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High Frequency Trading

Meditations on the Controversy

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Executive Summary

The mystique of High Frequency Trading (HFT) has come to dominate much of the public discourse since the allegations of a putatively "rigged market" emerged following the publication of Michael Lewis' incendiary novel *Flash Boys*. But a deeper examination of the history and practices of High Frequency Traders reveals that the issue may not be so simple as to admit of clear heroes and villains.

Ever since the genesis of algorithmic trading strategies in the late '90s, advocates have preached the immense efficiency gains from HFT (i.e. reduced trading costs and higher liquidity). Yet, critics have complained that these benefits are illusory; that HFT practices are, on balance, a bane to markets and operate by unfairly disadvantaging other investors. Naturally, these contradicting replies to the HFT phenomenon lead one to wonder: what exactly is the net effect of HFT? Is the market truly rigged? Which side is correct? What could be the source of this confusion?

However, by tracing the history of High Frequency Trading from its early origins to the more recent flash crash of 2010, it becomes clear that contemporary high frequency trading is much more nuanced than its supporters or detractors are apt to portray it. It is only by first recognizing the diversity of HFT strategies that one may begin to address the question of high frequency trading's impact on markets.

Unfortunately, due to the scarcity of data and the lack of a consistent definitional framework, the conversations around the subject have tended to linger at an impasse, remaining hostage to the constantly shifting winds of popular sentiment. The questions about HFT cannot be definitively resolved without more substantial transparency and a better grasp of the constantly evolving world of high frequency trading strategies.

Nonetheless, in considering the history of HFT and acknowledging the different types of strategies, it appears that certain classes of HFT activity pose unique challenges to market quality and may warrant additional regulatory scrutiny. To this point, recent regulatory initiatives by the SEC are expected to bring much needed transparency to the HFT landscape. But for most asset managers, it appears that HFT is not believed to be a significant threat due to the fact that they employ strategies with long-time horizons that are largely immune to the short-term activity that certain HFTs have been known to exploit.

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Introduction

The issue of High Frequency Trading (HFT) has been a subject of much controversy and debate for the past decade.[1] Although the practice in its current incarnation has been around since the late '90s, recent events in the media have rekindled the controversy over HFT. Amid the clamor of advocates and detractors, HFT has come to acquire numerous definitions, and as a result, it has become increasingly difficult to form, much less articulate, any sort of definitive opinion on the matter. Whenever such uncertainty about complex subject matter exists, there will invariably be those that arise to capitalize on the public tendency towards alarmism through hyperbole and sensationalist narrative (viz. *Flash boys*).[2] However, in such situations it becomes all the more vital to avoid falling prey to reactionary sentiment. In line with this philosophy of prudent judgment, this paper will attempt to summarize and elucidate salient aspects of the current HFT controversy.

We begin by providing a historical background for the controversy and proceed into a contemporary definitional framework for HFT. This is followed by an examination of the arguments for and against HFT and concludes with our final reflections on the subject. As a caveat, given the multifaceted nature of the subject, the perspectives presented herein are necessarily limited and represent the authors' best efforts to reconcile the diverse views of various HFT authorities from the public, private and academic arenas.

A Historical Groundwork for High Frequency Trading

While computerized trading was initially dominated by activity on the NASDAQ and NYSE, the introduction and spread of trading venues known as electronic communication networks (ECNs) revolutionized the market by establishing network systems that facilitated the exchange of financial products outside of traditional exchanges.[3,4] The passing of Regulation Alternative Trading Systems (Reg ATS) in 1998 further legitimized the use of ECNs and encouraged their growth. The rise in the use of early ECNs saw a concomitant increase in market operational efficiency associated with reduced costs and the lowered risk of trading errors that naturally resulted from automation.[5]

The proliferation of these ECNs in the late 1990s were accompanied by a rise in the use and development of increasingly more sophisticated algorithmic

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trading strategies, the ancestral precursors to many of the contemporary HFT algobots being discussed today. Many of these early algobots arose in response to the introduction of the maker-taker fee structure (the first of which established in 1997 by Island ECN) which charged a fee for liquidity access and provided rebates to liquidity suppliers on ECNs.[6]

Then in 2001, stock prices began to be quoted in decimals in lieu of fractions. The decimalization of the markets reduced the minimum price movement from 1/16th of a dollar to 1/100th of a dollar per share and resulted in an increase in liquidity which led to a corresponding surge in algorithmic trading as traders began splitting orders according to their algorithms to execute trades more efficiently.[7]

The next major market-structural development in HFT history was the passage of Regulation National Market System (Reg NMS) in 2005 and its subsequent implementation in 2007.[8] Reg NMS was a series of initiatives intended to modernize and strengthen the national equity markets. Principal among the new rules introduced by Reg NMS was the replacement of the loose definition of "best execution" with the more strictly defined "best price," taken to be the National Best Bid Offer (NBBO). The NBBO was in turn calculated by compiling all bids and offers for all equities within the Securities Information Processor (SIP). However, the unrelenting advancement of algorithmic trading eventually resulted in technologies that allowed select firms to process market data faster than the SIP. Naturally, AT firms began to develop specialized algorithms to capitalize on this and other appurtenant inefficiencies, eventually giving rise to the current incarnation of HFT firms.

With the advent of the modern HFT came what is commonly referred to as the "high frequency arms race", a resource competition between HFTs that had sunk millions of dollars in the development of their respective network infrastructures for advantages over one another as marginal as one microsecond.[9] One technique that emerged through the arms race that has gained a popular notoriety as of late is "co-location", the simple act of physically positioning an HFT firm's server in the same room as that of the SIP.

In more recent memory, HFTs have come to be associated with market "glitches" that have been interpreted by many as an increase in market fragility.[10,11] The most salient of these glitches was the Flash Crash of May 6th, 2010, during which a large, fundamental trader initiated a sell algorithm for the

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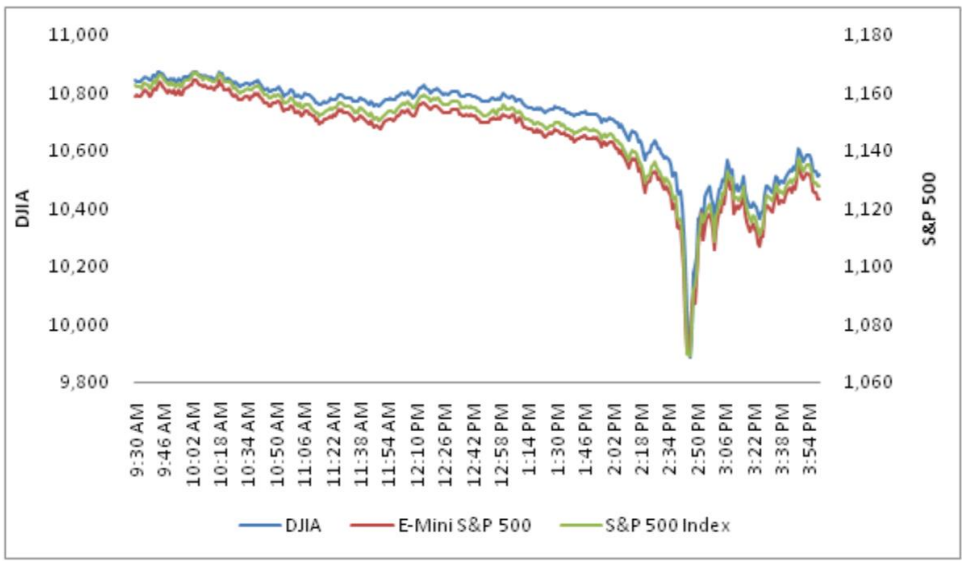
sale of 75,000 e-mini S&P futures contracts as a hedge to another of their existing positions. It is conjectured that the sell pressure generated by this large order was absorbed by HFTs, causing them to accumulate temporary long positions. In turn, the HFTs responded by aggressively selling their e-mini contracts to reduce these long positions. The instigating large sell order, coupled with the aggressive HFT sales, resulted in a strong downward price pressure that was exacerbated by a lack of corresponding demand for the e-minis. Consequently, a "hot potato" volume effect resulted as HFTs began to buy and sell the e-minis to one another, and the initial instigating order responded by increasing the frequency of its orders. The result was that within the 20 minutes between 2:40 p.m. and 3:00 p.m., 20,000 trades were executed at prices discounted 60% or greater than their initial 2:40 p.m. prices.[12] The visual representation of this event was widely witnessed as the Dow Jones Industrial Average plummeted 9% within the brief span of 20 minutes.[13]

Exhibit 1: May 6th Flash Crash as represented in select equity and futures indices.



Source: Bloomberg

However, as is often the case with most events in recent history, the exact interpretation of the causes behind the Flash Crash continues to be disputed. While some have pointed to the May 6th crash and other similar glitches as dispositive proof of HFT's aggravation of market fragility, HFT supporters have riposted that the quick recovery (relative to pre-AT periods) during the May 6th crash is actually evidence in favor of HFT's having improved market efficiency.[14]

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Regardless of which side ultimately proves to be right, one thing is certain: High Frequency Trading has indelibly altered the structure of the equities market.[15] In the early 2000s, HFT was estimated to account for 10% of total U.S. equity trades, while by late 2012, HFT was expected to comprise roughly 40 to 60% of all activity in the U.S. financial markets.[16] More recently however, estimates from a variety of sources have suggested that the prevalence of HFT market activity may actually be on the decline. The Brattle Group notes for instance that HFT trading volume has contracted by approximately 10%, and profits among HFT firms have been likewise exhibiting a declining trend after peaking in 2009.[17,18]

What is High Frequency Trading?

Having established a historical context for High Frequency Trading, the next necessary component to begin an intelligible discussion will be a definition of HFT. But any perfunctory review of the literature in the professional and academic circles will quickly reveal a considerable amount of discord as to what High Frequency Trading is, precisely. Some have defined High Frequency Trading as being synonymous with any form of rapid, automated trading while others have conflated HFT with more general algorithmic trading strategies (AT).[19,20] Others still have elected to circumscribe HFT as comprising only those predatory forms of algorithmic trading that have disadvantaged ordinary investors and fostered a "rigged" market system.[21]

Given the range of definitions on offer, we believe the broadest definition that most closely captures the consensus views is that provided by the SEC, which defines* a High Frequency Trader as "professional traders acting in a proprietary capacity that generate a large number of trades on a daily basis" with five typical characteristics: [22]

1. The use of extraordinary high-speed and sophisticated programs for generating, routing, and executing orders.
2. The use of co-location services and individual data feeds offered by exchanges and others to minimize network and other latencies.
3. Very short time frames for establishing and liquidating positions.
4. The submission of numerous orders that are cancelled shortly after submission.
5. Ending the trading day in as close to a flat position as possible.

*The SEC notes that this set is non-exhaustive and merely denotes those attributes that are most commonly identified among HFT firms.

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Clearly, as the above definition illustrates, there is substantial latitude for a wide diversity of different algorithmic trading strategies to fit the proverbial bill. The first obvious and critical fact to recognize is therefore the heterogeneity of HFT strategies.[23] Secondly, note that given the characterization of "high-speed and sophisticated programs," all High Frequency Traders are necessarily a subset of Algorithmic Trading strategies.[24] These distinctions will be crucial in the ensuing discussions.

Numerous perspectives have commented on this heterogeneity by superimposing their own taxonomic classifications of HFT strategies predicated on various attributes such as: latency differentials (low vs. ultra-low), analytics utilized, firm organization, and algorithmic function (market-making vs. arbitrage vs. opportunistic, etc.) to name a few.[25,26] These may again be further atomized into an innumerable set of unique types (e.g. structural, directional, latency, etc.).[27]

In light of the extremely variegated landscape of HFT strategies, it is easy to see where much of the confusion regarding HFT stems from. Since much of the recent controversy has centered on the impact of HFT practices, a classification of HFTs based on their tactics appears most pertinent to the current conversation. Borrowing from the SEC's HFT concept review and the work of economists Bruno Biais and Thierry Foucault, we may conceive of four general categories of HFT strategies:[28,29]

1. *Automated Liquidity Provision / Market-Making strategies* – involving the submission of non-marketable resting orders that provide liquidity to the marketplace at specified prices. Passive market-making strategies may generate an enormous number of order cancellations or modifications as orders are updated.

2. *Arbitrage strategies* – those strategies that seek to capture pricing disparities between related products or exchanges. Arbitrage strategies are not dependent on directional price moves, but on price convergence.

3. *Structural strategies* – strategies that exploit structural vulnerabilities in the market or in certain market participants.

4. *Predatory / Directional (a.k.a. Manipulative) strategies* – are controversial strategies that typically involve the establishment of long or short positions in anticipation of price movements. There is some question of potential overlap between manipulative-predatory type and directional-based strategies.

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4. (Cont.) Of particular interest have been those algos classified by the SEC as "order anticipatory" and "momentum ignition-based".

a. Order Anticipatory / Liquidity Detection strategies – seek to ascertain the existence of large buyers and sellers in the marketplace and then trade ahead of those buyers or sellers in anticipation that their large orders will move market prices. This was infamously catalogued by Michael Lewis as the alleged "front-running" of orders by HFT.

b. Momentum Ignition strategies – involve initiating a series of orders in an attempt to ignite a rapid price movement upon which to exploit by quickly unwinding their position for a profit at the artificially inflated price or by buying at a deflated price.

While the aforementioned predatory strategies have come under a number of different names (e.g. market-taking, latency arbitrage, slow-market arbitrage, dark pool arbitrage etc.), Biais and Foucault, along with the economists David Easley, Marcos Lopez de Prado, and Maureen O'Hara have further identified additional predatory behaviors by HFT that may pose significant threats to markets.[30,31] In particular:

Quote Stuffing – occurs when HFTs purposefully send a high number of order messages with the goal of slowing down the speed at which other traders process market information.

Spoofing – occurs when an HFT places orders that belie their true intentions and quickly cancels the orders before they are executed. The aim being to potentially scare other market participants into trading against the HFT's discreetly placed true order.

Quote Dangling – occurs when an HFT sends quotes that force a squeezed trader to chase a price against their interests.

Smoking – is the posting of alluring limit orders by HFTs to attract slow traders and then rapidly revising these orders to more costly terms in hopes of executing profitably against the incoming flow of slower trade orders.

Liquidity Squeezing – when a distressed large investor is forced to unwind their position, these strategies will then trade in the same direction and drain as much liquidity as possible in the hopes of overshooting prices that the HFT can exploit for profit.

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Pack Hunting – occurs when two or more HFTs become mutually aware of each other and coordinate to raise the probability of triggering cascading effects upon the price or volume of trades.

It is important to note that this classification schema serves only as a general approximation of various HFT behaviors to facilitate discussion. It should not be construed as a normative judgment upon HFT firms as it is possible that many HFT firms may, to varying extents, engage in a mix of predatory, market-neutral, and market-enhancing strategies. Moreover, it has long been a feature of markets that traders have always tended to work their orders for better outcomes, utilizing whatever advantages they may find available to them. That being said, having established a historical context and conceptual framework for High Frequency Trading, we now turn to a review of the contentions made in defense of and against HFT.

HFT and Market Quality

In surveying the battlefield of HFT arguments, it is easy to be overwhelmed by the vast variety of partisan claims that are each extolling and castigating HFT for different things. However, the controversy is quintessentially a question of how High Frequency Trading impacts market quality. At one end of the spectrum are claimants who assert that the presence of HFT has fostered an entire "rigged market" system. On the other end of this spectrum are those advocates who proclaim that HFT has raised the market to new heights of efficiency.[32,33] Although "market quality" is itself a nebulous concept, the debate surrounding it may perhaps be more intelligibly analyzed through the lens of three principal issues: efficiency, stability and fairness.

Efficiency

From the perspective of efficiency, the detractors of High Frequency Trading have alleged that High Frequency Traders aggravate market volatility, impede long-term price discovery by trading on non-fundamental information and cause a net increase in transaction costs through the superfluous and parasitic intermediation of existing trades (i.e. scalping and low-quality, fleeting liquidity).[34,35,36] On top of this, critics contend that the entire niche industry of HFT has resulted in a significant deadweight loss resulting from the massive resources sunk in the HFT infrastructural arms race.[37]

On the other hand, proponents of HFT argue that it has been responsible for dramatically improving market liquidity by reducing tick sizes and consequently narrowing bid-ask spreads.[38] As a corollary, advocates claim that HFT has

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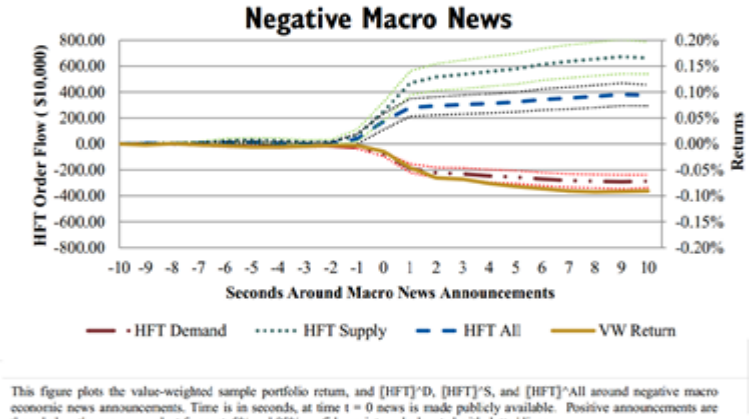
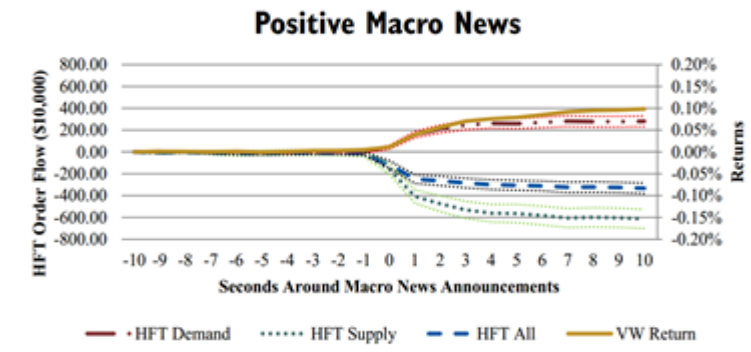
drastically ameliorated the efficiency associated with price-discovery through the near-instantaneous processing of relevant market information.[39]

Of recent interest, for instance, has been the work of ECB economists Jonathan Brogaard, Terence Hendershott and Ryan Riordan, which finds that, on both high-volatility days and on average, HFT activity is generally conducive to efficiency by being aligned with correct price signals against short-term volatility and does not cause instability through liquidity withdrawal in volatile circumstances. In particular, the authors find that HFT firms generally buy on negative macro news and appear to lose money in doing so. On the opposite side, HFTs will tend towards selling when positive news occurs. In sum, the authors find that HFT firms behave as market makers by taking the opposite side of trades that other participants seek to make in response to macro news.[40]

Exhibit 2: HFT trading and portfolio returns in response to different types of macro news*



This figure plots the value-weighted sample portfolio return, and [HFT]^D, [HFT]^S, and [HFT]^All around negative macro economic news announcements. Time is in seconds, at time t = 0 news is made publicly available. Positive announcements are those below the average analyst forecast. 5% and 95% confidence intervals denoted with dotted lines.



This figure plots the value-weighted sample portfolio return, and HFT^D, HFT^S, and HFT^{All} around positive macro economic news announcements. Time is in seconds, at time $t = 0$ news is made publicly available. Negative announcements are those below the average analyst forecast. 5% and 95% confidence intervals denoted with dotted lines.

Source: Brogaard et al., 54.

*Figures purport to demonstrate that macroeconomic announcements contain information to which HFT trading is related. In particular, the figures show that information is not fully incorporated into prices immediately and returns drift for a few seconds post-announcement. HFT demand follows similar drift, but the fact that HFTs' liquidity supply is greater than their liquidity demand is taken as evidence that HFT actively supplies liquidity surrounding macroeconomic announcements.

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However, despite this apparent efficiency gain, critics would be quick to point out that their findings are limited to one set of market-making HFTs that may quite simply be being beaten to the punch by faster HFTs.[41] Thus, once again, there is nothing that can be definitively claimed about the overall effect without also considering the efficiency impacts that these other HFT firms are having.[42]

Ultimately, whether this activity is truly more contributive to market noise or actual signals will be the deciding factor in determining if HFTs are promoting efficiency or hindering price discovery and thereby encouraging volatility.

Unfortunately, in spite of the recent evidence proffered by Brogaard et al., the academic literature on this front provides no clear resolution and continues to be highly mixed.[43,44]

And what of other liquidity indicators of efficiency such as trade volume? While much of the literature purports that HFT has been overall beneficial to market liquidity, critics have begun to doubt the relevance of these liquidity measures for assessing the impact of HFT activity in consideration of the transient and riskless nature of the positions assumed by HFT firms.[45]

Many of these doubts can be traced to the maker-taker fee structure that spread alongside the development of ECNs in the late 1990s and early 2000s. The introduction of liquidity fees and taker rebates naturally resulted in the appearance of HFT firms created for the sole purpose of capturing the spread between the maker rebate and the taker fee. Indeed, these maker-taker oriented strategies comprise a significant portion of the arbitrage-type HFT behavior discussed in our classification schema and are, for many HFT firms, their core competency. As these rebate-capture HFT strategies grew, the result was a drastic increase in trade volume on exchanges as HFTs traded in stocks with tight spreads, buying and selling 100 share increments thousands of times daily with extremely brief holding periods. While these developments radically changed the dynamics of the market, it is not yet clear whether HFT rebate-capture strategies are ultimately more beneficial to market liquidity through the resultant tightened spreads or whether the additional volume noise generated by these strategies is having a larger distortive effect upon true price discovery.

Stability

One of the most frequently voiced anxieties about HFT is that it has introduced, into the market, a high degree of systematic fragility of the sort that is commonly ascribed to the May 6th Flash Crash.[46] Predictably, this claim is disputed by HFT

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defenders who point to the multiplicity of factors surrounding the Flash Crash and make the counterclaim that the crash was principally the result of "human error." More staunch supporters have gone further in asserting the counterfactual: that HFT was responsible for preventing the crash from more disastrous deterioration.[47] Regrettably, since the impact on stability is inextricably tied to the unresolved question of the microstructural impact of HFT activity (i.e. whether it tends toward noise intensification or signal refinement), the net impact of HFT practices on market stability remains in contest. However, the clustered occurrence of similar algorithmic related market glitches in the months and years following the May 6th Flash Crash have lent credibility to the case that HFT, if not directly responsible for the Flash Crash, certainly contains the embedded potential to significantly aggravate market fragility.[48]

Exhibit 3: Timeline of clustered HFT related market glitches

Date	Event Description
3/23/12	The third largest U.S. stock exchange, BATS, halts trading in its own stock during its IPO, after a series of technical glitches in its system that disrupts the share prices of Apple and other companies. The system bug led to BATS' price plummeting from an opening level of $15.25 to less than a tenth of a penny in a second and a half.
5/18/12	An unanticipated bug in NASDAQ's IPO system interacts with trading behavior to delay Facebook's highly anticipated IPO by thirty minutes. U.S. regulators in March 2013 approve a NASDAQ plan to reimburse customers as much as $62 million for related losses.
8/1/12	Market-maker firm Knight Capital Group Inc. loses $460 million shortly after the open of trading at the NYSE, due to an error in newly installed trading software. The software malfunction led the firm's computers to rapidly buy and sell millions of shares in over 100 stocks for about 45 minutes after the markets opened. Knight was subsequently forced to seek rescue financing; it was eventually acquired by rival Getco LLC.
4/23/13	A Twitter hoax wipes $200 billion of value from U.S. stock markets in a flash. An alleged Associated Press tweet falsely reports that President Barack Obama had been injured in attacks on the White House, sending the Dow Jones Industrial Average, the NASDAQ and the S&P 500 all down by 1% immediately.
4/25/13	A software glitch shuts down the Chicago Board Options Exchange for half the day, stalling all trading activity in its heavily traded stock-index options contracts.
8/6/13	Trading outages affect both the BATS and Direct Edge exchanges, which together represent an average of approximately 20% of overall U.S. stock trading volume.
8/20/13	Goldman Sachs Group Inc. sends erroneous orders into the U.S. stock-options market due to a technical error, disrupting prices.
8/22/13	The SIP providing prices for stocks and exchange-traded funds listed on the NASDAQ Stock Market fails after suffering connection problems with the NYSE Arca exchange, paralyzing the market for all NASDAQ-listed securities for three hours. (The main data feed for NASDAQ-listed stocks went down again briefly on September 4, 2013). NASDAQ has since stated that it will manually shut off other exchanges' connections to SIP if they flood it with electronic messages in the future.
9/9/13	A computer glitch at the Federal Reserve Bank of New York blocks Goldman Sachs' multibillion-dollar order of three-month U.S. Treasury bills, altering prices in the debt market.

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9/16/13	U.S. options trading briefly grinds to a halt due to a problem with a benchmark data feed (the Options Price Reporting Authority, or "OPRA"), supplying options prices to traders.
9/18/13	Traders in Chicago exchange as much as $600 million in assets in the milliseconds before most other traders there could learn of the Fed's announcement to continue economic stimulus, faster than the speed of light.
9/25/13	NYSE Euronext and NASDAQ OMX Group discuss a plan to address technology glitches, in which each company would run a backup for the other's benchmark stock-pricing data.
9/26/13	A technology problem at the smaller electronic stock exchange run by BATS Global Markets Inc. prompts the company to switch its operations to a backup facility in Chicago after halting trades earlier in the day.

Source: Goldstein et al., "Computerized and High-Frequency Trading". The Financial Review (forthcoming), 21–22.

A corollary issue that may perhaps be more directly addressed is that of adverse selection. Opponents have charged that, because HFT trades on "privileged" information that is unavailable to the broader market (e.g. latency arbitrage and flash orders), HFT discourages market participation by the broader investing public.[49] The argument is extended to assert that this adverse selection effect has resulted in considerable market fragmentation reflected by the dark pools that have arisen to cloak order flow information. This argument has most recently been popularized by Michael Lewis in stylizing the entire financial market as a rigged system catering to the needs of HFT firms at the expense of non-HFT investors.[50]

While there is undoubtedly some degree of adverse selection at play in the financial markets, it is unlikely to be the case that HFT has engendered a rigged market to the extent that Lewis and others have imagined.[51] Aside from the fact that the recent evidence reflecting a diminution of HFT activity is contrary to the notion of an HFT-dominated financial system, the scarcity of accurate and useful data sets renders most claims about the scope of HFT's dominance dubious, to say nothing of a claim that professes that the entire stock market is rigged.[52]

Fairness

The central issue of HFTs market quality impact is that of fairness as any claim to an efficient market must imply one in which fairness is relatively robust. On this question, the two most common charges made against HFT have been the possession of unfair advantages and the practice of electronic front-running.

With regards to unfair advantage, opponents contend that HFT firms have privileged access to information through co-location, direct feeds and other speed advantages (e.g. flash orders, etc.) that permit them to exploit slower investors. While this differential access to information is troubling, insofar as

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the advantages conferred are a function of the returns to the intellectual capital invested by these firms, some of these advantages, though bizarre, may not necessarily be unethical.[53,54]

However, the most notoriously unfair advantage that HFTs stand accused of is the practice of electronic front-running (most commonly associated with, but not limited to, the predatory HFT algorithms that employ "order-anticipatory" and "momentum ignition" tactics). The basic idea is that, because an HFT is privy to an earlier view of the market than a non-HFT investor, HFT is able to trade ahead of the non-HFT investor and extract unfair arbitrage profits from their orders.

On the other hand, defenders of HFT categorically deny these charges of electronic front-running.[55] To bolster their defense, they contend that HFTs do not handle any customer orders as front-running is strictly defined as being "when a firm/person enters into an agreement to buy or sell an option or security when such member or person associated with a member causing such order to be executed has material, non-public market information concerning an imminent block transaction in the underlying security…or when a customer has been provided such material, prior to the time information concerning the block transaction has been made publicly available." [56] To the second obvious point that HFT is still engaging in the illicit use of information before it has been made publicly available, its defenders retort that order information is considered public at the very instant that it is placed. Therefore, it is not unfair for HFTs to view the information in advance. Superior speed, goes the popular refrain, ought not to be confused with front-running.[57]

Yet despite this bit of legalistic legerdemain, at some visceral-intuitive level, many are still apt to believe that there remains something fundamentally unfair about many HFT strategies if not in practice. To some, it would seem that HFT defenders are playing a game of doublespeak: moving the semantic goal posts around the concept of fairness by hiding behind specific outmoded legal definitions while opportunistically exploiting other regulatory omissions.[58,59] The fact that HFT has this effect of upsetting many of our innate notions of fairness has undoubtedly been a contributing cause to the persistent public fascination with HFT and the animus of its detractors. But while the impression of unfairness may often serve to indicate actual wrongdoing, is the perception of an injustice synonymous with an actual injustice?

In questioning current conceptions of what makes for an equitable market, it quickly becomes apparent that the concept itself, like HFT, is amenable to

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a variety of definitions. Among these diverse definitions of economic justice, perhaps those most relevant to HFT are those of "procedural fairness," which deals in the just application of rules to all parties, and of "distributive fairness," which primarily concerns the equality of outcomes.[60] In this context, HFT might be considered as outwardly conforming to procedural fairness while perpetrating a distributive inequity; hence the outpour of outrage against HFT.

However, the complexity of HFT fairness is complicated further by the fact that the very allegations of adverse market impacts continue to be questioned (i.e. ambivalent results regarding efficiency and stability impacts). Moreover, the diversity of different HFT strategy types must be accounted for in evaluating how each unique strategy type conforms to notions of procedural and distributive justice. For instance, while it is conceivable that many arbitrage, structural and market-making HFT strategies may ultimately be exonerated of violating fairness norms, those predatory HFT strategies that aim principally at the manipulation of markets at the expense of other participants (e.g. momentum ignition, quote stuffing, etc.) may potentially prove to be both blatantly unethical and illegal.[61] In extending this analysis, much of the overall ambivalence concerning other aspects of HFT are more than likely the result of a similar failure to adequately discriminate between the distinct species of HFT strategies. Recent events in the popular press have only served to further confound the issues by vilifying HFT as an inherently unfair, monolithic market cancer.[62]

Ultimately, the complexity of this issue has meant that there is not currently an objective, easy and clear-cut answer to the question of how HFT firms are impacting the costs of investment managers as a group. But in attempting to gauge the winds of the inchoate public consensus, a survey of Bivium's own manager pool revealed that the overwhelming majority of managers estimated that the impact of HFT upon their trades has been negligible due to the fact that they employ strategies with long time-horizons that are largely immune to the short-term price volatility that aggressive HFTs are known to exploit.[63]

Closing Thoughts: High Frequency Frontiers and the Evolution of Market Microstructure

Having reviewed the essential aspects of the HFT debate, it is obvious that the subject eludes a clear resolution within the confines of the current conversation. As some experts have opined, to confront the issue of HFT is "to confront a basic problem with financial innovation: the difficulty of measuring its benefits" and its costs.[64] Beyond this difficulty of impact

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quantification however, is a problem of an insufficient level of discrimination. As the discussion on fairness has revealed, any effort to determine the fairness of HFT requires a prerequisite grasp of the existence of a diverse taxonomy of various HFT strategies. A related difficulty may be the over-proliferation of different classification systems and the lack of a consistent set of identifiers for HFTs. In any event, the failure to have a relatively clear and consistently agreed-upon set of classifications that can adequately account for the subtle distinctions of the HFT world perpetuates an equivocal conversation that permits each side, armed with their respective pet papers and tendentious interpretations of evidence, to argue vehemently (and fruitlessly) the merits of their favored ideologies.

To illustrate, take the example of HFT's effects upon market efficiency. It is undoubtedly true that there has been a correlation in the past decade between lowered trading costs and the rise of automated trading. But as we all know, correlation is not causation. And just exactly what share of the gains is attributable to HFTs as opposed to generic AT, if at all? What is the consensus on where the proper bright line should be drawn between a generic AT and an HFT? How should we measure these gains against the harmful classes of HFT activity? (Or, for that matter, against the deadweight loss of HFT resource tournaments?) These are all difficult questions that academics continue to struggle with.[65] But until these twin problems of insufficient discrimination and measurement ambiguity are resolved, or at least significantly ameliorated, the HFT discussion will likely continue to be one that is full of sound and fury but little insight.

In recognition of these difficulties with the current dialogue and in returning to our initial taxonomy, perhaps the very least that may be said is that there exists, at the broadest level of distinction, beneficial and deleterious forms of HFT.[66] To the extent that it is possible, future regulation will need to focus on constraining detrimental practices and eliminating actual unfair advantages without undoing the efficiency gains that may have been borne from HFT.[67] The first step will be the devising of reliable metrics that can accurately assess the market impact of different HFT strategies. From there, an accurate assessment of HFT impact on market quality will require a comparative analysis of the relative prevalence of harmful versus helpful HFT activity within the market. Without this analysis, the true impact of High Frequency Trading will continue to be limited to vague consensus and boisterous opinion.

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Arriving at this disappointing and inconclusive result makes it tempting to view this entire examination as having been a feckless meditation, an elaborate exercise in mental shoulder shrugging as so many agnostic voices in the debate have opted to express.[68] But we need not be so pessimistic. Rather than being resigned to the irresolution of this Gordian knot, reflecting upon the problem's nuances has highlighted the need to update our regulatory, ethical and market structure paradigms to accommodate the high-speed world of HFT.[69,70] The controversy itself is perhaps the best evidence for the inadequacy of our dated frameworks in evaluating market efficiency and trading microstructure in the contemporary world of HFT. Nonetheless, even in the absence of a definitive resolution to the controversy, the shadow of the Flash Crash and the potential for aggressive strains of HFTs to unfairly manipulate markets suggests a need for new regulatory safeguards.[71]

In response to this need, the SEC has recently launched several probes into the HFT world and proposed a number of new reforms intended to rectify potentially market-adverse elements of HFT. These planned initiatives include: an overhaul of Regulation Systems Compliance and Integrity (Reg SCI), a careful review of ways that Reg NMS may have contributed to market fragmentation, the development of an anti-disruptive trading rule to protect against harmful trading activities when markets are under stress, enhancements to the SIP, the requirement that HFTs register as broker-dealers with FINRA, greater disclosure around dark pools and broader risk-management oversight of trading algorithms.[72,73] While these proposals represent a step in the right direction in terms of bringing much-needed transparency to HFT, regulation has always exhibited a lag with respect to the pace of market innovation. Needless to say, it will likely be some time before these changes take effect.[74]

In the interim however, given the existence of malicious HFT tactics, the more pressing question is: What strategic defenses do non-HFT investors have at their disposal to minimize predation? On this point, Easley, Lopez de Prado, and O'Hara have suggested a number of countermeasures ranging from volume burst trading and the avoidance of seasonal effects to the development of specialized statistics for tracking HFT activity.[75] Other trading specialists and activists have also recommended a variety of different solutions from the development of special exchanges (e.g. IEX) to the vigilant surveillance of trade executions.[76] The availability of this range of options illustrates that investors are far from powerless against predation by malevolent HFT tactics.

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Regardless of whether High Frequency Trading is a natural outcrop of market development, a parasitic practice or a market blessing, it is likely here to stay. While its arrival on the market landscape poses many new challenges to the extant paradigms, the evolution of the market cannot be held hostage to outmoded views. In lieu of reacting to these challenges with fear, loss of market confidence or blanket regulatory disapprobation, a more productive response should consist in the clarification of these problems through greater transparency and the innovation of new ways to overcome them. The most powerful response investors have to the HFT phenomenon is, and continues to be, a commitment to staying knowledgeable and their own ingenuity.

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