

# The Need For Speed



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Virtually all stock trading today is electronic and fast. The floor of the New York Stock Exchange (NYSE) is essentially a prop for CNBC. A broker yelling buy and sell orders is as relevant to the trading of stocks today as a milkman is to the dairy industry.

A speed revolution has transformed the capital markets. Is the need for speed a positive development that has benefited investors? Or has ultra-fast trading made the markets unstable?

This paper explores the controversial subject of high-frequency trading (HFT). It explains what HFT is, what makes it different from standard electronic trading, outlines the benefits that many believe trading at warp speed has brought to the market, and also explains the concerns that some have with HFT.

## All Trading Is Now Fast

Advanced technology has brought breathtaking speed to the execution of stock trades. As the Securities and Exchange Commission (SEC) stated in its 1994 report on the U.S. equity market, a retail stock order “in 1975 would have taken from several minutes to an hour to travel from the branch office that accepted the order to the firm’s trading desk, and finally to the firm’s broker on the floor of the exchange.”<sup>1</sup>

In today’s rapid-fire, automated, electronic markets an hour is an eternity. Between 2005 and 2009, the average trade execution time on the NYSE fell from over 10 seconds to just fractions of a second.<sup>2</sup> On many orders, investors now receive almost instantaneous order confirmation—waiting an hour is unheard of. This increased transparency has democratized the markets—investors and brokers now operate on a more level playing field.

Many different types of investors, including high-frequency traders, are competing in today's computer-driven marketplace. Some electronic investment strategies use algorithms—automated computer programs that are programmed to trade based on a very specific set of trading instructions. Algorithms can range from relatively simple to stunningly complex.

The most basic electronic algorithmic trading programs are not considered high frequency trading. These more basic programs operate based on explicit instructions to transact in a single security. For example, when a large institutional investor, like a mutual fund, sells 100,000 shares of Coca-Cola, they try to do so without alerting the market to their intentions. If other market participants know that a massive position is being unloaded they will react by lowering their bid price. As a result, the mutual fund will be forced to sell for lower prices. Therefore, large institutions use something called an “execution algorithm” to break up larger orders into smaller pieces in order to get the best price for the order.

An algorithm may be programmed to sell a quantity of Coca-Cola shares equal to 5% of Coca-Cola's total trading volume over the course of each hour of the trading day. If 1 million shares of Coca-Cola stock trade over the course of an hour the automated algorithm would sell no more than 50,000 shares, or 5% of the hour's trading volume.

High frequency trading is a blanket term that describes a specialized subset of algorithmic trading. What makes HFT special is that it leverages every available cutting edge computing and telecommunications technology to trade stocks in rapid-fire fashion.

In general, HFT firms share these 4 characteristics:

- **Highly Sophisticated Algorithms:** According to the SEC, they use “extraordinarily high-speed and sophisticated computer programs for generating, routing and executing” trades.<sup>3</sup>

- **Co-Location:** They co-locate their trading technology as close to a market data center as possible and continuously seek to reduce the time it takes to send and receive market information.<sup>4</sup>
- **Very Short-Term Investments:** They buy a stock or commodity and sell seconds, or minutes later in most cases. HFT firms rarely hold securities positions overnight.<sup>5</sup> They endeavor to be “flat”—holding no securities—at the end of each trading day.
- **High Cancellation Rates:** They submit and rapidly cancel over 90% of their orders.<sup>6</sup>

## The Key Aspects of High Frequency Trading

In 1997, Deep Blue, a computer designed by IBM, beat World Chess Champion Gary Kasparov in a match. The most advanced HFT algorithms are like Deep Blue. They are designed to replicate logical human reasoning.

The algorithms used by high frequency traders are far more dynamic and nimble than the simple execution algorithm explained above. These algorithms—some with more than 500,000 lines of source code—are able to make split-microsecond trades, and like Deep Blue, are designed to observe the moves of their opponents in the market and react strategically to make a huge volume of profitable trades within tiny time intervals.<sup>7</sup>

High-speed electronic market making is one popular HFT trading strategy. This strategy focuses on analyzing market data, spotting price inefficiencies between stocks trading on an exchange in New York and a stock futures contract trading in Chicago, and executing trades based on that information faster than any human could ever dream of.

While the goal of HFT firms is to execute large numbers of trades that each make a small profit, not all strategies pay off. Speed trading has become more competitive and firms can

and do lose money. According to Rosenblatt Securities—a private firm that researches the HFT industry—profits have been falling industry-wide. Between 2009 and 2012 the total profits of speed trading firms fell from \$5 billion to \$1 billion.<sup>8</sup>

For HFT firms, each microsecond the market is open is an opportunity to execute thousands of trades. A 2012 report by Credit Suisse clarifies the difference between simple algorithms and complex HFT programs. The report states, HFT programmers design automated computer programs to automatically recognize “whether and when to trade, which security, the size and whether to buy or sell. They are profit maximizing and generally aim to be flat at the end of the day, with full discretion on the trading decision.”<sup>9</sup>

## **Location Matters**

Not long ago, if you wanted to get market information first you needed to be on the floor of the New York Stock Exchange. Stocks traded manually—a broker holding an order to sell would be matched with a broker who had an order to buy that same security. To be well-informed about market moving information—like what stocks were trading in large volume, and who was doing the buying or selling—a trader had to have access to the floor either in person or over the phone.

This person-to-person connection to the market has been replaced by computer-to-computer connections. Each order sent to an exchange is routed through the exchange’s data center. Within the data center, the exchange’s matching engine does the job the floor brokers used to do—it pairs buy and sell orders. When a trade occurs the transaction details are instantly blasted to market participants all around the world.

HFT is designed to make multitudes of trades that each aim to make pennies, so HFT firms must get market information first and they are willing to go to extraordinary lengths to do so. With computers doing the sorting of information, being

first means moving a firm's trading equipment closer to the data center and taking steps to minimize the time it takes to send and receive data.

Because data travels through fiber optic cables at about 100 miles per millisecond, a firm that co-locates in the NYSE's data center in Mahwah, New Jersey secures a .3 microsecond advantage (the amount of time it takes a bullet to travel 1/100th of an inch) over a firm receiving the data 30 miles away in Midtown Manhattan.<sup>10</sup>

Speed trading firms are like Olympic sprinters—they are always looking to get a fraction of a second faster. But “co-location” doesn't come cheap. Exchanges are more than happy to benefit from the need for speed by renting out space in their data centers for \$10,000 per month.<sup>11</sup>

In 2010, a Mississippi-based cable-construction-company invested \$300 million to lay a 825 mile straight-line cable between the Nasdaq data center in New Jersey “over farmland in western New Jersey, through the granite and schist of the Allegheny Mountains in central Pennsylvania,” and eventually into downtown Chicago.<sup>12</sup> They were betting that the need for speed was so great that high frequency traders would pay to access the cable—which would shave 3 milliseconds off the time it took data to travel between the Nasdaq data center in New Jersey and Chicago. And they were right.

Using this speed advantage, high-speed traders have participated in an estimated 70% of overall daily stock trading volume on some trading days.<sup>13</sup> Without co-locating their trading technology in market data centers, and reducing the time it takes to send and receive data, this volume of trading would not be possible.

## **What are the benefits of HFT?**

A decade ago, if an investor wanted to buy Coca-Cola shares, the order would most likely get routed to the floor of the NYSE. An NYSE floor trader, known as a “specialist,” would

have to physically find another trader willing to sell Coca-Cola stock. They would agree on a price and the trade would occur.

Today, orders are routed through a multitude of electronic exchanges and trading platforms. High-frequency algorithms are highly-specialized tools that are capable of making microsecond-fast trading decisions on these various trading venues.

Supporters of HFT argue that investors—individual shareholders, pension funds, 401(k) shareholders, and holders of mutual funds—are getting better prices for their investments, selling them with greater ease, and paying far less per-trade, in part, because of high frequency trading.

They point out that increased speed and connectivity has created the two important benefits described below:

## **1. Tighter “Bid-Ask” Spreads**

An asset’s bid-ask spread is the difference between the price that investors are willing to pay and the price at which they are willing to sell. Spread tightening has allowed investors, on a per-trade-basis, to buy and sell stocks at advantageous prices compared to a decade ago. According to Morgan Stanley, the average spread on an S&P 500 stock is just slightly more than one penny.<sup>14</sup>

As Donald Mackenzie states in *How to Make Money in Microseconds*, “Twenty years ago the ‘spread’ between the price at which a human market maker would buy and sell a share was sometimes as much as 25 cents; the fact that it now often is one cent means substantial savings for mutual funds, pension funds and other large institutions.”<sup>15</sup> In the past, NYSE specialists pocketed the 25 cent spread to compensate for the risk of holding a stock until they found a buyer. Ultimately, that 25 cent cost was paid by investors.

The benefits of tighter spreads extend beyond the equity markets—commodity markets have benefited from tighter bid-ask spreads too. The savings from tighter bid-ask

spreads in the market for lean hog future contracts, for example, allow commodities to be traded at advantageous prices compared to the pre-electronic, manual floor trading era.

Electronic trading and HFT has relegated the 25 cent bid-ask spread to the dustbin of history. The savings from a tighter bid-ask spread is now in the hands of pensioners, 401(k) holders, and other investors.

## **2. Increased Market Liquidity**

The fact that HFT is, in most cases, willing to buy your shares from you has added liquidity to the capital markets. Liquidity describes the ability of investors to buy or sell an asset promptly with minimal price impact—the trade does not drive the market price up or down significantly. In today's algorithm-populated markets investors can easily locate a willing counterparty for their trades. And small trades occur with minimal price impact.

In other words, it is far easier today to find someone (or something) to buy your 100 shares of Coca-Cola stock than in the past. Not only is it now easier for investors, especially smaller investors, to buy and sell stocks, but when they do trade they are benefiting from better prices.

Because information about prices is transparent, and spreads have become so tight, price discovery—or the ability to trade stocks at fair market value—has improved.

George Sauter, former Chief Investment Officer at Vanguard, believes that the market has derived benefits from the liquidity that speed traders provide. In 2010, he stated, “Generally speaking, high-frequency traders provide liquidity and ‘knit’ together our increasingly fragmented market place, resulting in tighter spreads that benefit all investors.”<sup>16</sup>

*The U.S. equity markets are the most liquid in the world. But what does market liquidity mean in practice? Consider this example which compares the liquidity profiles of Deutsche Telekom, Germany's largest telecommunications company, with its smaller U.S. subsidiary, T Mobile. Deutsche Telekom's market capitalization, or "market cap", is \$35 billion; T Mobile's market cap is \$4.4 billion.<sup>17</sup> On average, 5 million shares of T Mobile change hands each day in the U.S. markets.<sup>18</sup> That means, on average, \$120 million, or 2.7% of T Mobile's \$4.4 billion market cap turns over each day.<sup>19</sup> By contrast, only \$115 million, or about .3% of Deutsche Telekom's \$35 billion market cap turns over each day.<sup>20</sup> In short, the shares of the German company—which is 8 times larger than its U.S. subsidiary by market cap—are 10 times less liquid. Which shares would you rather own? If you trade in the more active U.S. markets you will benefit from having many more opportunities to sell your shares. And your trades will have less market impact. HFT adds to the market's liquidity by standing ready to buy your shares of T Mobile.*

## **Is There a Downside to Speed?**

HFT critics tell another story. In their view, the per-trade benefits that HFT provides investors are simply a snapshot—one moment in time. They argue that if you allow the camera to roll, and watch the market in real-time, an unstable picture is revealed.

Two of the most prominent criticisms of HFT are that:

### **1. HFT Increases Market Instability**

In normal market conditions, HFT adds to market liquidity by continuously and rapidly buying and selling shares. But, critics say that during stressful market events high-speed traders pull out of the market and the liquidity they provide



disappears. This, they argue, has caused the markets to become unstable.

The most hotly debated, traumatic event in recent market history was the “Flash Crash” of May 2010. During the 20-minute-long crash the major stock market indices, which were already trading 4% lower on the day and experiencing high levels of volatility, suddenly plunged a further 6% in a matter of minutes. The Dow Jones Industrial Average (DJIA) suffered its largest intraday point decline in history, shedding \$1 trillion in market value in less than a half-hour.<sup>21</sup>

At 2:32 PM, the market domino effect started when a mutual fund initiated a non-HFT execution algorithm. The purpose of the mutual fund’s trade was to hedge its stock holdings by selling a large amount of stock index contracts.

Until 2:41 PM, high-frequency traders gobbled up the contracts that the mutual fund was selling. But since speed traders do not want to hold inventory, they only bought the futures contracts for about 10 minutes. And then they reversed course and began to rapidly liquidate.

After 2:41 PM, “high frequency traders reached their critical inventory levels and began to quickly and aggressively unwind their long inventory levels at a key moment when liquidity was sparse, adding to the downward pressure on market prices. High frequency traders rapidly passed contracts back and forth, contributing to the ‘hot potato’ effect that drove up trading volume, exacerbating the situation,” explain Andrei Kirilenko and Andrew Lo in “Moore’s Law vs. Murphy’s Law: Algorithmic Trading and Its Discontents.”<sup>22</sup>

As Donald MacKenzie states, “High-frequency trading systems are often programmed to cease operating if unusually large price movements occur, and other systems are monitored by human beings who have what is in effect a large red stop button on their screens. Throughout the United States the automated systems stopped and the red

buttons were pushed. With HFT no longer providing liquidity the market plunged further.”<sup>23</sup>

When the red buttons were pushed, HFT-provided liquidity evaporated. The rapid exodus effectively paralyzed the market.

Andrew Haldane, Executive Director for Financial Stability at the Bank of England, casts doubt on the benefits of the liquidity that HFT provides in “A Race to Zero.” He states that because the liquidity that HFT provides can be quickly withdrawn, it can add to market volatility during times of intense stress. “Far from solving the liquidity problem in situations of stress, HFT firms appear to have added to it. And far from mitigating market stress, HFT appears to have amplified it. HFT liquidity, evident in sharply lower peacetime bid-ask spreads, may be illusory. In wartime, it disappears.”<sup>24</sup>

### **Black Monday: Black Eye for NYSE Specialists**

*Liquidity providers fleeing the market during chaos is not without precedent. NYSE market-makers, known as specialists, have a duty to continuously make markets. This preserves market liquidity and stability—especially in times of crisis. But, during the “Black Monday” market crash of October 1987 many specialists did not buy stocks as the market sold off sharply. As the January 1988 Report of the Presidential Task Force on Market Mechanisms notes, “a substantial number of NYSE specialists appear not to have been a significant force to counterbalancing market trends.”<sup>25</sup>*

## **2. Bad HFT Actors Have Been Accused of Market Manipulation**

It is illegal to enter an order to buy or sell a stock if the intent of the order is to manipulate the market.<sup>26</sup> You can't flood the market's infrastructure with orders that are meant to distract, rather than transact. Federal securities regulators have the authority to police market manipulation.

Critics of HFT point to two illegal practices that they believe are used by bad actors to manipulate the market: "quote stuffing" and "layering the order book."

"Quote stuffing"—which is a lot like jamming a phone line—describes the practice of flooding "the market with huge numbers of orders and cancellations in rapid succession."<sup>27</sup> In a 2010 speech, former SEC Chairman Mary Schapiro highlighted that more than 90% of HFT orders are quickly cancelled.<sup>28</sup> This high cancellation rate makes market participants question if this order flow provides "meaningful liquidity."<sup>29</sup> Some market participants argue that an order to buy a stock that only exists for a millisecond before it is cancelled provides no real value to the market.

Inundating the market with orders that are instantly cancelled creates huge blasts of activity in a stock. Critics claim that quote stuffing is used to trick other

market participants into making bad trades based on illusory price signals.

"Layering the order book" is a similar tactic that refers to the practice of entering large volumes of orders to buy or sell a stock in order to trick market participants into altering their price. When market participants lower their selling price in response to an algorithm's allegedly false selling activity, this allows an HFT firm to buy shares at a discount to where the market was trading just moments before they entered their large (and ultimately cancelled) orders. Critics argue that these practices have impeded market participants who want to invest for the long-term.

Speed has also frustrated the Commodity Futures Trading Commission (CFTC) and the SEC, the two federal securities regulators who are responsible for policing markets. It is hard

to decipher if the intent of an order cancellation is to manipulate the market or if the cancellation is the result of a high-speed trader making a lightning fast, and totally legal decision to withdraw from the market.

In an effort to keep up with speed traders, the SEC rolled out the Market Information Data Analytics System (MIDAS) in February 2013. This system is intended to track the micro-second fast movements in the market and spot market manipulation in real-time.

In a 2012 *The New York Times* article, Richard Bentley, Vice President for Capital Markets at Progress Software stated, “We’ve managed over the past few years to equip traders with Ferraris and the regulators are trying to keep up with them on bicycles.”<sup>30</sup>

It’s too early to tell whether MIDAS will have the speed to keep up.

## Conclusion

The speed revolution that has transformed the markets in recent years has been staggering. High-speed trading has created value for investors but it has also forced them to confront the issues that are inherent when new innovations disrupt long-held practices.

The benefits of high-speed trading are real. Bid-ask spreads have collapsed in the last decade. Investors, on most occasions, are able to access instant liquidity. These changes have translated into real economic savings on a transaction-by-transaction basis.

What is the best way to retain the benefits of speed trading while also working to ensure the markets don’t fall apart in periods of stress? That is the question policymakers and regulators must grapple with as they try to balance the forces of innovation—and the need for speed—with the demand for market stability.

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