in turn impacts price and alpha.¹⁰¹ Cancellations may also serve to create alpha in three potential ways. First, the market for the particular security slows in order to account for the explosion in interest that subsequently impacts the NBBO. This creates an artificial latency arbitrage opportu-

97. See “Momentum Ignition”—The Market’s Parasitic ‘Stop Hunt’ Phenomenon Explained, ZEROHEDGE (Dec. 14, 2012), <http://www.zerohedge.com/news/2012-12-14/momentum-ignition-markets-parasitic-stop-hunt-phenomenon-explained>; see also Hirschey, *supra* note 95, at 37 (finding that HFTs that sell stock aggressively can forecast future trading activity by non-HFTs that continues five minutes into the future).

98. See *supra* text accompanying note 67.

99. “Spoofing” is not limited to HFTs. In early 2017, the CFTC levied a \$25 million fine against Citigroup for placing orders in the U.S. Treasury futures market with the intent of canceling them to artificially increase their price shortly before liquidating its position. See Press Release, CFTC, *CFTC Orders Citigroup Global Markets Inc. to Pay \$25 Million for Spoofing in U.S. Treasury Futures Markets and for Related Supervision Failures* (Jan. 19, 2017), <http://www.cftc.gov/PressRoom/PressReleases/pr7516-17>; see also Sarah N. Lynch, *Citigroup Unit to Pay \$25 Million Over ‘Spoofing’ in U.S. Treasury Futures*, REUTERS (Jan. 19, 2017, 10:12 AM), <http://www.reuters.com/article/us-citigroup-spoofing-idUSKBN1532AM>.

100. Adam Adler, Comment, *High Frequency Regulation: A New Model for Market Monitoring*, 39 VT. L. REV. 161, 172–73 (2014).

101. See Fox et al., *supra* note 77, at 251.

nity where HFTs take advantage of slower market participants.¹⁰² Second, the HFTs initiating this strategy obtain a relative speed advantage over those HFTs that must now analyze the vast number of orders.¹⁰³ Third, though relatively rarer, some HFTs may even try to spam and cancel in order to cause an entire exchange to lag, creating artificial arbitrage opportunities across trading venues.¹⁰⁴

IV.

COMMON HIGH FREQUENCY TRADING TOOLS SOLD BY EXCHANGES

Exchanges no longer derive a majority of their revenue from transaction-based fees.¹⁰⁵ Non-transaction revenue has become the most important aspect of their bottom lines and this is in large part due to products and services that provide superior speed and data. HFTs are the most important consumers of these offerings because they are the most impactful, high-volume consumers.¹⁰⁶ This section explores three tools that exchanges offer that facilitate HFT strategies.

Before commencing this exploration, it is worth noting that even though the forthcoming tools do create an advantage for HFTs, this advantage may overstated by critics. Specifically, institutional investors have had information and latency advantages for decades vis-à-vis their privileged positions as company insiders. Moreover, evidence indicates that when large investors like hedge funds implicitly or explicitly coordinate their behavior ex ante to act in cohort as “wolf packs,” the resulting competitive advantage is significant.¹⁰⁷ Therefore,

102. Bruno Biais & Paul Woolley, *High Frequency Trading* (Toulouse Sch. of Econ., IDEI, Working Paper, 2011), <http://www.eifr.eu/files/file2220879.pdf> (finding that quote stuffing creates market congestion that impairs the market for slow traders).

103. Jared Egginton, Bonnie F. Van Ness & Robert A. Van Ness, *Quote Stuffing 2* (Miss. State Univ., Working Paper, 2011); see also Brogaard, *supra* note 6.

104. Egginton et al., *supra* note 103, at 19.

105. See *supra* Introduction.

106. *Id.*

107. John C. Coffee, *Hedge Fund Activism: A Guide for the Perplexed*, THE CLS BLUE SKY BLOG (Jan. 25, 2016), <http://clsbluesky.law.columbia.edu/2016/01/25/hedge-fund-activism-a-guide-for-the-perplexed/>.

this section's discussion of the tools offered by most exchanges to assist HFT should be viewed in this context.

A. Co-Location

Co-location allows traders to place servers in the same space where an exchange locates its own servers. To the casual observer, this privilege may seem trivial. However, shaving milliseconds of latency off of each order through co-location translates into millions of dollars' worth of profit for HFTs.

HFTs are the primary consumers of co-location which, in combination with novel order types discussed in Part C of this section, enables them to monopolize the top of the book, or at least enjoy a larger proportion of the top-of-the-book orders by allowing execution of orders first, ahead of institutional and retail orders. Users like HFTs pay handsomely for this privilege. For example, the NYSE pricing guide for co-location runs six pages long. It costs tens or even hundreds of thousands of dollars in initial and monthly fees to co-locate.¹⁰⁸ NASDAQ has three tiers of co-location, each with a different latency. As discussed in more detail in Part B of this section, even though obtaining access similar to that enjoyed by HFTs is expensive, the SEC's logic is that anyone with the money could do it, and it is therefore in line with the agency's mandate to ensure fair markets.¹⁰⁹ Co-location assists market making, arbitrage, and directional strategies because it permits HFTs to construct the NBBO faster than those using the basic SIP distributed publicly to all market participants.¹¹⁰ In other words, co-location (working in conjunction with private data feeds, discussed in

108. Co-location prices for NASDAQ are by request only, but it is inferable that they are similar to those of the NYSE. See N.Y. STOCK EXCHANGE, NYSE Price List 2017, 20–30, https://www.nyse.com/publicdocs/nyse/markets/nyse/NYSE_Price_List.pdf.

109. NYSE Euronext agreed to a \$5 million settlement over claims that it violated Reg. NMS by sending market data to proprietary data feeds before sending such data to the SIP. Co-location is not discussed explicitly, however discussion of the SEC's logic with respect to proprietary data feeds is applicable to its treatment of co-location. See SEC File No.3-15023 *In the Matter of New York Stock Exchange LLC, and NYSE Euronext* (Sept. 14, 2012), <https://www.sec.gov/litigation/admin/2012/34-67857.pdf>.

110. Adam D. Clark-Joseph, *Exploratory Trading*, Job Market Paper (January 13, 2013) (finding that aggressive HFT strategies like momentum ignition and order anticipation are aided by low latency and high frequency information, and that low latency access to market information enables ag-

Part IV.B) permits HFT strategies because HFTs can execute trades ahead of all other market participants.

B. *Private Data Feeds*

Private data feeds, also known as enriched data feeds, are sold by most exchanges and work in conjunction with co-location to rapidly provide information upon which HFTs can act. These data feeds are distributed to subscribers with more detailed information than what is publicly available on the SIP. They lay out order revisions and cancellations, whether the order – all orders processed on the specific exchange – was a buy or sell, as well as the time when these orders were placed, revised, or canceled fractions of a second quicker than the SIP.

The big four exchanges all sell private data streams,¹¹¹ and users pay handsomely for the privilege just as they do for co-location rights. For example, the monthly fees for private data feeds from the NYSE are nontrivial – they easily total in the hundreds of thousands of dollars. The real-time data pricing guide provided by the NYSE is 29 pages long.¹¹² It costs between \$1,000 and \$40,000 for a subscription to *each specific data point*, of which there are dozens.¹¹³

Taken together, private data feeds and co-location work in tandem to assist market making, arbitrage, and predatory HFT strategies. HFTs cannot maximize the value of one tool without the other, which in a sense shifts some leverage back to exchanges, which continue to charge high fees for both services, likely in recognition of their relationship. The depth of the data acquired and the speed at which HFTs can analyze and act upon that information permits HFTs to model the behavior of retail and institutional investors fractions of a second before such investors act, and allows HFTs to model short-term price movements millions of times each day. HFT are basically paying to trade ahead of publicly available information.¹¹⁴ Thus, increased speed and information allows HFTs to com-

gressive HFTs to obtain information about the market's response to their aggressive orders.)

111. NASDAQ operates ITCH. BATS operates PITCH. NYSE and Direct Edge also operate their own.

112. See N.Y. STOCK EXCHANGE, *Proprietary Market Data Pricing 2017*, <http://www.nyxdata.com/Data-Products/Real-Time-Data>.

113. *Id.* Please note that the NASDAQ pricing guide is by request only.

114. *Id.*

pete for rebates, to conduct latency and statistical arbitrage, and to initiate market movements or to take advantage of existing movements.

The SEC, through strict interpretation of Reg. NMS, considers co-location and private data feeds to be compliant with Rule 603(a)(2)'s prohibition on "unreasonably discriminatory" distribution of market data by exchanges. Specifically, the SEC interprets this provision to permit the private distribution of data, however, private data cannot "be made available on a more timely basis than core data is made available to a Network processor [the SIP]."¹¹⁵ In other words, Rule 603(a) allows an exchange to transmit data to HFTs more rapidly than to the SIP "as long as the signal sending the data to the HFT did not precede the signal sent to the SIP."¹¹⁶ In practice, through its selective enforcement, the SEC as of the date of this Note will not object to exchanges offering co-location and private data feed arrangements where the *signal* sent to HFTs does not precede the *signal* sent to the SIP. However, if such a signal is sent to HFTs before it is sent to the SIP, then the SEC seems to be willing to act.¹¹⁷ To be sure, it is widely known to the SEC and to the market that exchanges transmit data simultaneously to the SIP and private feeds, translating into speed and access for subscribers. To an extent, emphasis on the signal transmitting the information, rather than the moment when that signal is accessible, appears to be a technical loophole that exchanges, HFTs, and the SEC are unwilling to close.

Further controversy surrounds the nature of latency arbitrage enabled through co-location and private data feeds. Critics allege it is a form of illegal front running, trading ahead of publicly available information. Traditionally, a broker owes a legal duty to a customer to not use knowledge of the customer's order for personal gain. Such behavior is prohibited at the federal and industry levels.¹¹⁸ Front running occurs when a broker breaches this duty by trading ahead of a customer's order. The electronic front running enabled by latency arbitrage functions similarly, however, with a key difference that

115. See Regulation NMS, 70 Fed. Reg. 24, 37,496, 37,567, 37,569 (June 29, 2005) (adopting the release).

116. Fox et al., *supra* note 77, at 270. Emphasis added.

117. See NYSE Price List 2017, *supra* note 108.

118. The SEC prosecutes front running as a violation of Exchange Act Section 10b-(5). See Concept Release, *supra* note 4, at 3608-09.

determines its legality: HFTs have no preexisting relationship with the opposite party that places the order that it detects. Since there is no relationship, there is no duty or contractual obligation on behalf of the HFTs to behave like a broker in possession of knowledge regarding a customer's order. Of course, this interpretation may change. A recent class action lawsuit filed against all of the nation's registered exchanges as of 2014 alleged collusion with HFTs to facilitate illegal front running.¹¹⁹ However, since the SEC does not believe that properly supplied co-location services and private data feeds are "unreasonably discriminatory" under Rule 603(a), electronic front running is not illegal per se.

C. *Novel Order Types*

1. *Hide Not Slide Orders*

Novel order types, in general, are controversial in part because they are custom-built for certain exchange clients, most notably HFTs. The government¹²⁰ and industry insiders harbor such sentiments. In fact, according to former NASDAQ Executive Vice President Thomas Wittman: "Complex order types exist, in large part, to capture liquidity rebates and avoid paying access [taker] fees . . . [novel order types exist] solely as one means for exchanges and dealer systems to compete with each other [for order flow]."¹²¹

The Hide Not Slide (HNS) order type and its variations is one such controversial order and, arguably, the most significant. To illustrate, assume that HFT firm ABC is considering buying shares in Bank of America. The NBBO is \$23.01–\$23.02 on the NYSE. Further assume that ABC places a standing buy order at 3:00 PM at \$23.02 on NASDAQ and wishes to wait until that price is reached. According to Rule 610 of Reg. NMS, this is impermissible. It locks the market. If ABC's order on NASDAQ was a regular limit order, NASDAQ

119. Amended Complaint at 26, *City of Providence v. BATS Global Mkts., Inc.*, No. 14-cv-2811-SMF (S.D.N.Y. Sept. 2, 2014).

120. See *Computerized Trading: What Should the Rules of the Road Be?*, Hearing Before the Subcomm. on Sec., Ins., & Inv. of the S. Comm. on Banking, Hous., & Urban Affairs, 112th Cong. 5, 7–8, 11, 14–16, 35, 37–39, 41–42, 60, 70, 73, 75–78, 81 (2013).

121. See Thomas Wittman, Statement at the Equity Market Structure Advisory Committee Meeting 5 (May 13, 2015), <https://www.sec.gov/comments/265-29/26529-14.pdf>. Emphasis added.

would automatically “slide” the order back to \$23.01 in order to “unlock” the market. All exchanges slide such orders automatically. However, assume instead that at 3:01 PM the NBBO shifts to \$23.02–\$23.03. NASDAQ would then “slide” any regular limit orders up to \$23.02 and give them a time stamp of 3:01 PM. If ABC’s initial order was a Hide Not Slide order, then the same thing would happen, except that the order would have a time stamp of 3:00 PM, placing the order ahead of regular orders in the exchange’s order book. Put more simply, the displayed public price was \$23.01 until the market went to \$23.03, at which point the HFT’s \$23.02 order was revealed (because it was never slid back to \$23.01). Once \$23.02 was revealed, it became the new de facto NBBO. Because exchanges price slide automatically, hiding certain orders from this automated process exempts those orders from Rule 610’s ban on locked markets – the order is technically not public and not locking the market. And since the quote is not displayed publicly, it does not fall under Rule 611’s mandate that orders be routed to the venue with the best execution. Since price sliding determines which orders are placed ahead of others in the order queue, and determines when and at what price to book the orders, HFTs’ orders are hidden until the market unlocks, and then immediately jump to the front of the line as the “lit” price and are executed at that better price.¹²²

Since price sliding modifies the price of an order that locked the market by “ticking back” the order in a “convenient” and “sensible” manner, when their order is slid back, HFTs know that there was an order ahead of them with better queue placement, and that they should cancel their order and retry.¹²³ In other words, HFTs would know to cancel their slid orders because the slide indicates that the price they stand to receive is less favorable, and ordinary retail or institutional orders would subsequently move to the bottom of the book while HFTs’ orders would go to the top. Moreover, if HFTs’ orders are not slid, they are executed at the more favorable price,

122. EDGA Exch., Exch. Act. Rel. No. 74032 (Jan. 12, 2015). In 2015, Direct Edge, a BATS affiliate, was fined by the SEC for selectively disclosing information about how these orders operated to its members. *See also* BODEK, *supra* note 40, at 33–35. This paragraph’s HNS order example draws from this source.

123. *Id.*

ahead of others. This enables market-making strategies via monopolization of the top of the order book, unnecessarily exposing ordinary retail and institutional investors to HFTs.

All exchanges, with the exception of the Investors Exchange (IEX) (discussed in greater detail in Part VI.A.), currently offer this order type,¹²⁴ and the SEC penalizes those that fail to properly disclose its function. For example, BATS was fined \$14 million in 2015 for its failure to disclose, the largest penalty ever levied by the SEC against a stock exchange.¹²⁵ To be sure, because the aforementioned price sliding, locking, and unlocking happens so quickly, HNS is a tool for HFTs, not retail or institutional investors. Even though exchanges may not profit directly from the use of this order type – that is, HFTs do not pay for its use – exchanges offer it at least as a hook to gain HFT business. If an exchange fails to offer HNS, HFTs will likely go to one that does, assuming rational economic behavior.

2. *Intermarket Sweep Orders*

The Intermarket Sweep Order (ISO) combs the market for the best price regardless of the NBBO. It functions as an exemption to Rule 611 of Reg. NMS, permitting exchanges to ignore the requirement to check if the limit order should trade through any better protected price at an “away” exchange. For HFTs, this further enables passive, arbitrage, and predatory strategies.

An example of ISO in operation is useful to illustrate its importance. Assume HFT firm ABC wanted to buy 100 shares of a stock and placed an order on NASDAQ. The exchange takes the order and discovers that the lowest price is \$10 on the NYSE. However, NASDAQ finds only 10 shares available on the NYSE at that price. The order protection rule of Rule 611 would function to only allow ABC to purchase those NYSE shares at \$10, even if there are 90 shares available on the BATS exchange for \$10.10. ABC would acquire only 10 shares in this example and would need to submit other orders to obtain the remaining desired shares. Now assume that ABC used an ISO

124. BATS: BATS Only Post Only (BOPO); EDGX: ALO + Hide Not Slide; NYSE: Post No Preference ALO Blind (PNP ALO B); NASDAQ: Post Only + “Automatic Re-Entry”.

125. *See supra* note 121.

to place its initial 100-share order. ABC would be able to buy the 10 shares on the NYSE at \$10, and it would also be able to buy the 90 shares available on NASDAQ for \$10.10, bringing ABC's average price to \$10.09 and obtaining all 100 desired shares.

Like HNS, ISO is a tool offered by exchanges to attract HFT business: it enables HFTs to execute their strategies quickly. If an HFT could not obtain all the shares it ordered, even if it is at a higher cost, then its market making, arbitrage, and predatory strategies would stall. Even though exchanges offer ISO to (and it is indeed used by) institutional customers, HFTs are permitted to use it. Moreover, an ISO variant known as the Day ISO offers even more power to HFTs. Put simply, this ISO permits its user to post a quote that is executed before competing orders already posted at the same price.¹²⁶ In light of these advantages, it is easily conceivable that HFTs would take their business elsewhere if they were unable to use ISOs, since their strategies executed on a non-ISO-offering exchange would be slow relative to an exchange that does offer ISOs. This further underscores the assertion that HFTs and exchanges exist in symbiosis. HFTs continue to use these ISOs and exchanges continue to offer it to them and to enjoy their business.

V.

THE IMPACT OF HIGH FREQUENCY TRADING ON MARKET STRUCTURE

This section explores the market impact of the close relationship between HFTs and exchanges. As discussed, HFTs have had a profound impact on market structure – an impact effectuated by the tools provided by exchanges. Any impact that HFTs have on market structure is thus a direct product of their relationship with exchanges. In this section, I discuss the impact on spreads, liquidity, volatility, and price discovery. These criteria are closely tied to traditional roles played by exchanges. In order to give the most informed perspective possible, a brief literature survey is necessary. In addition to technical discussion, which is appropriate given the complexity of HFT and its impact, this section will include non-technical ex-

¹²⁶ *Order Type Guide*, DIRECT EDGE, http://cdn.batstrading.com/resources/membership/EDGE_Order_Type_Guide.pdf.

planations that will tie the selected market manifestations to the evolving role of exchanges where possible.

A. *Impact on Spreads*

The literature is unanimous that HFT has lowered spreads and that this is generally beneficial for the market because it decreases trading costs for retail and institutional investors. Pocketing the spread between bid and ask prices is partially how exchanges earn profit, although the value of this source of revenue has diminished. Narrower bid–ask spreads result in lower trading costs for all market participants: HFTs, retail, and institutional.

According to Conrad et al. (2014), HFT activity is associated with equity pricing patterns that “more closely resemble a random walk,” which in turn “significantly lower [the] cost of trading” by decreasing bid–ask spreads and commissions.¹²⁷ Hasbrouck and Saar (2013) support these findings, concluding that HFT activity has a positive, or decreasing, effect on spreads.

Exchanges originally had leverage over their constituents by virtue of their control over transaction volume in a unified market. They were the gatekeepers and were where all market participants went to buy and sell. Now, the exchanges no longer have this leverage because the market is fragmented and HFTs controlled between 55% and 75% of the total trading volume between 2009 and 2016. The explosion of transaction volumes generated by HFT translates into razor-thin spreads and the loss of exchange leverage.¹²⁸

B. *Impact on Liquidity and Volatility*

The literature is split on whether HFT activity increases or decreases liquidity and increases volatility. It makes sense to discuss both concepts together, since fluctuations in liquidity significantly influence market volatility. Exchanges and the market makers they employ have traditionally provided access to liquidity and varying degrees of market stability against volatility. As new market makers, HFTs have transformed this duty

127. Jennifer Conrad, Sunil Wahal and Ji Xiang, *High Frequency Quoting, Trading and Efficiency of Prices*, J. OF FIN. ECON. (Nov. 2014), <http://ssrn.com/abstract=2357122>.

128. See *supra* Introduction.

and now play a central role in today's market for liquidity and its attendant volatility.¹²⁹

By executing passive, arbitrage, and predatory strategies, HFT emerged as new, electronic market makers. HFTs account for a majority of the limit order executed trades,¹³⁰ and as consequence HFT strategies practically resemble market making.¹³¹ By operating continuously, automatically, and pervasively, HFTs have undermined the role of traditional market makers on exchanges, and at the very least have diminished the value of obtaining formal, designated market maker status. For HFTs, the affirmative obligations attached to official market maker status do not outweigh the inherent risks of posting quotes in times of stress, particularly since HFTs can continue to execute profitable strategies regardless of the formal market maker designation. Consequently, on the NYSE, for example, “*not a single* firm serving as a NYSE specialist in 2006 . . . [is] a NYSE designated market maker as of 2016.”¹³²

As informal market makers, HFTs have tremendous impact on liquidity. Studies support this assertion, but tension surrounds the nature of their impact. On the one hand, Rirodan and Sotkenmaier (2011) find that the overall decrease in latency in the market that is caused by pervasive HFT strategies produces an increase in market liquidity, mostly in small and medium-sized stocks.¹³³ Moreover, Hasbrouck and Saar (2013) also argue that HFTs increase liquidity in such stocks, and that they can even serve this function in times of falling demand.

On the other hand, these findings are contested by Kim and Murphy (2013), who assert that HFTs do not increase overall market liquidity because traditional measures of liquidity incorrectly assume average order sizes that are too large for

129. Joint CFTC-SEC ADVISORY COMM., RECOMMENDATIONS REGARDING REGULATORY RESPONSES 10 (2010).

130. See Jonathan A. Brogaard, *High Frequency Trading and its Impact on Market Quality* (July 16, 2010) (unpublished dissertation at 11), http://www.fisher.osu.edu/supplements/10/10463/Jonathan_Brogaard_Paper.pdf.

131. See Dolgoplov, *supra* note 73, at 659 n.29.

132. *Id.* This is with the anticipated purchases of Barclays' franchise by GTS, an HFT firm, and KCG's franchise by Citadel, a more diversified firm that could still be classified as belonging to the HFT camp, with both of these deals announced in January 2016.

133. Ryan Rirodan & Andreas Sotkenmaier, *Latency, Liquidity and Price Discovery*, J. OF FIN. MKTS. (Nov. 2011), <http://ssrn.com/abstract=1247482>.

the purposes of HFT. In other words, they argue that the stock market may look more liquid than it truly is when average order size is corrected to account for the massive volume and relatively small order sizes generated by HFTs. By collapsing buy and sell transactions in their dataset, the authors analyze trades at the speed and size at which they empirically operate, providing a more accurate depiction of HFT's impact on market liquidity. They determine that the liquidity value of HFT is overestimated.¹³⁴ There is, therefore, debate in the literature as to whether HFTs are a genuine source of liquidity. Notwithstanding disagreements, in the face of ample evidence on both sides of the argument, it is settled that HFTs are some of the most influential liquidity providers in today's market.¹³⁵

Studies regarding HFTs' collective role as liquidity providers go on to demonstrate the inherent risks of HFT-sourced liquidity through exploration of HFT's impact on volatility. In many ways, some argue that HFT has undermined market stability and created a more fragile environment where, if a handful of HFTs shift their behavior automatically, no major liquidity providers would exist to post limit orders. Since HFTs can become active liquidity takers instead of passive liquidity makers, they are potential sources of extreme volatility. This is particularly true in light of the massive trading volume generated by HFTs.

Volatility or market stability more generally can refer to many concepts, but for the sake of this discussion it refers to situations where certain events could disrupt market operations, often in rapid fashion. On a fundamental level, volatility is tethered to systemic risk, which implies emphasis on long-term instability and uncertainty. Such long-term focus is unnecessarily narrow when discussing the impact of HFT, most obviously due to the speed at which HFTs operate. Therefore, volatility will refer to both short and long-term market instability, which results in part from the impact that HFTs have on the beta of the securities in which they trade.

134. The authors in *Latency, Liquidity and Price Discovery* also find that due to HFT, "[i]n 1997–2006, the average size of a single trade was 2,700 shares, with a standard deviation of 15,000, while in 2007–2009, it was only 400 shares, with a standard deviation of 6,600." *Id.*

135. Albert J. Menkveld, *High Frequency Trading and the New-Market Makers*, 16 J. FIN. MKTS 712 (2013).

Since HFTs have “the ability to instantaneously morph into active position takers” from market makers, they may erode the quality and reliability of the liquidity that they provide.¹³⁶ This, in turn, impacts volatility. HFTs create a trading environment where thousands of trading decisions are programmed and executed automatically every second. Consequently, market stability may be upended in fractions of a second if a flaw or overestimation in HFT algorithms is allowed to compound. It is reasonable then to assume that HFT’s impact on volatility must be priced into investment decisions determined on a risk-adjusted basis.

The possibility of a sudden and severe market upheaval was brought to bear during the “Flash Crash” in May of 2010. This is the most prominent negative example of HFT’s impact on volatility. In thirty minutes, the Dow Jones Industrial Average dropped about 1,000 points, losing nine percent of its value.¹³⁷ This was the greatest one-hour decline in the history of the Dow Jones.¹³⁸ Some prominent stocks like Accenture dropped to pennies, and others like Apple skyrocketed to nearly \$100,000 per share.¹³⁹

According to the official CFTC report on the incident, a large sell order entered the market immediately before the Flash Crash, triggering HFT algorithms, notably those of prominent HFT firm Knight Capital, to trade automatically and rapidly. The attendant dramatic (albeit temporary) removal of liquidity by HFTs was thus a response to publicly available information, obtained more quickly and acted on more emphatically by HFTs than the rest of the market. The

136. See PRAGMA SEC., HFT AND THE HIDDEN COST OF DEEP LIQUIDITY 5 (2012); Stephen Bain & Shary Mudassir, *The Hidden Cost of Tighter Spreads*, TABB FORUM (Mar. 25, 2013).

137. This value was almost immediately recovered, however. See STAFFS OF THE CFTC & SEC, FINDINGS REGARDING THE MARKET EVENTS OF MAY 6, 2010 I (2010) [hereinafter Flash Crash Report]; see also Alexandra Twin, *Glitches Send Dow on Wild Ride*, CNN MONEY (May 6, 2010), http://money.cnn.com/2010/05/06/markets/markets_newyork.

138. Tom Lauricella & Peter A. McKay, *Dow Takes a Harrowing 1,010.14-Point Trip*, WALL ST. J. (May 7, 2010, 12:01 AM), <http://www.wsj.com/articles/SB10001424052748704370704575227754131412596>.

139. Fox et al., *supra* note 77, at 246 (citing Tom Lauricella & Scott Patterson, *Legacy of the ‘Flash Crash’: Enduring Worries of Repeat*, WALL ST. J. (August 6, 2010), <http://www.wsj.com/articles/SB10001424052748704545004575353443450790402>).

CFTC therefore found that HFTs were not directly responsible for the crash.¹⁴⁰ By removing their quotes in order to minimize their losses, and by liquidating any long positions, the CFTC concluded that HFTs exacerbated – but did not trigger – the dramatic price fluctuations.¹⁴¹ When combined with data that suggest intra-day volatility levels have actually declined between 2012 and 2015 despite the rise of HFT, arguments that HFTs do not contribute to increased volatility are supported.¹⁴²

Even though certain evidence suggests a positive impact on volatility, it is possible to infer a different conclusion from the same evidence. Proponents of HFT may fail to consider the broader picture in their analyses of volatility by claiming that because predatory HFT strategies were not at fault in the Flash Crash, HFTs must be exonerated from culpability. At the most basic level, HFTs' collective role as liquidity providers, either informal or formal, has a profound impact on volatility regardless of whether their predatory activities were a cause of or reaction to falling demand. This underlying reality in turn impacts both short and long-term volatility, assuming investment decisions are made on a risk-adjusted basis. In other words, HFTs' potential to actuate or accentuate a crash must be priced into a security assuming rational economic behavior.

Studies like those conducted by Zhang and Riordan (2011) support this assertion by showing that HFTs provide liquidity when demand is high and take liquidity when demand is low.¹⁴³ As a practical matter, this means that any market condition that eliminates demand would dramatically alter HFTs' ability to serve as liquidity providers and as contributors to market stability. Furthermore, studies reveal that serving as liquidity providers enhances predatory HFT strategies like momentum ignition and liquidity detection.¹⁴⁴ By continuously

140. Flash Crash Report, *supra* note 137, at 6.

141. *Id.* at 29.

142. See JAMES J. ANGEL, LAWRENCE E. HARRIS AND CHESTER S. SPATT, *Equity Trading in the 21st Century: An Update* (2013), <http://www.q-group.org/wp-content/uploads/2014/01/Equity-Trading-in-the-21st-Century-An-Update-FINAL1.pdf>.

143. Sarah Zhang & Ryan Riordan, *Technology and Market Quality: The Case of High Frequency Trading*, in ECIS 2011 PROCEEDINGS (2011), <http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1094&context=ECis2011>.

144. Dolgoplov, *supra* note 73, at 700–01.

posting limit orders, often using order types like ISO and HNS, across venues that are rapidly and automatically executed, HFTs exploit “nontransparent market structure shortcuts.”¹⁴⁵ These “transmutations of securities markets” create “stealth wealth transfers” and instances of “opportunistic skimming” and “discriminatory advantages.”¹⁴⁶ To the market, these transmutations create beta. To HFTs, they create alpha.

To be sure, this conclusion runs counter to data indicating a decline in volatility over the past five years. Moreover, even assuming a more pronounced impact on investor behavior as discussed above, the possibility of another flash crash will likely have minimal impact on measurable risk. After 2010, HFT’s potentially negative impact on short-term and long-term volatility vis-à-vis another flash crash has likely been priced into investors’ value at risk (VaR) models. The VaR impact is likely insignificant. Volatility by definition tends to “cluster”—that is, it is reasonable to assume that successive periods of volatility will be identical.¹⁴⁷ This creates trends that can be extrapolated into the future. The flash crash does not give rise to any such assumption—the net effect on prices was neutral, and quotes returned to their normal levels in minutes. Markets actually proved resilient in the face of rapidly receding HFT-sourced liquidity. To a significant extent, HFTs are *consumers* of volatility—seeking to trade across imbalances.

Notwithstanding this reality, however, the market will continue to confront liquidity and volatility concerns inherent in HFT because HFTs have no obligation to maintain fair and orderly markets, unlike the contractually designated market makers of the NYSE and NASDAQ—a relationship explored in more detail in Part V.C’s discussion of regulation.¹⁴⁸

145. *Id.* at 701.

146. *Id.* at 706 (quoting HAIM BODEK, THE PROBLEM OF HFT: COLLECTED WRITINGS ON HIGH FREQUENCY TRADING & STOCK MARKET STRUCTURE REFORM 7 (2013)).

147. IRENE ALDRIDGE, HIGH-FREQUENCY TRADING: A PRACTICAL GUIDE TO ALGORITHMIC STRATEGIES AND TRADING SYSTEMS (2010).

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

C. *Impact on Price Discovery*

The literature is split with respect to the impact of HFT on price discovery.¹⁴⁹ Facilitation of price discovery for securities pricing is an important and traditional function of exchanges. Exchanges and their market makers, formal or informal, work together to improve price discovery by continuously posting quotes for stocks that theoretically integrate all publicly available information. This enables stock prices to more accurately reflect a true “value.”

Some studies suggest overall increases in the efficiency of price discovery without regard for any differences in impact resulting from different HFT strategies.¹⁵⁰ Brogaard et al. (2014), for example, argue that: “HFTs facilitate price efficiency by trading in the direction of permanent price changes and in the opposite direction of transitory pricing errors” as a general matter. The SEC provides qualified support for this finding. Since HFTs act so quickly, particularly in the execution of arbitrage strategies, the SEC contends that they incorporate new information into their quotes ahead of others, enabling more accurate and rapid pricing.¹⁵¹ It is likely that such pricing improvements hold true in the short term.

Yet other research undermines these conclusions, especially with respect to the long term. Zhang (2010), for example, identifies decreased price efficiency due to HFT activity because markets become hypersensitive to momentum-shifting news and market developments.¹⁵² Zhang contends that HFTs as a whole have basically created their own brand of the super strong efficient market hypothesis that overestimates the true impact of market conditions on stock prices. This conclusion

149. For an overview of the forthcoming arguments in Part IV.C, see Haferkorn (2013). On balance, more studies support a positive role played by HFT in facilitating price discovery.

150. See, e.g., Jonathan Brogaard et al., *supra* note 69; Ryan Riordan & Andreas Storkenmaier, Latency, *Liquidity and Price Discovery*, 15 J. FIN. MKTS. 416, 435–36 (2012); Martin Haferkorn, *High Frequency Trading and Its Role in Fragmented Markets*, TWENTY-THIRD EUROPEAN CONFERENCE ON INFORMATION SYSTEMS (2015); Allen Carrion *Very fast money: High frequency trading on the NASDAQ*, 16 J. FIN. MKTS. 680 (2013).

151. See Concept Release, 3614.

152. See X. Frank Zhang, *High-Frequency Trading, Stock Volatility, and Price Discovery*, 33–35 (2010), <http://papers.ssrn.com/sol3/papers.cfm?abstractid=1691679>.

is more aptly applied to long-term, rather than short-term, price discovery.

Regardless of the time horizon, however, studies tend to overlook the variety of HFT strategies and their respective varied impact on price discovery. Research that actually distinguishes on the basis of strategies suggests that passive market-making strategies serve to enhance price discovery relative to aggressive, predatory strategies.¹⁵³ Moreover, statistical arbitrage strategies may also benefit price discovery, whereas latency arbitrage may not.¹⁵⁴

Notwithstanding this diversity of opinion, it is undeniable that HFT impacts price discovery. Although the nature of this impact is heretofore unsettled, one can safely assert that it is an oversimplification to consider HFT's effect on price discovery to be positive or negative in the aggregate. There must be a distinction between HFT strategies in order to identify those tactics that may improve or diminish price discovery. As the literature stands, predatory and arbitrage strategies likely tend to decouple stocks from their fundamentals, undermining price discovery.

VI.

RESPONSES TO HIGH FREQUENCY TRADING

As previous sections illustrate, HFTs enjoy latency and informational advantages over retail and institutional investors. Even if the positive and negative market consequences of these advantages balance, policymakers and market participants are now considering responses that may help level the playing field for all investors. This section divides these potential responses into three groups: competition, supervision, and regulation. Competition is purely market-based. Exchange-led supervision requires increased exchange oversight. Regulation involves actions initiated by regulators that are universally applicable to all trading venues. Of course, there is overlap between these categories, and this section only discusses a few of the many available response options.

153. See Tech. Comm. Of the Int'l Ord. of Sec. Comm'n, *Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency*, 25 (2011).

154. Matt Prewitt, *High-Frequency Trading: Should Regulators Do More*, 19 MICH. TELECOMM. & TECH. L. REV. 1 (2012).

A. *Exchange Competition*

Federal encouragement of competition between trading venues is not a novel idea. Congress and the SEC explicitly try to promote competition in the securities market in the interest of increased efficiency. Indeed, the NMS amendments, Reg. ATS, and Reg. NMS were all meant to enhance competition.

A new form of competition, however, may serve to enhance the interests of all market participants. New exchanges that explicitly avoid catering to HFTs may diminish HFTs' collective influence on market function. The manner in which this avoidance manifests can take many forms, but the most commonly advanced mechanism is a mandatory fixed delay on all trading conducted on an entire venue. IEX is the first of its kind to implement this sort of "speed bump," among other novelties.¹⁵⁵ IEX instituted its 350-millisecond delay on all orders routed to its servers in order to eliminate any latency advantages enjoyed by HFTs. This, in turn, decreases the probability that retail and institutional orders will needlessly interact with orders placed by HFTs, lessening retail and institutional investors' exposure to the passive and active HFT strategies that disadvantage them. As an added benefit, the speed bump is a market-based solution operating independent of SEC mandate, streamlining its implementation.

IEX is not without controversy. The approval of IEX as a registered exchange in October 2016 elicited strong emotions on both sides. Of course, traditional exchanges and their stakeholders proffered dozens of comment letters to the SEC arguing that IEX threatens retail and institutional investors' interests. For example, one managing director for leading market maker Citadel stated that IEX "executes market orders at dramatically worse prices, fails to execute a dramatically high percentage of those orders, and charges significantly

155. See Investors' Exchange, LLC, Exchange Act Release No. 34-78101, File No. 10-222, (June 17, 2016). IEX also refuses to offer novel order types, to pay maker rebates, to extract taker fees, and to offer co-location and "excessive" private data services. See generally, FREQUENTLY ASKED QUESTIONS, <https://www.iextrading.com/faq/>. See also Nicole Bullock and Philip Stafford, *NYSE to challenge IEX with 'speed bump' of its own*, FIN. TIMES, (Jan. 25, 2017), <https://www.ft.com/content/bc6bd4e4-e30c-11e6-9645-c9357a75844a>.

higher fees for its inferior results.”¹⁵⁶ Other opponents of IEX raised similar arguments.

In contrast, some prominent asset owners and investment managers lent credibility to IEX as a market-based response to the pervasiveness of HFT. Specifically, they claimed that IEX may “provide long-term investors and their agents with a genuine alternative in the exchange landscape: one that does not pay execution rebates, does not offer an array of complex order types, and does not emphasize speed and opportunities for structural arbitrageurs.”¹⁵⁷

Notwithstanding this difference of opinion, IEX’s approval by the SEC to operate as the country’s thirteenth registered exchange represents a new, market-based approach to addressing concerns about HFT. To be sure, it is too early to conclude whether IEX will succeed in the long run. Preliminary results, however, are positive. IEX currently holds approximately 2% of daily transactions volume,¹⁵⁸ and the NYSE announced plans in late January 2017 to introduce a delay for incoming and outgoing orders and proprietary data feeds.¹⁵⁹ Growing market share and imitation by competitors are strong indicators that exchange competition is a viable response to HFT.

B. *Individual Exchange Supervision*

Exchanges operate as self-regulating organizations (SROs) that set their own internal policies on myriad criteria within a broader regulatory framework set by FINRA, the SEC, the CFTC, and other overseers. Supervision therefore does not operate absent regulatory influence. As a general matter, instead of system-wide regulation, the SEC prefers “more flexi-

156. John C. Nagel, Esq., Managing Director and Sr. Deputy General Counsel Citadel LLC, Comment Letter Re: Release No. 34-75925; File No. 10-222; Investors’ Exchange, LLC; Notice of Filing of Application, as Amended, for Registration as a National Securities Exchange under Section 6 of the Securities Exchange Act of 1934 (Feb. 23, 2016), <https://www.sec.gov/comments/10-222/10222-411.pdf>.

157. Kevin McCreddie et al., Comment Letter Re: Investors’ Exchange LLC Form 1 Application Release No. 34-75925; File No. 10-222 (Mar. 21, 2016), <https://www.sec.gov/comments/10-222/10222-458.pdf>.

158. IEX STATISTICS (Jan 28, 2018), <https://www.iextrading.com/stats/>.

159. See John McCrank, “NYSE plans NYSE American to counter ‘Flash Boys’ exchange IEX”, REUTERS (Jan. 25, 2017), <http://www.reuters.com/article/us-ice-nyse-speedbump-idUSKBN1591YE>. See also Prewitt, *supra* note 154.

ble, competitive solutions that could be adopted by trading venues,” such as “affirmative or negative trading obligations for high-frequency trading firms that employ the fastest, most sophisticated trading tools [that are] analogous to the ones that historically applied to the proprietary traders with time and place advantages on manual trading floors.”¹⁶⁰ Therefore, according to former SEC Chair Mary Jo White, “an evolving patchwork” of “SEC-vetted rules adopted by individual trading venues” is the likely government response to the negative market manifestations of the new relationship between HFTs and exchanges.¹⁶¹

Exchanges may consider increasing their internal supervision of HFTs to guard against predatory strategies. In particular, momentum ignition and liquidity detection may be controlled with increased oversight. To be sure, trading venues already have obligations to supervise their employees to spot illegal activity. For example, the CFTC’s Director of Enforcement made clear as late as January 2017 that: “[CFTC] registrants with supervisory responsibilities must provide their employees with sufficient training and have in place adequate systems and controls to detect spoofing.” He went on to state that: “Failure to do so will have significant consequences.”¹⁶²

The SEC¹⁶³ and FINRA¹⁶⁴ have similar supervisory requirements for registrants and any brokers that they employ. Assuming that similar logic is extended to all forms of predatory HFTs strategies that as of now straddle the line of legality but have drawn the ire of critics, the exchanges not only have

160. Dolgoplov, *Regulating Merchants of Liquidity*, 712 (quoting Mary Jo White, Chair, U.S. Sec. & Exch. Comm’n, Enhancing Our Equity Market Structure: Remarks at Sandler O’Neill & Partners, L.P. Global Exchange and Brokerage Conference (June 5, 2014)).

161. *Id.* at 710.

162. See Press Release, *supra* note 99.

163. See generally Securities Exchange Act of 1934 §§ 15(b)(4), 15(b)(6), 15 U.S.C. §§ 78o(b)(4), 78o(b)(6) (2012); SEC, “Frequent Asked Questions About Liability of Compliance and Legal Personnel at Broker-Dealers under Sections 15(b)(4) and 15(b)(6) of the Exchange Act (Sept. 30, 2013), <https://www.sec.gov/divisions/marketreg/faq-cco-supervision-093013.htm>. Under Sections 15(b)(4) and 15(b)(6) of the Securities Exchange Act of 1934 under the roles and duties of Chief Compliance Officers and related personnel at SEC-registered broker-dealers.

164. FINRA Rule 3110, http://finra.complinet.com/en/display/display_main.html?rbid=2403&element_id=11345.

an inherent reputational interest in supervising against this sort of activity, but they may also have an impending affirmative legal obligation as well. There already seems to be a trend toward increased internal supervision absent regulatory mandates. ICE, the parent of the NYSE, actually banned “disruptive market practices” on its exchanges in the beginning of 2015.¹⁶⁵ This includes practices like momentum ignition that “mislead” the market.

It is worthwhile, however, to consider exchange-led initiatives independent of universal, system-wide methods of curbing the influence of HFTs. Of course, exchanges are likely loath to upset their customers with increased oversight. It is at the very least plausible though that public and regulator sentiments regarding the newfound symbiosis of exchanges and HFTs will sour significantly in the medium or long terms, particularly if retail and institutional investors exercise their collective muscle in the markets and in Washington. Indeed, an increasingly critical atmosphere indicates just how plausible this souring has become.

C. *Universal Regulation*

System-wide, universal regulation is the most impactful and obtrusive option to address the impact that the relationship between HFTs and exchanges has on the market. In many ways, regulation resembles a system of increased supervision discussed above in Part V.B. As discussed, the SEC indeed prefers a system of heterogeneous, exchange-implemented rules. Regulators, however, must also consider more consequential blanket requirements, regardless of their preference for market-based solutions. Simply put, the forthcoming recommendations are too structural and too impactful to originate from any entity other than the government.

1. *Eliminate or Sync Private Data Feeds; Ban Co-Location; Limit Novel Order Types*

One of the most straightforward suggestions to rein in the activities of HFTs is to eliminate the tools provided by ex-

165. Intercontinental Exchange Notice on Disruptive Trading Practices, https://www.theice.com/publicdocs/futures_us/exchange_notices/IFUS_Disruptive_Practices_Notice.pdf?spMailingID=10268326&spUserID=MTE0Mzg0NDQ4NzIS1&spJobID=442380389&spReportId=NDQyMzgwMzg5S0.

changes to assist HFT strategies. For example, the SEC may consider requiring private data feeds to sync with the SIP or to be eliminated altogether. This would decrease the number of arbitrage opportunities because speed creates advantages for HFTs and conflicts of interest for exchanges. The SEC's stated objective is to ensure that all market participants have equal opportunity to obtain up-to-date (or, more accurately, up-to-the-millisecond) market data, and syncing data feeds may sufficiently serve this aim.¹⁶⁶ In addition, a ban on co-location would similarly undercut the speed advantage enjoyed by HFTs. Regulators may also consider limiting the use of novel order types offered by exchanges for either institutional or retail investor use, if applicable. Taken together, the removal of the three tools—private data feeds, co-location, and novel order types—used by HFTs would take leverage away from HFTs and return it to exchanges.

Although simple, elimination or limitation of private data feeds, co-location, and novel order types would negatively impact exchanges in the short run.¹⁶⁷ In the long run, it is conceivable that the cost of lost revenues would be passed to other exchange clients in the form of higher costs of trading. Regardless of the impact, however, it is safe to assume that for-profit exchanges would fight such regulation tooth and nail, considering the tremendous profits generated from these non-transaction services.¹⁶⁸ Moreover, the indiscriminate curtailment of HFT activity en masse may not be a desirable outcome given the aforementioned impact of HFT on spreads, liquidity, volatility, and price discovery.

2. *Market-Maker Obligations*

Many purport that if HFTs were required to post limit orders to buy or sell stocks traded on exchanges at all times regardless of market conditions like traditional market makers, then their potentially negative impact on liquidity and attendant market volatility might be mitigated.¹⁶⁹ As discussed in

166. See NYSE Price List 2017, *supra* note 108.

167. See Charles M. Jones, *What Do We Know About High-Frequency Trading* 10, 26 (Columbia Bus. Sch. Research Paper, Paper No. 13-11, 2013), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2236201.

168. See *supra* Introduction.

169. E.g., Oliver Linton, Maureen O'Hara, and J.P. Zigrand, *Economic Impact Assessments on MiFID II Policy Measures related to Computer Trading in Finan-*

Part IV, HFTs already operate as informal market makers. The SEC, however, has not mandated that all HFTs become true designated market makers (DMMs) or contractual market makers (CMMs) with affirmative obligations to the exchanges on which they operate.

As it stands, from the perspective of HFTs, the inherent risk of acting as a formal market maker—obligated to buy or sell certain securities under prevailing market conditions—is not balanced with greater access to the top of the order book, lower transaction fees, and higher rebates currently offered by trading venues.¹⁷⁰ Therefore, as a practical matter, HFTs are not inclined to encumber themselves with affirmative obligations to the venues on which they trade.¹⁷¹ Moreover, seeking formal market maker status is undesirable for HFTs because of the nature of the new relationship they enjoy with exchanges: they purchase tools to execute strategies, which undercuts the value of formal market maker status. Some observers contend that this status quo creates a “race to the bottom in which market maker obligations are completely eviscerated.”¹⁷² Surprisingly, however, many HFTs actually want the SEC to impose stricter market-making obligations.¹⁷³ These firms believe that

cial Markets 17-20 (U.K. Gov’t Office for Sci., Aug. 2012), https://secure.fia.org/epta-downloads/Economic-Impact-assessments-on-MiFID-2-policy-measures_083012.pdf.

170. They obtain higher market maker rebates through their DMM status. See Order Approving Proposed Rule Change by NASDAQ OMX BX, Inc. Relating to Directed Market Makers, Exchange Act Release No. 74,129, 80 Fed. Reg. 4954 (Jan. 23, 2015), <https://www.sec.gov/rules/sro/bx/2015/34-74129.pdf>.

171. Vikas Raman, Michel A. Robe & Pradeep K. Yadav, *Electronic Market Makers, Trader Anonymity and Market Fragility* Dec. 2012, U.S. COMMODITY FUTURES TRADING COMM’N, http://www.cftc.gov/idc/groups/public/@economics/analysis/documents/file/oce_electronicmarket1212.pdf.

172. Letter from Peter Kovac, Chief Operating Officer & Fin. & Operations Principal, EWT, LLC, to Elizabeth M. Murphy, Sec’y, U.S. Sec. & Exch. Comm’n 19 (Aug. 27, 2010), <https://www.sec.gov/comments/s7-02-10/s70210-279.pdf> (“The definition of market making activity and the establishment of incentives for this activity should not be the left to individual market centers . . . [and the SEC should avoid] a situation which leads either to a race to the bottom in which market maker obligations are completely eviscerated, or to exclusive market maker designations that increase dependence on single firms.”).

173. Michael Morelli, *Regulating Secondary Markets in the High Frequency Age: A Principled and Coordinated Approach* 41–42 (June 2016) (unpublished discussion paper) (on file with the John M. Olin Center, Harvard Law School)

creation of affirmative market-making obligations to exchanges would decrease the possibility of sporadic incidents of volatility, like the Flash Crash.

In order to impose market-making obligations on HFTs without imposing onerous costs, regulators must first consider a requirement for HFTs to remain in the market for a certain period of time during trading hours and to quote competitive prices for certain securities with a minimum market capitalization within an exchange's *publicly disseminated* NBBO.¹⁷⁴ By requiring HFTs to remain in the market at all times, regardless of another Flash Crash scenario where HFT algorithms detect a drop in demand (either legitimate or not), the quality of HFT-sourced liquidity may improve and overall market volatility may fall. Sporadic incidences of volatility would certainly be eliminated if HFTs were required to remain exposed, and there would be no uncertainty regarding HFTs' ability to provide liquidity in times of stress.

Opponents of these obligations assert that they might actually have the opposite of their intended effect. First, as a general matter, market makers stand to incur potentially huge losses if they are required to post quotes continuously, even in times of stress. This is not a novel criticism of market making obligations. Indeed, exchanges recognize this risk by compensating market makers through lower access fees (specifically, lower "taking" fees). Opponents, however, further argue that risks of losses to HFT go beyond those incurred by traditional market makers because HFT strategies are regularly implemented across multiple trading venues and classes of securities. In other words, HFTs are highly exposed. Thus, if HFTs are obligated to post quotes continuously, opponents argue that the results will be catastrophic for HFTs and the market as a whole—undermining market liquidity and exacerbating volatility. If an HFT goes down, it will bring the market down with it. These concerns are well-founded, but potentially resolvable.

(citing Liz Moyer, *High-Frequency Firms Urge SEC to Add to Market-Makers' Obligations*, FORBES (Jul. 13, 2010), <http://www.forbes.com/sites/streetaalk/2010/07/13/high-frequency-firms-urge-sec-to-add-to-market-makers-obligations/#775bc43e29bb>).

174. This is similar to what the EU has done with MiFID I and II. See 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/>.

For example, the MiFID II system implemented in the EU, which regulates algorithmic trading on public exchanges, permits market makers to exit the market in response to “exceptional circumstances.”¹⁷⁵ Regulators can fashion such an escape hatch in order to bring HFTs into a market-making fold that creates a more regulated and orderly market for all.

A more fundamental problem voiced by opponents of extending market making obligations to HFTs concerns the enforcement of such obligations. It is difficult for regulators to enforce requirements to continue to post quotes in times of stress, especially as market stress begins to look more like a market crash.¹⁷⁶ If the market needs liquidity and HFT market makers instead close their positions to minimize their exposure, in violation of their affirmative obligations, then the market impact of their refusal will manifest immediately and long before regulators can initiate any corrective action. The purpose of market making obligations will be circumvented without prompt enforcement. This is, however, a problem inherent in market making generally and not market making by HFTs specifically. Therefore, this too may be resolvable. For example, trading venues can compensate HFTs for assuming increased market-making risks through reformation of the maker-taker model, discussed in more detail in Part V.C.3. Of course, such reform must be in conjunction with a MiFID-inspired escape hatch because as a practical matter, in times of extreme market stress, market makers of any designation will join the rest of the market in removing liquidity.

Another concern relates to the possibility that HFTs could evade market-making obligations to continuously post quotes if “quote” is defined too loosely in their agreements with exchanges.¹⁷⁷ For example, as former SEC Chairman Mary L. Schapiro alludes, HFTs may be able to post a quote on NASDAQ that bets on market movement in one direction, and simultaneously post a quote on the NYSE in the opposite direction of the first quote at a non-competitive price. This process is called “stub quoting,” and would undermine, not

175. See Tony Katz & Puesan Lam, *MiFID II: Microstructural Issues*, DLA PIPER (Oct. 2015), https://www.dlapiper.com/~media/files/insights/publications/2015/10/dla-piper_mifid-ii_microstructural-issues_october-2015.pdf.

176. See Fox et al., *supra* note 77, at 271–74.

177. Morelli, *supra* note 173, at 41–42.

strengthen, the quality of liquidity provided by HFTs as market makers. This challenge, however, is again not insurmountable. The SEC could institute guidelines regarding the nature of the quotes posted by HFTs to eliminate stub quoting. Minimum quote sizes and maximum quote lengths would ensure that placing bets on either side of a quote would not create a profitable arbitrage opportunity. In addition, requirements that market making HFTs post quotes within the publicly available NBBO range for certain securities may help to create sufficiently well-defined obligations that do not impose costly compliance burdens. The SEC restricted stub quoting by market makers in 2010, but has not extended this to HFTs.

Even if market-maker obligations are implemented, their enforcement will rest largely on the exchanges themselves as SROs. This creates an enforcement issue. Moreover, from the exchange perspective, any attempt to create a universal national system of market making obligations for HFTs would be both difficult to formulate and implement since market makers and trading venues—visible and dark—operate in heterogeneous systems governed by different rules.¹⁷⁸ From the perspective of HFTs, it is unlikely that all HFTs are convertible into official market makers given the sheer variety of their trading strategies and inter-venue operations.¹⁷⁹ Streamlining this would be difficult, perhaps prohibitively so. Notwithstanding the potentially positive impacts on liquidity and volatility, the question remains as to whether providing any trading privileges—perhaps in the form of regulatory concessions—to offset any trading obligations circumvents the purpose of extending such obligations to HFTs in the first instance.¹⁸⁰ In addition, in light of the aforementioned costs to HFTs and the practical hurdles inherent in extending market-making obligations, this requirement is likely not feasible.

3. *Dynamic Maker–Taker Fees*¹⁸¹

Recall in Part II the discussion of the maker–taker pricing model instituted by exchanges to comply with Reg NMS’s ban on locked markets. Exchanges reward traders that add liquid-

178. Dolgoplov *supra* note 73, at 711.

179. *Id.*

180. *Id.* at 709–10.

181. Morelli *supra* note 173, at 42.

ity with a small rebate and penalize those that take liquidity with a small fee, with exchanges taking the spread between make and take rates. Critics argue that the relationship between HFTs and exchanges and the impact of HFT on market structure would be positively transformed if this model was amended or abolished.

As a general matter, the maker-taker model as it stands creates potential conflicts of interest between brokers and their customers.¹⁸² Brokers have a legal duty to seek the best execution of their customers' orders. The maker-taker model, however, incentivizes brokers to execute orders on venues that offer the highest rebates or the lowest fees. Large brokers, like TD Ameritrade, E-Trade, Fidelity, and Scottrade, currently structure their routing algorithms on bases that maximize rebates or minimize fees, with most of their orders sent to EDGX.¹⁸³

The maker-taker model is also criticized for its opacity and complexity.¹⁸⁴ According to some critics, "certain fee-rebate structures are deliberately nontransparent and available only to select market participants."¹⁸⁵ The most prominent example of such selectivity is the creation of novel order types, discussed in Part IV.B.1, that cater to HFTs by enabling their strategies like market-maker rebate arbitrage, among others. In addition, the diverse mix of rebate and fee structures across venues makes the process of identifying the venue of execution complex for retail and institutional investors. Consequently, it is unclear to most market participants where their orders are sent and whether they were executed at the best price or for the best fee or rebate. These complications inherent in the maker-taker model are largely products of the new relationship between HFTs and exchanges, and further underscore the need for reform.

182. See, e.g., Letter from Sen. Carl Levin (D-MI), to Mary Jo White, Chair, SEC (July 9, 2014) (https://www.hsgac.senate.gov/download/levin-letter-to-sec-chairman-mary-jo-white-re-equity-market-structure-july-15_2014).

183. See, e.g., Robert Battalio, Shane A. Corwin, & Robert Jennings, *Can Brokers Have it All? On the Relation Between Make-Take Fees and Limit Order Execution Quality*, 71 J. FIN 2193, 2194 (2016)

184. See, e.g., Stanislav Dolgoplov, *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).

185. *Id.*

One of the most common suggestions for improvement involves lowering the current cap on maker–taker fees in a dynamic, tiered manner.¹⁸⁶ This recommendation was eloquently set forth in a 2015 open letter penned by BATS CEO Joe Ratterman.¹⁸⁷ Since Reg NMS’ implementation in 2005, Ratterman writes, the relationship between market makers, brokers, and exchanges has evolved. Alluding to the impact of HFT—without explicitly mentioning it—Ratterman contends that liquid stocks do not need tethering to maker–taker fees in order to provide market makers (like HFTs) with incentives to post narrow spreads for such stocks—they will trade at high volumes anyway. By tying maker–taker fees to the liquidity of a stock, determined on the basis of a stock’s historical characteristics, he advocates that a tiered rebate and fee structure is preferable. This structure could take into account whether a stock is illiquid, moderately liquid, or highly liquid, determined by the stock’s historical characteristics. In addition to maintaining a market for less liquid securities, which is in part a key consideration behind the use of maker–taker fees, Ratterman argues that this system eliminates conflicts of interest.¹⁸⁸ Even though the transparency of this system may not improve and its complexity may actually increase under a new dynamic fee structure, market makers operating under a new system may be adequately incentivized to provide liquidity in times of crisis vis-à-vis fees that treble up or down on the basis of market conditions for a particular stock. This would be a valuable shift.

Dynamic maker–taker fees could therefore address the stranglehold that HFTs have on exchanges. They could cut into the profitability of passive market making strategies and simultaneously ensure that HFTs are incentivized to provide liquidity in times of low demand if they are brought under official market making designation—addressing the enforcement problem discussed in Part V.C.2 above. It could be in the exchanges’ financial interests to enforce these obligations. If HFTs are compensated in times of stress, then they may be

186. The current cap is set at \$0.003 per share. 17 C.F.R. 242.610(c).

187. See Open Letter from Joe Ratterman, Chief Exec. Off., BATS & Chris Concannon, President, BATS, (Jan. 6, 2015) (<http://cdn.batstrading.com/resources/newsletters/OpenLetter010615.pdf>). This paragraph draws from this source.

188. *Id.* See also Dolgoplov, *supra* note 73, at 726.

more likely to post quotes when they are most needed. Furthermore, a dynamic maker–taker fee structure could enhance the quality of liquidity that HFTs provide and address concerns regarding HFT’s contributions to market volatility. Tying maker–taker fees to the evolving characteristics of a stock—to market capitalization, volatility, liquidity, and volume—could thus enable exchanges to cleave leverage away from HFTs and to minimize HFT’s negative externalities.

Of course, it is unknown if the dynamic maker–taker fees will function in the aforementioned positive ways in practice. This is because, as a practical matter, HFTs already post narrow quotes. Moreover, such a system will most likely fail in times of extreme stress. When the guillotine falls, HFTs will predictably behave as ordinary market participants: they will liquidate positions and halt trading. Thus, while dynamic maker–taker fees more clearly serve to address the conflicts of interest confronted by exchanges, it is empirically unclear if they will have the intended impact on the behavior of HFTs and their attendant influence on liquidity and volatility.

4. *Batch Auctions*

Aside from a ban on co-location and private data feeds, previously discussed regulatory recommendations neglect to directly address one of the chief advantages enjoyed by HFTs: speed. HFTs helped establish—and exchanges helped facilitate—a market where price is secondary to speed, particularly in a fragmented system.¹⁸⁹ Indeed, thanks to a continuous trading system, the trader that first accesses and acts on information will profit over others, even those willing to offer a superior price. Batch auctions can undermine the prioritization of speed by eliminating the continuous trading system.¹⁹⁰ Instead, batch auctions would permit execution of orders only at fixed, predetermined intervals across venues that then process these orders simultaneously.

In the spirit of syncing or banning private data feeds, the batch auction system would ensure that all traders have access to the same pricing information at the same time. Subse-

189. Morelli *supra* note 173, at 34.

190. See Eric B. Budish, Peter Cramton, & John J. Shim, *The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response*, THE Q.J. OF ECON. (Nov. 2015).

quently, price would become more important than speed because, assuming hidden bids, the trading venue on which an order is submitted will not necessarily be the venue on which that order is executed—a result over which HFTs currently exercise a significant degree of control through use of arbitrage tactics that leverage latency advantages. Under a batch auction system, HFTs would struggle to implement their passive and predatory strategies dependent on speed, and exchanges would subsequently scale back their efforts to cater to them.¹⁹¹ Abandonment of the continuous system can therefore decouple the interests of HFTs and exchanges.

As a practical matter, however, the impact of batch auctions on liquidity and volatility are potentially negative. Fixed interval auctions by definition undermine liquidity, relative to a continuous system. Imagine, for example, you have a row of ten coins equally spaced one inch apart in a straight line. Imagine further that you are tasked with keeping all the coins in a straight line at all times, and the coin in the center is subsequently moved up by one inch. To fulfill this task, you would simply move the other nine coins up one inch to create a straight line. This process would be fairly quick if executed continuously. But imagine that you were only able to move the other nine coins once every five seconds. The process slows. Moreover, in between these intervals, where some—but not all—of the coins are moved upward, the impact is distortive. Even though the goal is for all ten coins to be in a straight line, four coins could be up, while six could be down for five seconds; five coins could be up and five could be down for another five seconds, and so forth. If these coins represent tradable securities in a basket—for example, the underlying securities of an ETP—and the fixed intervals represent batch auctions, then it is easy to see how accurate price discovery could be inhibited by this system. In other words, a five second snapshot of the market is not representative of true market conditions—it is incomplete. Moreover, if a batch auction system is implemented across trading venues, then this interconnectedness can increase incidences of volatility in the securities market.¹⁹² In addition, arbitrage opportunities across venues may still materialize, sustaining HFTs' profitable

191. Morelli *supra* note 173, at 34.

192. *Id.*

advantages. Thus, without modifications to address these concerns, batch auctions are risky.

Another, more structural obstacle is the extant regulatory regime itself. Specifically, it could be difficult to implement batch auctions under Rule 611's requirement to route orders to the venue quoting the best NBBO. If all trading venues must conduct batch auctions, then brokers will be unable to determine the best NBBO until *after* an auction's conclusion, preventing (or at least hindering) compliance with Rule 611 and negatively impacting price discovery. Reg. NMS would thus need to be modified to permit such a system. Considering that it took 30 years after the NMS amendments for the SEC to adopt Reg. NMS, any necessary changes will probably take time.

5. *HFTs Registration; Kill Switches; Financial Transactions Tax; HFT Ban*

HFT can be corralled in several other ways worth mentioning in brief. First, a requirement that all HFTs register with the SEC and FINRA and make regular disclosures may increase the transparency of HFT strategies. Even though many HFTs are already subject to SEC oversight as brokers, increased scrutiny may disincentivize predatory activities and improve overall market transparency, fairness, and stability. In 2015, the SEC proposed an amendment to Rule 15b9-1 of the Exchange Act that would require many HFTs to register with FINRA.¹⁹³ Some policymakers like former SEC Commissioner Luis Aguilar believe that registration "will ensure that . . . [HFTs] can be held responsible for any potential misconduct."¹⁹⁴

Second, a requirement that all trading venues and HFTs install "circuit breakers," or "kill switches," for example, a brief (i.e., five-minute) pause on trading activity for certain liquid shares of large market capitalization firms that drop significantly (for example, 10%) in market price in the preceding

193. Securities Exchange Act Release No. 74581 (March 25, 2015), 80 FR 18036 (Apr. 2, 2015). *See also* 15 U.S.C. §78, et seq.

194. Jeff Kern & Brian Garrett, *SEC Requires FINRA Registration for High Frequency Traders* (March 27, 2015), CORPORATE AND SECURITIES LAW BLOG, <http://www.corporatesecuritieslawblog.com/2015/Goo03/sec-requires-fin-raregistration-for-high-frequency-traders/Enforcement>.

few minutes, could be a cost-effective way to prevent incidences of volatility like another flash crash. Opponents of kill switches consider them to be difficult to implement because it is unclear when a trading venue should halt trading, even with defined thresholds in place. The NYSE, for example, actually had a kill switch in place during the Flash Crash, but failed to cease trading.¹⁹⁵ Regulators, like former CFTC Commissioner Bart Chilton, nonetheless have contended that kill switches may be useful “in the event that cheetah programs [used by HFTs] go feral.”¹⁹⁶

Third, a tax on all orders, whether or not executed by HFTs, would help prevent speculative behavior, decrease intraday trading volumes, and shift investor time horizons away from the short-term and toward the long-term.¹⁹⁷ Joseph Stiglitz and other proponents of a financial transactions tax, also referred to as a “Tobin tax” after Nobel laureate James Tobin, maintain that a small fee on every order would suffice to generate positive impact.¹⁹⁸ Indeed, a Tobin tax has growing support in the EU.¹⁹⁹ Taxes, however, can have distortive impact on the allocation of capital, and can actually disincentivize financially and socially profitable investing behavior.²⁰⁰

In order to prevent these potentially perverse consequences, some suggest taxing only those orders above a specified order-to-trade ratio. For example, NYSE Euronext recently implemented a surcharge on each order above a 100:1

195. Emmanuel Olaoye, *Kill switches may be too difficult to implement despite new call by CFTC member, expert says* (Oct. 17, 2102), REUTERS, <http://blogs.reuters.com/financial-regulatory-forum/2012/10/17/kill-switches-may-be-too-difficult-to-implement-despite-new-call-by-cftc-member-expert-says/>.

196. *Id.*

197. Jared Bernstein, *The Case for a Tax on Financial Transactions* (July 22, 2015), N.Y. TIMES, https://www.nytimes.com/2015/07/22/opinion/the-case-for-a-tax-on-financial-transactions.html?_r=0.

198. Steve Matthews, *Stiglitz Calls High-Speed Trading “Front Running,” Suggests Tax*, BLOOMBERG (Apr. 15, 2014), <http://www.bloomberg.com/news/2014-04-15/stiglitz-calls-high-speed-trading-front-running-suggests-tax.html>. See also Buttonwood Blog, “Tobin or not Tobin?,” THE ECONOMIST, (Nov. 4, 2011), <http://www.economist.com/blogs/buttonwood/2011/11/taxing-finance>.

199. C. R., *Do Tobin taxes actually work?*, THE ECONOMIST (Sept. 10, 2013), <http://www.economist.com/blogs/economist-explains/2013/09/economist-explains-1>.

200. Zsolt Darvas & Jakob Von Weizsäcker, *Financial Transaction Tax: Small is Beautiful*, BRUEGEL POL. CONTRIBUTION (Feb. 2010).

order-to-trade ratio.²⁰¹ This means that a fee is imposed for every 100 canceled orders.²⁰² This surcharge—a form of transaction tax—could disincentivize latency arbitrage and predatory strategies like quote stuffing, but may also disincentivize *all* quote revisions above the ratio by HFTs.²⁰³ Even though there is heretofore insufficient empirical data to pass definitive judgment, even a limited tax may widen spreads, diminish liquidity, and harm price discovery. Therefore, if such a tax is desirable, it may be more appropriate for exchanges to adopt it independent of regulatory mandate—competition would ensure that customers decide for themselves whether the costs outweigh the benefits.²⁰⁴

Finally, the most extreme option for mitigating the impact of HFTs is to ban their operations outright. Nobel laureate Michael Spence notably advanced this idea.²⁰⁵ This is, however, practically untenable. It is settled that HFT have positively impacted spreads. Also, as discussed in this section, with some regulatory adjustment, HFTs' heretofore mixed impact on liquidity, volatility, and price discovery can be improved. A ban on HFT is also risky for similar reasons why a transaction tax is undesirable – it may decrease liquidity, increase volatility and inhibit price discovery.

6. *Three-Pronged Approach Aimed at Exchanges*

Short of a complete rebuild of the regulatory framework upon which Reg. NMS was built, a potentially viable approach to effectively regulating the relationship between HFTs and exchanges involves a mix of novel market-based and bold regulatory action. Even though the market impact of HFT is not entirely understood to be positive or negative, certain steps can be taken now given what we know. I recommend a two-step

201. Fox et al., *supra* note 77, at 268.

202. *Trade to Order Volume Ratios*, U.S. SECS. AND EXCH. COMM'N (Oct. 9, 2013), <https://www.sec.gov/marketstructure/research/highlight-2013-01.html>.

203. Fox et al., *supra* note 77, at 268.

204. *Id.*

205. Matthew Philips, *Should High-Frequency Trading Be Banned? One Nobel Winner Thinks So*, FREAKONOMICS, (Mar. 28, 2011, 12:00 PM), <http://freakonomics.com/2011/03/28/should-high-frequency-trading-be-banned-one-nobel-winner-thinks-so/>.

regulatory approach that should work in conjunction with private actors.

First, the maker-taker model ought to be abolished. Even the modification to a dynamic system suggested by BATS' Ratterman does not go far enough. Under a dynamic system, opportunities for opportunistic aggressive HFT strategies remain. As discussed in Part III, these strategies are Pareto efficient in favor of HFTs at best. Moreover, a dynamic system will likely not adequately incentivize HFTs' market-making activities in times of stress given that the risks to HFTs would still outweigh the benefits. Indeed, market making under all market conditions runs counter to the ethos of every HFT strategy discussed in this Note – that is, the profitability of these strategies is known with reasonable certainty *ex ante*. Rebates and fees thus primarily exist to create perverse incentives and to subsidize HFTs at the expense of optimal price execution for ordinary investors.²⁰⁶

Opponents of abolishment could argue that it threatens the liquidity of lightly traded, small-to-medium cap stocks. This argument, however, is exaggerated. It is unnecessary to incentivize ordinary market participants to trade in less liquid securities given that the rebates and fees are so miniscule that the only market participants they could possibly incentivize are HFTs. They are the only player engaged in trading at such high volumes on an intraday basis that a fee of 2 cents per 100 shares sold or a rebate of 3 cents per 100 shares purchased is potentially significant.²⁰⁷ Moreover, HFTs are the chief consumers of enriched data on order flow generated as a by-product of the maker-taker model. Therefore, if this system is abandoned, the profitability of HFT strategies will diminish. If HFTs still wish to engage in passive market making, they will need to do so the old-fashioned way, pocketing the difference between a buy and sell price like the specialists and dealers on the NYSE and NASDAQ of yesteryear. The preservation of passive market-making strategies, minus rebates, will serve to maintain the potentially positive impact that such strategies

206. *See generally*, ELAINE WAH ET AL., A COMPARISON OF EXECUTION QUALITY ACROSS U.S. STOCK EXCHANGES (2017).

207. *Trading Fees*, N.Y. STOCK EXCH., <https://www.nyse.com/markets/nyse/trading-info/fees> (last visited Feb. 6, 2018).

have on liquidity, price discovery, and volatility while eliminating the potential costs.

Second, in conjunction with eliminating an unnecessary subsidy on trading, the SEC should begin to enforce Rule 603(a)(2)'s prohibition on "unreasonably discriminatory" distribution of market data by exchanges more strictly. If the language is read less permissively to apply not to the timing of the *signal* that transmits the information, but rather to the timing of the *access* of such information, HFTs will no longer be able to pay for co-location and private data feeds. The appeal of novel order types will also diminish due to the de-prioritization of speed. Functionally, such a shift in SEC enforcement will actually serve to correct the imbalances and unintended consequences of Reg. NMS. Trading will no longer be a race divorced of fundamentals; it will become a thoughtful exercise rooted in reality. If the Rule 603(a)(2) enforcement loophole is shut, then aggressive and predatory HFT behavior will fade. Passive strategies could still be employed, but HFTs could no longer transform into arbitrageurs.

Third, competition from exchanges like IEX that eliminate novel order types, rebates, and fees, and execute all trades simultaneously is a market-based solution that regulators ought to encourage while it corrects the current landscape. Indeed, the SEC's recent approval of IEX in October 2016 is a positive first step. If the elimination of the maker-taker model comes to pass, then the option to send orders to IEX becomes more appealing. Once HFTs' profits shrink in the absence of rebates and brokers begin to seek the true "best execution" of orders—that is, not chasing the lowest fees and highest rebates at the expense of their customers' interests—exchanges like IEX will serve as the platform where the incentives of investors and exchanges realign and the securities markets regain their fairness. With a regulatory environment that favors venues like IEX, order flow could conceivably shift away from venues where ordinary investors needlessly interact with HFTs.

CONCLUSION

This Note explores the relationship between HFTs and stock exchanges. It traces the market and regulatory origins of HFT, identifies a shift in exchange business models that

sought to cater to the new market structure, examines key HFT strategies and how exchanges facilitate them, and illustrates the inadequacy of the prevailing regulatory framework.

At a fundamental level, this Note asks: What do stock exchanges accomplish today? Do they serve as guardians of market stability and investor protection, or do they serve their own financial interests? Do they encourage the promotion of capital formation for all, or do they promote the business of a minority class of shareholders and market participants at the expense of the majority? As this Note illustrates, exchanges exist today in significant part to serve their shareholders. The fragmented and computerized landscape of the contemporary market dictates that the best—and perhaps the only—way exchanges can achieve this end is to serve HFTs which, in turn, rely on the exchanges as powerful allies to maintain the status quo.

As this Note was written, however, the NYSE released new, optional connectivity tools at increased costs that shave even more milliseconds of precious latency off of order execution.²⁰⁸ Moreover, NASDAQ will introduce a 350-millisecond delay in order execution, but only on one of its trading venues.²⁰⁹ By creating this idiosyncratic gap in time, the exchange has either intentionally or accidentally created yet another cross-venue arbitrage opportunity for its best customers under the guise of market equality. Even though motives are unclear, these actions support the notion that the once symbiotic relationship between exchanges and HFTs is becoming increasingly parasitic—a potential signal of impending turmoil in the implicit alliance between HFTs and exchanges.

Unless the SEC acts to close the loopholes that permit the customizable sales of latency and data, and unless competing exchanges can cleave trading volume away from the old guard, ordinary investors will continue to lose. Luckily for the public, however, the status quo is slowly beginning to reveal the exchanges' true colors: green.

208. See Coffee, *supra* note 107. When compared to the 2016 NYSE Pricing List, dozens of additional connectivity options are now offered at varying latencies. Assuming the HFT business model still relies on the minimization of latency, these new offerings are meant to capitalize on a NYSE's newly minted leverage over their HFT clients.

209. See *supra* note 154.