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High Frequency Trading: Evolution and the Future

How the emergence of high frequency trading is altering the financial landscape as firms look to make money on the millisecond

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Contents

1 Highlights

Over the last few decades, regulators globally have been promoting greater transparency and competition among the exchanges in their market. Such regulatory changes, along with the advent of highly sophisticated and fast computer technology have given rise to a new class of trading known as high frequency trading (HFT). HFT is a form of trading in which security positions are turned over very quickly by leveraging advanced technology and the associated extremely low latency rates.

Ever since its inception at the turn of the 21st century, the popularity and usage of high frequency trading has been growing at an astonishing rate globally, bringing about significant changes in the way capital market firms carry out their trades. The floor-based style of trading is gradually being phased out, as more and more firms adapt to this new style of automated trading.

While HFT has numerous advantages, it creates its own set of unique challenges. Due to a number of market events including the infamous 'May 6th Flash Crash'[1] in 2010, HFT has come under criticism, resulting in regulators from across the world putting forth proposals aimed at curbing current HFT practices.

The recent controversies and regulatory proposals surrounding HFT have made most market participants sit up and take notice. This paper introduces the concept and origin of HFT, its impact on the markets, and what has caused regulators to pay special attention to this form of trading. The paper also talks about how both new and existing HFT firms can potentially benefit by focusing on certain investments and capabilities.

[1] The 'May 6th Flash Crash' was an event that took place on May 6th, 2010, when the Dow Jones Industrial Average unexpectedly fell by 600 points, and then recovered, all within a few seconds

2 Introduction to High Frequency Trading

2.1. A Short History of Trading

Securities trading methods and techniques have come a long way since the early 18th century when they were carried out in a commodities market on Wall Street. At the beginning, both the volume of securities being traded and the number of traders involved in the marketplace were very small.

As trading evolved, traders started acting as buyers and sellers, standing on crowded trading floors seeking to find the right counterparty in order to carry out a certain trade. Until as recently as the 1960s, financial information spread slowly, typically through ticker tapes. Trading was carried out almost entirely manually.

The 1970s saw the markets adopt more modern technology. In 1971, the National Association of Securities Dealers Automated Quotations (NASDAQ) became the world's first electronic stock market and introduced an electronic quotation system for competing market makers to trade securities. A few years later, in 1976, the Designated Order Turnaround (DOT) system was introduced in the New York Stock Exchange (NYSE), allowing the electronic transmission of orders to buy and sell securities.

The 1980s saw the advent of Program Trading, a computerized type of securities trading involving a number of different portfolio trading strategies, where there was a purchase or sale of a basket of securities having at least fifteen stocks, valued above $1 million total. Program trading gained popularity for trades between the S&P 500 equity shares and the futures market, such that a program could automatically put in an order in the NYSE's electronic system when there was a pre-determined difference between the two markets.

Electronic trading received a big boost in the 1990s, with the introduction of Electronic Communications Networks (ECNs). An ECN allows trading of financial securities outside of regular exchanges. Individuals can subscribe to these systems and enter orders electronically.

Since the 1990's, trading firms have increasingly made investments into ECNs, enjoying all the benefits they offer over traditional exchanges including greater speed and efficiency, lower costs, and fewer manual errors, which in turn has resulted in a greater use of algorithmic trading[2]. In 1998, in order to restrict the monopoly enjoyed by NYSE and NASDAQ, the U.S. Securities and Exchange Commission (SEC) passed the Regulation Alternative Trading Systems (Reg. ATS) resulting in the emergence of a number of alternative electronic trading platforms.

[2] Algorithmic trading is a form of electronic trading that is carried through computers. A pre-programmed algorithm decides when and how to carry out a certain trade, based on certain conditions specified in the algorithm and checked for against other market data being received from external sources

Just a few years later, algorithmic trading gained immense popularity due to a number of factors. In addition to the technological advances which have made algorithmic trading possible, other key factors include:

- **Narrowing Spreads:** In 2001, U.S. stock exchanges began quoting prices in decimals instead of fractions, bringing down the minimum spread between the bid and ask prices[3] from 1/6th of a dollar (6.25 cents) to one cent. This resulted in traders who previously profited from the spread seeking better alternatives, which in turn gave algorithmic trading a strong boost.
- **Regulatory Changes:** In 2005, the SEC passed the Regulation National Market System (Reg. NMS), which updated the Trade-through Rule,[4] promoting transparency and competition between markets and requiring trade orders to be posted nationally and not at individual exchanges. Traders could now leverage and profit from any small price difference of a security between two different exchanges, as long as they could act quickly enough to take advantage of the momentary lag between them.

Regulations aimed at improving market transparency and competition, as well as modern, sophisticated technologies have acted as catalysts in the development of High Frequency Trading.

These changes, along with improving high-speed technology have acted as a catalyst, giving rise to a new approach to trading: high frequency trading.

2.2. High Frequency Trading Today

High frequency trading is a specialized case of algorithmic trading involving the frequent turnover of many small positions of a security. While there is no formal definition of HFT, the U.S. Securities and Exchanges Commission attributes certain specific characteristics, including:

- The use of extremely sophisticated and high-speed computer programs for generating, routing, and executing orders.
- The use of individual data feeds from exchanges as well as co-located servers[5] in order to minimize network and other types of latencies.
- Maintaining very short timeframes for establishing and liquidating positions, resulting in the frequent turnover of many small positions in one or more financial instruments.
- Submitting a number of orders that are cancelled soon after submission.
- Maintaining very few, if any, overnight positions.

[3] The bid price on a trade is the highest price at which the buyer is willing to buy a security, and the ask price is the lowest price at which the seller is willing to sell it

[4] The trade-through rule is a rule that was instituted by the NYSE with an aim of fostering competition and transparency in the markets and ensuring that investors receive the best prices at the least execution costs when trading shares

[5] Co-located servers are server machines that are placed in rented racks that belong to the co-location provider, with an aim of minimizing potential latency

High frequency traders typically act in a proprietary capacity, making use of a number of strategies and generating a very large number of trades every single day. They leverage technology and algorithms from end-to-end of the investment chain—from market data analysis and the operation of a specific trading strategy to the generation, routing, and execution of orders and trades. What differentiates HFT from algorithmic trading is the high frequency turnover of positions as well as its implicit reliance on ultra-low latency connection and speed of the system.

Currently, there exist three distinct types of HFT firms.

- The first and biggest segment consists of **independent, proprietary firms**. These firms carry out HFT using private money and different strategies, but most of them tend to remain rather secretive about their operations. Many of these firms act as market makers, generating buy and sell orders automatically throughout the day.
- Next are the **broker-dealer proprietary desks**. Traditional broker-dealer firms have separate proprietary trading desks for HFT, which are not related to their client businesses. Examples include some of the largest investment banks.
- The third type of HFT firms consists of **hedge funds**. These hedge funds generally focus on statistical arbitrage and take advantage of pricing inefficiencies among various asset classes and securities.

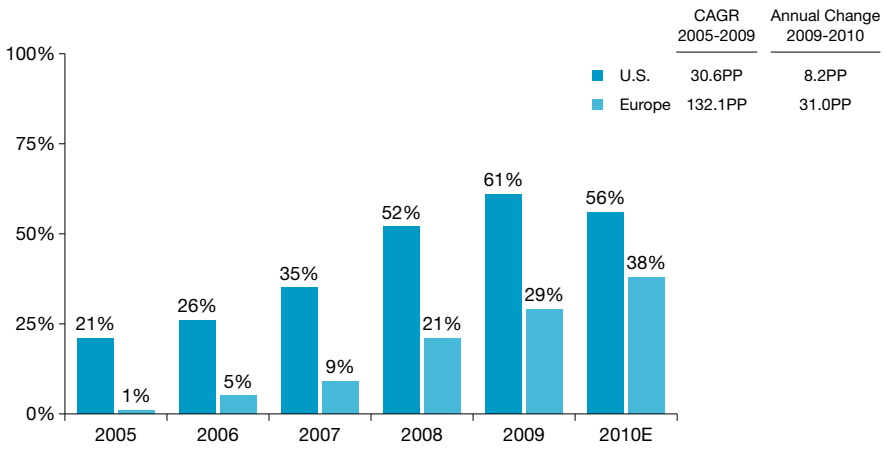
3 The Growth and Impact of High Frequency Trading on Markets

3.1. Rising Popularity

In a relatively short span of time, high frequency trading has captured a large share of the overall U.S. and European equity trading volume, and is fast gaining popularity in other regions such as Asia-Pacific. The enormous growth seen in HFT trade volumes and total HFT trade value has been driven primarily by easier access to the modern technology that makes it possible.

In 2010, HFT was estimated to have accounted for 56% by volume of the entire equity turnover in the U.S., up from 21% in 2005.

Exhibit 1: High Frequency Trading as a % of Equity Turnover by Volume, U.S. and by Value, Europe 2005–2010E



Source: *Financialtimes.com*, accessed November 2011

Easier access to modern technology has been instrumental in the popularity of high frequency trading spreading beyond North America and Europe to other parts of the world.

Similarly in Europe, HFT as a percentage of equity turnover by value was estimated to be around 38% in 2010, up from 29% just a year earlier in 2009, and from just 1% in 2005. This translates to a compounded annual growth rate of over a 106% from 2005 to 2010.

Since Asia Pacific is a more heterogeneous market than the west, it has had a mixed response to HFT. Tokyo is the core for HFT in Asia, and it is estimated that HFT accounts for 45% of the equities trading volume there[6]. In January 2010, the Tokyo Stock Exchange launched the Arrowhead trading platform, along with certain trading rule revisions in an attempt to increase HFT volumes. Additionally, Japanese regulations are very favorable to HFT, and this has helped its growth.

[6] *U.S. High-Frequency Trading Firms Look Eastward, http://www.advancedtrading.com*, May 2011

It is expected that the popularity of HFT will continue to rise in several major global markets, driven by the growth of independent, proprietary trading firms and quantitative hedge fund strategies.

Singapore is another Asian market where the use of HFT is rapidly increasing, aided significantly by HFT-friendly regulations. While 15% of all derivatives on the Singapore Exchange (SGX) were traded through HFT in 2009 Q1, this number went up to 26% by 2010 Q1[7]. Additionally, the Singapore Exchange (SGX) is currently migrating to a new IT platform, which is expected to make it one of the fastest markets in the world.

Amongst the emerging markets, India provides a good opportunity for HFT traders due to a number of factors such as co-location facilities and sophisticated technology at both the major exchanges; a smart order routing system; and stock exchanges that are well-established and liquid.

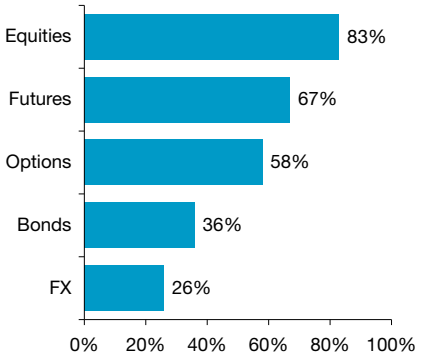
However, there are still a few markets such as China which have not been as successful in HFT adoption. Regulations in China are not very favorable towards HFT, and the latency levels in Chinese exchanges are currently not conducive to HFT.

Going forward, it is expected that the popularity of HFT will continue to rise in several major global markets, driven by the growth of independent, proprietary trading firms and quantitative hedge fund strategies. Over the last few years, HFT has grown rapidly not just across various regions, but also across the various asset classes that are being traded. While equities remain the most commonly traded asset class, HFT's popularity is fast spreading to other asset classes as well.

Since the origin of both algorithmic trading and HFT was in equities, this may explain why equities remain the most commonly traded HFT asset class. 83% of proprietary HFT firms in the U.S. traded equities in 2009.

With improving technology, HFT is beginning to play an important role in the trading of other asset classes as well. For instance, futures make up another asset class where a significant amount of trading is now done through HFT, and it is believed that HFT has a significant influence on the futures market. As per data released by the Commodity Futures Trading Commission (CFTC) in July 2011, 95% of U.S. crude oil futures trading

Exhibit 2: Asset Classes Traded by Proprietary High Frequency Trading Firms (% of Firms)[8], U.S., 2009



Source: *Advancedtrading.com,* accessed November 2011

[7] 'Electronic Trading in Asia-Pacific A Market by Market Update on the Dynamic Region', Celent, 2010

[8] For every asset class, we are showing the percentage of proprietary HFT firms that trade these, and hence the percentages do not add up to 100%

With improving technology, HFT is beginning to play an important role in the trading of other asset classes.

volume is generated by day trading, a large part of which is undertaken by the HFT firms. In 2009, 67% of all U.S. based proprietary HFT firms were trading futures. Also, in the same year, 58%, 36%, and 26% of U.S. based proprietary HFT firms traded options, bonds, and FX respectively, making these additional asset classes that are gaining popularity in HFT trading.

As the popularity of HFT grows and more exchanges adapt to modern, sophisticated technology, it is likely that the use of HFT will increasingly spread to other asset classes as well.

3.2. Commonly Deployed Strategies

Traders make use of a number of strategies to profit from high frequency trading, with each having their own nuances and complexity. In this section, we will look at some of the most popular HFT strategies:

Market Making

Firms using the 'Market making' strategy make money on the bid-ask spread. High frequency traders place bets on both sides of the trade by placing a limit order to sell slightly above the current market price, or to buy slightly below the current market price, thereby profiting from the difference between the two. HFT traders use algorithms where the limit orders with these conditions are specified, so that the system can automatically enter trades when the conditions are right.

Liquidity Rebate Trading

Certain exchanges and ECNs offer traders a rebate for providing the markets with shares, or liquidity, when there is a need for it. They generally pay traders to buy at the bid price and sell at the ask price, thereby providing liquidity, and charge traders for placing market orders. Liquidity rebate traders look for large orders, fill a part of that order, and then offer these shares back to the market by placing a limit order, which makes them eligible to collect the rebate fee for providing liquidity, with or without them making a capital gain.

Statistical Arbitrage

Firms and traders looking to make profits from market arbitrage essentially exploit the momentary inconsistencies in factors such as rates, prices, and other conditions between different exchanges or asset classes. For instance, a trader could buy a security at a certain price on one exchange and sell it at a higher price on another exchange within the gap of a few seconds during which a price differential may exist. Traders also exploit the differential between co-related securities such as derivatives and their underlying securities, or Exchange Traded Funds (ETFs) and their underlying stocks.

Momentum Ignition
Momentum ignition strategies involve initiating and cancelling a number of trades and orders with a certain security in a particular direction, which may ignite a rapid market price movement. The quick submission and cancellation of these orders could get detected by algorithms of other traders, resulting in them buying or selling the security. The firm submitting these orders and trades—by virtue of having established a position early on—can then profit by leveraging the subsequent price movement.

Leveraging Structural Differences
Some firms also use strategies that leverage the structural differences in the market or in certain market participants. One way to do this is by obtaining market data much sooner than other participants who receive consolidated data feeds, by leveraging co-location arrangements with exchanges or by receiving individual data feeds from many ECNs and exchanges. The firm leveraging these structural differences can take advantage of their faster access to data and trade accordingly.

3.3. The Impact of High Frequency Trading on Markets

Despite its relatively recent inception, HFT has already made a deep impact on the markets in a number of ways. Here we look at both the positive and negative impacts of HFT.

Positive impacts on markets include increased liquidity, narrowing spreads, improved market efficiency, and increased fees for exchanges.

Positive Impact on Markets

- **Increased Liquidity:** It is believed that the high number of trades typically entered by HFT traders results in greater liquidity in the markets. HFT firms contribute to over 50% of the equity turnover by volume in some major markets, and play a critical role in providing order flow, increasing the liquidity level. Traditional liquidity providers such as market makers now earn rebate fees by leveraging HFT strategies to make up for the loss of income caused by smaller spreads.
- **Narrowing Spreads:** The use of algorithms and computers in trading has resulted in the prices of securities being updated more frequently and more accurately. A study from NYSE Euronext shows that quoted spreads from 2007-2009 were lower than those from 2002-2006, a period when HFT was relatively less prevalent. This indicates that HFT has resulted in traders providing the most competitive bid-ask prices and in spreads narrowing.
- **Improved Market Efficiency:** In more efficient markets, prices reflect market information more quickly and accurately. HFT enables this to happen by ensuring accurate pricing at smaller time intervals. Also, HFT has enabled smaller spreads and lower trading costs, and these benefits are passed on to individual customers who invest indirectly in the markets through mutual and pension funds.

Negative impacts on markets include impact on institutional investors, increased volatility and disadvantages to smaller investors.

- **Increased Fees for Exchanges:** HFT has led to a significant increase in the trading volumes of both, exchanges as well as ECNs. In 2008, the number of equity trades at both the NYSE and NASDAQ grew by more than 80% compared to a growth of 76.7% for NYSE and 56.2% for NASDAQ in 2007[9]. This growth has led to higher revenues and transaction fees for both exchanges and ECNs.

Negative Impacts on Markets

- **Impact on Institutional Investors:** Some institutional investors allege that certain HFT strategies look for repetitive trading patterns and front run the institution by detecting an incoming order flow, after which the HFT system buys the same security and then turns around and sells it to the institution at a slightly higher price. Such strategies from HFT participants may adversely impact the strategy and market impact costs for these institutional investors.
- **Increased Volatility:** Since HFT involves rapid intraday trading with positions generally held only for minutes—or even just seconds—it can give rise to price fluctuations and short term volatility. Given that HFT volumes are normally a relatively high percentage of overall trading, the price fluctuations caused by this strategy can lead to overall volatility in the market. Also, the practice of making trades and instantly cancelling them only to trigger automated buying from other firms is an ethical issue that has been questioned by many analysts.
- **Disadvantages to the Smaller Investors:** HFT firms leverage special services such as co-location facilities and raw data feeds, which are typically not accessible for smaller firms and retail investors as they are not able to make the required investments. This places these smaller firms and investors at a disadvantage. In addition, some HFT firms often enter trades just for the liquidity rebate, but this adds no value to the retail or long-term investor.

[9] 'Demystifying and Evaluating High Frequency Equities Trading', Celent, 2009

4 Role of Technology in High Frequency Trading

4.1. Technology as an Enabler

The emergence of HFT can be largely attributed to the technological advancements made over the last few years. Two key elements that have made HFT a possibility and that are most critical for its success are:

- **Low latency and latency arbitrage:** Systems experience a time delay, or latency, when messages and data are processed and transmitted. Over the last several years, trading firms have been working to ensure that their systems have as low latency as possible, allowing them to receive and process information as fast, or faster, than their competitors.
- **Algorithms as competitive differentiators:** High frequency trading is carried out by computers. Computers are instructed based on a series of algorithms which are developed by firms to match their trading strategies and represent competitive differentiators and are critical to the success of their firms.

The dependence on technology for HFT to succeed has led to a 'technology arms race' between firms, with each firm trying to become faster and smarter than the others.

HFT firms' dependence on technology as an enabler and differentiator has led to a technological arms race, with each firm trying to become faster and smarter than the others.

Factors Contributing to Low Latency

Low latency is a relative phenomenon as improvements in technology are constantly bringing down latency levels. What is considered as "low" today may be considered as unacceptably high in a few years time. Low latency is at the heart of HFT, and a number of technology breakthroughs have brought it down to levels acceptable today. These factors include:

- **Fiber Optics:** With fiber optics replacing traditional copper wires for long-distance network communication, firms can share information across continents much faster. Recent advancements have also made it possible to physically shorten the length of cables, leading to a further reduction in transmission time.
- **Bandwidth:** For HFT firms, it is important to push great volumes of data across their networks while maintaining the high speed of data transfer. Technological advancements have resulted in data transfer speeds increasing from 1 gigabit per second to 10 gigabits per second, making much faster trading speeds possible.
- **Field Programmable Gate Arrays (FPGAs):** FPGAs are integrated circuits typically used in high performance computing, and have only recently been adopted by the financial services industry as a technology. Firms configure FPGAs to perform specific functions from their algorithms in a repetitive and quick manner, leading to lower latency.

- **Multi-Core Processing:** A multi-core processor is a single computing component that is made up of several cores or processors. HFT firms use modern multi-core processors, which make data processing much faster as there are several processors working on several tasks at the same time, resulting in a significant increase in the overall system speed.

Other Tools Related to Latency Arbitrage

As discussed, latency arbitrage is the practice of leveraging the small time differences in the broadcasting of pricing data by trading a financial instrument on the basis of a decision that is driven by data received slightly ahead of other market participants. In order to leverage latency arbitrage, a firm would need to receive pricing information slightly before at least some other market participants. The primary tools used for latency arbitrage are co-located servers and raw data feeds from exchanges:

- **Co-Located Servers:** By cutting down the physical distance between their trading server and the exchange server, firms ensure that the latency in data transfer between the two points is minimized. Therefore several HFT firms purchase real estate as close as possible to securities exchanges, and place the servers of their trading systems in rented racks belonging to co-location providers.
- **Raw Data Feeds:** Several exchanges and ECNs offer individual data feeds consisting of their own best-priced quotations and other trade-related information, which are leveraged by HFT firms. This is in contrast to the consolidated data feeds consisting of the best prices and other data from each exchange, some ECNs, and Alternative Trading Systems (ATS) in a single feed that is used by most other market participants. The process of consolidating this data creates some latency and by the time the data reaches the market participants it is already slightly old. Consequently, several HFT firms prefer using raw, individual data feeds which saves them from the latency that is introduced in processing and consolidating.

How fast can you trade? According to a recent MIT study, the speed of light is the biggest bottleneck for HFT traders to execute trades at a global level.

A recent MIT study[10] has shown that the speed of light is becoming a bottleneck for HFT traders to execute trades at a global level. Traders would like information to flow as fast as possible, but there is a physical limit to speed since data cannot flow any faster than light itself. As part of this study, the researchers plotted out certain optimal points between geographically separated exchanges, from where it would take the least amount of time for information to travel between them. For instance,

[10] *Relativistic statistical arbitrage*, A. D. Wissner-Gross and C. E. Freer, 2010

It is possible that, in the future, firms may leverage optimal points in the ocean to minimize the information travel time between global exchanges and set up floating trading centers.

the optimal point to exploit the price difference between the New York Stock Exchange and the London Stock Exchange was found to be at a spot in the mid-Atlantic ocean. According to these researchers, several hedge funds and technology firms are looking to leverage these findings, and given that infrastructure in the form of undersea data cables already exists, such floating trade centers could be a possibility in the future.

Algorithms as Competitive Differentiators

Along with low latency, HFT firms require smarter algorithms that are updated constantly to outperform the competition. Firms update their algorithms frequently for two reasons:

- **To Accurately Reflect Market Changes:** HFT strategies are based on interpretation of market events and news, and rely on the correlations between several factors such as pricing, interest rates, and different markets events. As a result, there is always a need for traders to constantly upgrade their algorithms as their underlying assumptions change based on various market events. This has particularly been true in the last few years, when volatility in the markets has been high and there has been a need to frequently reassess strategies.
- **Short Utility Period Due to Reverse Engineering:** The shelf life of most algorithms remains limited as competitor firms are generally able to decipher each other's strategies through reverse engineering. Once a strategy is exposed to the competition, it can become extremely risky to execute and can often prove to be counterproductive, as the firm's competitors would know exactly what the firm is doing. It is therefore imperative for firms to constantly update and upgrade their strategy in order to stay a step ahead of the competition.

Technological innovations have made the frequent upgrades of algorithms much easier and far more economical than they were in the recent past. Modern algorithmic trading platforms have a simple interface that allows traders to create, test, and deploy their strategies in the form of algorithms in an extremely quick, simple, and efficient manner.

4.2. The Role of the FIX Protocol

The Financial Information eXchange (FIX) Protocol is a non-proprietary, open source, electronic messaging standard, consisting of a series of messaging specifications for the real-time, electronic communication of securities transactions. It is maintained by FIX Protocol Limited—a non-profit industry association that defines and manages FIX for electronic trading. These standards have been developed in collaboration with banks, broker-dealers, ECNs, exchanges, institutional investors, and information technology providers, and are widely used by exchanges and financial market participants from all over the world.

The increasing popularity of HFT has resulted in FIX Protocol Limited creating a working group to address the need of a latency standard in the industry. Ultimately, the goal is to make it easier for all HFT market participants to measure and exchange latency data.

The Need for a Latency Protocol

The emergence of HFT has led to a heightened competition for arbitrage opportunities and speed. In order to stay ahead of the competition, financial market participants have been making significant investments in low latency technologies which, in turn, have led to further technology and latency competition.

To manage and reduce latency, firms first need to measure it. However, there are no standards for measurement at present, which makes it difficult to compare latency data between different entities. Consequently, there is no standard for exchange of interparty latency data. Once the FIX working group's proposed standards are implemented, it should to lead to greater interoperability between the different latency monitoring solutions used by different market participants.

5 The Future of High Frequency Trading

Despite the increasing usage and popularity of HFT, it still faces a unique set of challenges which raise some questions about its future and further growth.

5.1. Challenges Faced by the Industry

Most of the challenges faced by the HFT industry may be caused, to some extent, by the emerging nature of the industry, and are expected to be resolved with its natural progression:

Despite its increasing popularity and rapid adoption, HFT faces a number of challenges, primary among which is the threat of new regulations which could alter the way HFT trades are executed today.

Operational Issues

Firms need to be very careful about their algorithms and their impact, and need to ensure that these are tested completely and thoroughly before they are deployed on live systems. Already, we have seen certain situations where faulty or improperly tested algorithms have caused severe, undesired consequences: In January 2010, Credit Suisse was fined by NYSE Euronext after a faulty algorithm resulted in the exchange trading system receiving hundreds of thousands of erroneous messages[11]. In February 2010, a runaway algorithm from Infinium Capital Management caused a spike of $1 in oil prices, and the trading program had to be shut down after five seconds[12]. Again, in June 2010, AQT, a proprietary trading team at Deutsche Bank, placed sell orders worth $182 million in error, due to a faulty algorithm[13]. All of these incidents reiterate the need for strong, robust testing of these algorithms and programs at all stages.

Entry Barriers

Although the entry barriers to high frequency trading have come down to some extent over the last few years, there remain some barriers that need to be considered by those seeking to enter the HFT market. Extremely low latency demands, significant investments in co-location facilities and high speed networks, and acquiring high volumes of market data are some of the primary technological barriers firms need to consider.

Risk Issues

HFT firms face a number of risks—particularly market, technology, and compliance risks. The algorithms that control HFT are based on a number of assumed market conditions, and any change in the market can have an unexpected impact on the outcome. Also, given the high dependence on technology and the IT infrastructure, there is always a technological risk, such as an element of the infrastructure going down. There is also a compliance risk that firms need to closely monitor.

[11] 'Controlling Risk in a Lightning-speed Trading Environment', Carol L. Clark, Federal Reserve Bank of Chicago, 2010

[12] 'Exclusive: Firm faces civil charges for U.S. oil trading mayhem', 2010, http://hft.thomsonreuters.com/2010/09/23/exclusive-firm-faces-civil-charges-for-u-s-oil-trading-mayhem/

[13] 'Electronic Trading in Asia-Pacific A Market by Market Update on the Dynamic Region', Celent, 2010

Impact of Regulation
Over the last couple of years, regulators all over the world have questioned the potential negative impact that HFT could have on the market structure, and have put forward certain proposals that could severely impact HFT. Regulations currently being considered include banning certain HFT and algorithmic trading strategies as well as imposing a transaction tax for every trade made. Given the enormous number of trades HFT firms make within a short span, as well as their low levels of profit per trade, these regulations could have an adverse impact on the business.

5.2. Recent Controversies and Criticisms

Over the last couple of years, even as its increasing popularity has repeatedly placed HFT in the spotlight, the strategy has attracted criticism from several key market participants for a number of different reasons listed below. However, there is no unanimous verdict and it is still unclear as to what extent HFT is responsible for all these allegations.

Alleged Unfair Advantages
HFT firms invest large sums of money in technology for communication systems as well as for the development of sophisticated algorithms, which not all market participants can afford. Some analysts believe the fact that HFT firms are often able to gather certain market information and execute trades faster than other participants puts the overall fairness and integrity of the markets at risk. It is also believed that such advantages that HFT firms have can lead to an erosion of investor confidence in the market, and in the long run, may result in a reluctance to participate.

Risk to Market Efficiency
Some market participants feel that as the share of HFT firms in the overall trading volume is increasing, the natural process of price discovery of assets in a free market is becoming affected. It is alleged that the nature of high frequency trading—with its short-term strategies and high-speed, high-volume trading—may impact the price of securities in the short-term. Another concern is that HFT can lead to greater market volatility, especially since market triggers can cause a large volume of securities to be traded and held for short time intervals.

Risk to Market Stability
Some analysts believe that an over-reliance on automated trading and algorithms can pose risks to market stability and lead to a fragile market structure. It is believed that 'rogue algorithms', algorithms that are defective and behave in an unexpected manner, can lead to a chain reaction and impact the liquidity in the market in a very short span of time. It is widely believed that the May 6th Flash Crash—when the Dow Jones Industrial Average fell by 600 points, and then recovered, all within a few minutes—was caused by a faulty trading algorithm.

The May 6th Flash Crash

A particular event that took place in the U.S. equity markets in May 2010 brought HFT to the forefront of the attention of all market participants, and subsequently to that of the SEC and regulators the world over.

On May 6, 2010, a trader at a large U.S. mutual fund firm entered an order to sell 75,000 E-mini futures contracts which mimic movements in the S&P 500 Index using a trading algorithm that had specifications only for volume, but not price and time. A number of HFT firms which had bought a part of these contracts from the mutual fund firm soon started selling these themselves in addition to the mutual fund firm which was still trying to sell its remaining futures contracts.

Soon, the HFT firms started trading these contracts among themselves, creating a loop that resulted in the price of these contracts falling rapidly within minutes.

Between 2:45:13 PM and 2:45:27 PM, firms traded over 27,000 contracts, accounting for about 49% of the total trading volume, and resulting in a huge drop in the Dow Jones Industrial Average. At 2:45:28 PM, trading had to be paused for five seconds as the falling prices had triggered a stop logic functionality[14]. When trading resumed, prices stabilized and the contract started to recover rapidly.

Exhibit 3: The Dow Jones Industrial Average, May 6th, 2010

Source: *Cnnmoney.com,* accessed November 2011

Later, a SEC report on the May 6th Flash Crash clearly mentioned that aggressive selling by HFT traders accelerated the index decline on this date, and the event was instrumental in bringing the potential implications of HFT to the notice of regulators all over the world.

[14] A provision designed to avoid extreme price movements that can occur because of continuous triggering of stop orders

5.3. The Impact of Regulations

While regulations were instrumental in the birth of HFT, ironically they now may threaten its future. A number of regulatory reforms in different markets globally originally created a favorable environment for the inception of HFT over the last decade or so.

In the U.S., the late 1990s and 2000s saw the SEC introduce a number of reforms which had a deep impact on the U.S. equity market structure. The Reg. ATS was passed in 1998 to restrict the monopoly of a few exchanges, giving rise to a number of electronic trading platforms serving as alternative trading systems. In 2005, the SEC passed the Reg. NMS, updating the 'Trade-Through Rule,' promoting transparency and competition between markets and requiring that trade orders be posted nationally and not at individual exchanges. This in turn, made it possible for traders to leverage HFT to exploit the momentary differences in prices between exchanges and co-related securities.

In 2001, the Canadian Securities Administrators introduced the Marketplace Rules which fostered the environment for HFT. The Marketplace Rules allowed greater competition and provided a framework for alternative trading systems in Canada. These rules also provide fair access requirements, which review areas such as the offering of co-location services as well as the fees charged for services.

The Markets in Financials Instruments Directive (MiFID) was introduced in Europe in November 2007, and abolished the Concentration Rule. As a result, the traditional concentration of trading activities in certain exchanges gave way to alternate trading venues. This was done in order to increase the competition between financial markets and bring down the trading transaction costs across Europe, which, once again, fostered the environment for HFT.

However, recent market events such as the May 6th Flash Crash (see sidebar) and cases of runaway algorithms have resulted in regulators sitting up and taking special notice of HFT. Policymakers globally have developed a number of initiatives, consultations, and proposals aimed at HFT regulation.

In January 2010, in its concept release on the U.S. equity markets structure the SEC solicited comments on the impact of HFT strategies on the quality and integrity of markets. In May 2010, a joint committee was formed between the SEC and CFTC to provide advice on emerging regulatory concerns. In February 2011, this committee released a report with regulatory response recommendations to the May 6th Flash Crash. In Canada, the Canadian Securities Administrators published a rule for comment focused on the risks associated with automated trading in April 2011.

In Europe, the European Commission's MiFID Review Consultation document put forth several regulatory proposals on automated trading and HFT in December 2010—after the European Securities and Markets Authority (ESMA) called for evidence on micro-structural issues in the European equity markets in April 2010.

Market regulators in Asia-Pacific have also been investigating the effects of HFT: In March 2010, the Securities and Exchange Board of India (SEBI) set up a Technology Advisory Committee to advise on matters pertaining to HFT, co-location services, and security issues related to internet-based trading. In Australia, in November 2010, the Australian Securities and Investment Commission issued a consultation package on updating the equity markets regulation which also looked at the benefits and challenges arising from HFT.

While the full impact of these consultations and proposals is yet to be realized, it is likely that these might result in new regulations which could significantly alter the nature of HFT as we know it today.

5.4. Going Forward

Despite some uncertainty involving the impact of new regulations on HFT, it is widely believed that its popularity and use will continue to grow in the coming years.

Given the challenges HFT firms face today, significant gains can be achieved by focusing on core competencies and leveraging services firms for other areas, particularly those pertaining to technology and risk management.

New regulations may help bring about greater transparency and reduce the volatility levels in the markets. However, experts believe that HFT is a natural step in the evolution of markets, and that firms will continue to leverage advancements in technology in order to make greater profits. The potential benefits of HFT are predicted to result in an increasing number of firms investing in HFT technology, and in greater opportunities for all concerned stakeholders.

Firms looking to adopt high frequency trading could significantly benefit from investing in and focusing on certain capabilities beyond their core competencies. Examples of areas HFT firms should pay special attention to include:

- **Risk and Compliance Management:** As the regulatory burden on HFT firms increases, greater stress is expected on reporting, pre-trade controls and compliance, which can be efficiently managed by trained and experienced personnel. HFT firms can leverage the offerings of specialist firms to help them manage their various types of risk and compliance.

- **Adapting to Technology:** As trading firms with a lesser reliance on technology realize the need to catch up with their competition, they may want to engage specialist firms to upgrade their trading applications and infrastructure.
- **Code Optimization:** Speed is of utmost importance to HFT firms, so they need to ensure their software code is fine tuned and optimized for minimal latency and system processing time.
- **Code Testing and Quality Management:** Algorithm and code testing have become extremely critical for HFT firms, especially in light of several recent cases where malfunctioning algorithms have caused significant losses to one or more stakeholders. HFT firms should make certain that there is comprehensive testing of their trading applications and strategies. Firms also need to test their strategies using real world simulation, historic and current data as well as by shocking the system for various risk factors in order to ensure their strategy and system is fully robust and stable.

The high frequency trading industry today finds itself at a crossroad. Despite the huge potential for growth, HFT is threatened by new regulations and greater competition as more market participants adopt this form of trading. However, these are still early days for the HFT industry, and it is imperative for firms to continue to focus on growth by taking advantage of improving technology in order to realize the benefits HFT holds.

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