The Choices of High Frequency Traders in the Flash Crash of 2010

STS Research Paper
Presented to the Faculty of the
School of Engineering and Applied Science
University of Virginia

By

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May 6, 2020

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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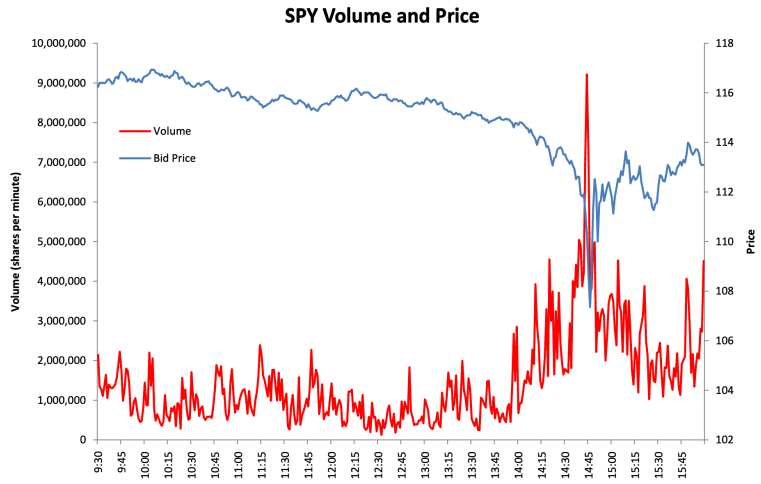
Introduction

On May 6, 2010, stock markets opened down 3% on unsettling news about the worsening European debt crisis. Markets stayed that way for most of the day until about 2:42 p.m., when a large sell order for the S&P500 E-mini contract appeared representing about 30% of trading volume. Initially, automated trading systems known as high frequency traders (HFT) absorbed some of the shock by taking the other side of the trade and buying the E-mini contracts. Soon afterwards, however, they started to exacerbate the problem. Having now an excess of these E-mini contracts, HFTs began to sell these contracts that they had just bought, mostly to other HFTs that would immediately sell again, causing a spiral effect that drove the stock market down 6% in just six minutes (Melin, 2016). Investors started to panic, unsure if they were uninformed of a catastrophic world event. Then, just as suddenly as the market went down, it began to go back up. By 3:07 p.m., the stock market had rebounded back to its original level before the sudden crash, and investors were left wondering what had happened. This event became known as the flash crash of 2010 (CTCF & SEC, 2010).



The flash crash of 2010 is now a reminder of how HFTs can cause havoc in the market, and was also a catalyst for trading rules that would prevent another crash like it from happening. Most scholarly literature examining the flash crash also focus on why the crash happened and how it could have been prevented. However, little discussion

focuses on what the right choice was in the moment to reduce financial loss in the flash crash. This lack of scholarly discourse could be a disaster in the event that another flash crash occurs, since the correct response for HFTs in that situation has not been adequately examined.

I believe prior literature does not analyze the consequences of HFTs' decisions in the flash crash of 2010. As I am focusing on consequences, the ethical framework of utilitarianism is well-suited to analyze this case. In this paper, I will use utilitarianism to morally evaluate HFTs' roles in the flash crash and show that their response was not the right choice in the interest of all market participants, causing panic and financial loss.

Background

High frequency traders (HFTs), loosely defined as systems trading in milliseconds and at high volumes, became increasingly prevalent in the years leading up to 2010 (Keller, 2012). Since then, HFT growth has stagnated due to the hyper-competitive field and the sharp decline of profits, but they still play an important role in financial markets. HFT is not understood properly by many people, and is sometimes regarded as an unnecessary player in the financial markets (McGowan, 2011).

Before explaining the role of HFTs, some knowledge and terminology of the financial markets is required. In the United States, there are 13 registered stock exchanges such as the New York Stock Exchange and the NASDAQ, where market participants including conventional traders at hedge funds and banks, retail traders at home, and computer algorithms can buy and sell stocks to each other. They often don't make trades directly between one another; instead, a middleman called the market maker, which is usually an HFT, buys and sells stock. Since the HFTs can process many trades at once, they provide investors with liquidity, which in rough

terms means the availability of buyers and sellers and how easy it is to complete a trade. Regarding the types of trades that can occur, a stock is just one type of asset that can be traded on the exchanges. People also trade assets based on indexes such as the S&P500, which weights the stock prices of the 500 largest companies into one number known as the S&P500 index (Soltas, 2014). The types of assets can get even more complicated, but they are out of the scope of this paper. In the flash crash of 2010, the type of security traded was called an S&P500 E-mini contract, which is basically a bet on the price of the S&P500 index in the future.

Literature Review

There is a scarcity of scholarly literature about the flash crash of 2010 and the ethics of the HFTs behind the crash. This is likely due to two factors: complexity and secrecy. Scholars note that "the universe of HFT strategies is diverse and opaque" due to intense competition between trading firms (Keller, 2012). To try to solve this issue, studies have attempted to simulate HFT algorithms in a fake stock market environment to explain their behavior and the function they play in the market. However, this will never accurately represent the actual HFT landscape due to its secretive nature and the ever-changing algorithms, which are usually employed for no more than a few months before being changed (Keller, 2012). Other than simulations, some scholars try to explain how the flash crash occurred from factors in previous days, issues with the stock market structure, and technical signals present during the flash crash.

Easley, de Prado, and O'Hara conducted a study in 2010 examining how a factor called VPIN, which measures the risk that other traders have more information, affected the withdrawal of HFT from the market. They found that VPIN levels were highest on May 6th, and also abnormally high in the week leading up to May 6th, causing market makers to be on alert. This

meant that in a volatile situation, HFTs would assume other traders had much more information than them, causing them to lose money. As a precaution, they cut their losses by selling their inventory of stock and withdraw from the marketplace, thus reducing liquidity. The authors conclude by saying that the VPIN is a good predictor for market makers, who normally provide liquidity, to turn into liquidity consumers.

Kirilenko et al. take a more empirical approach on HFT behavior by running a stock market simulation. In a study conducting in 2017, they found that when the sell pressure was high in the S&P500 E-mini contracts, HFTs followed the rules coded into them which limited buying large, risky amounts of E-mini contracts. However, the HFTs differed from textbook market makers in their simulation because they did not significantly alter their risk-taking dynamics when faced with abnormal situations like a large liquidity imbalance. This shows that HFTs may work well during uneventful trading days, but behave detrimentally during unexpected scenarios.

What these studies and others have failed to do is consider the decisions made by HFT through an ethical lens. Although market simulation and technical analysis can provide insight into why the flash crash happened, it does not judge whether the actions taken by HFTs should have been taken. My work will build on prior studies by synthesizing the costs and benefits that resulted from HFTs' decisions to withdraw from the market, and then use utilitarianism to make a moral judgment that their decision was detrimental to the whole of the market.

Conceptual Framework

I will analyze the morality of HFT using the concept of utilitarianism, which allows me to weigh the negative and positive effects of the technology on society. Developed by Jeremy

Bentham in the 18th century, utilitarianism guides one's actions by maximizing the pleasures and minimizing the pains of the consequences of an action. This ethical framework is strongly tied to the value of hedonism, the idea that pleasure is the only thing that is good in itself, and forms the basis for all other experiences (Driver, 2014). Bentham also introduces the concept of the utility principle: the greatest happiness for the greatest number of people. Other moral terms like "proper", "responsible", and "correct" are only meaningful if they are used for actions in agreement with the utility principle. The utility principle can be applied using a moral balance sheet, which is similar to a cost-benefit table with the left side listing negative consequences and the right side listing positive consequences. Usually a monetary value is assigned to each consequence because Bentham says the experiences can always be bought or sold. Then the total value in each column is multiplied by the number of lives the action would affect to arrive at a total benefit and total cost. If the total benefit is higher, the action is morally permissible (van de Poel & Royakkers, 2011).

Utilitarianism fits HFT well because most pleasures and pains in the stock market are in terms of financial gain or financial loss. For example, one company can make a trade faster than another company, resulting in a profit for the first and a loss for the second. Moreover, a common drawback to utilitarianism - placing value on invaluable things like a human life - is absent in this analysis because HFT does not cause any physical harm. It is a solely electronic entity operating on a solely electronic platform. And in financial markets, with thousands of participants competing against each other to make the most profit, everyone is on a level playing field, and there are no favored relationships between two participants. Therefore utilitarianism does not have to place value on the connections between participants when making moral

considerations. Since utilitarianism is well-suited to analyze the ethics of HFT, I will use it to outline the costs and benefits of their decisions during the flash crash of 2010, showing that the total sum of the costs and benefits amounted to a loss for the greater good.

Analysis

As mentioned in the introduction section, the flash crash was initiated by a large sell order from a mutual fund, then exacerbated by the actions of HFTs. I will focus on two main actions that HFTs took: rapid selling and withdrawing from markets. I will also discuss investor sentiment after the flash crash to show the further negative effect that HFTs' decisions had.

Rapid Selloff

Throughout the flash crash, HFTs did not consider the market as a whole, and instead hyper-aggressively competed against other HFTs to reap profits at the expense of the investors they were supposed to provide liquidity to. Initially, as the large sell order from Waddell and Reed entered the market, market makers stepped in to provide liquidity and buy up the E-mini contracts. However, because market makers never keep a position for long, they started selling the E-mini contracts. The CFTC and SEC found that the 16 HFTs involved in the crash (out of 15,000 other trading accounts) never held more than 3,000 contracts on May 6, while they traded over 1,455,000 contracts. This shows that they did not attempt to alleviate the sell-side pressure, but rather did the opposite. Moreover, the CFTC and SEC also found that there was an unusually high level of "hot potato" trading volume, where HFTs would buy and sell E-mini contracts repeatedly among each other, causing the 6% crash. The downward spiral was only stopped by a stop-logic functionality in the Chicago Mercantile Exchange (CME) that paused trading for five seconds (CFTC & SEC, 2010).

The most important factor to note here for the utilitarianism analysis is that there were only 16 HFT market participants, while there were 15,000 other normal trading accounts. Using the utility principle, the greatest happiness and financial gain would be a normally operating market for the vast majority of other market participants. HFTs usually do this by quoting the right prices for stocks and buying and selling appropriate amounts. In this flash crash though, the HFTs seemed to have completely disregarded the other slower traders, while competing aggressively for profits between the other 15 HFTs in the market. They did not recognize that the 1,455,000 contracts were bought and sold in an unusual volume and at an incredibly fast rate, causing 15,000 other investors to be left out of the market. The majority would have no way of keeping up with the rapid trading and price drops that the HFTs caused, and therefore lose money in the flash crash. This loss of wealth for the majority of market participants is a violation of the utility principle.

The firms that employed the HFT strategies should have considered a scenario like this when programming their algorithms. The morally correct action would be to create a HFT program that provides the greatest good for the people. The greatest good definitely does not involve a 6% sell-off in six minutes that would have continued for longer if it were not for the CME stop-logic functionality. In addition, the sell-off across all 16 HFT market participants showed that all of them did not consider the morally correct choice; if even a few of them had implemented algorithms that prevented this, then the market would not have crashed so suddenly or severely.

Withdrawal from the Market

Not only was HFTs' initial response poor, but the subsequent actions they took to withdraw from the market caused even more problems. During the downward spiral of the E-mini contract price, a significant number of HFTs made the decision to shut down their algorithms and withdraw from the market, fearing "the occurrence of a cataclysmic event of which they were not yet aware, and that their strategies were not designed to handle" (CFTC & SEC, 2010). Some of these shutdowns were triggered by automatic warnings in the algorithms, and others were manually overridden. After shutting down the algorithms, traders and risk managers could fully assess market conditions before resuming trading.

When these trading algorithms were shut down, the E-mini contract was not the only trading that stopped. The algorithms took in data from many market sources to make trades, so shutting the system down would result in the shutdown of trading for common stocks too, like P&G, Accenture, 3M, and Apple. Investors were shocked to see $40 stocks drop to $0.01 as prices fluctuated wildly, since there was no longer an efficient pricing process from the market makers (CFTC & SEC, 2010). Moreover, for market makers to stick to their obligations to offer prices, some of them offered "stub prices" as low as $0.01 and as high as $100,000 that were not intended to be traded on. Even more extraordinary was the fact that over 20,000 trades were executed at prices more than 60% away from their original value. Thankfully, these erroneous trades were "broken", or reversed and refunded, by the exchanges and federal regulators in the following days (CFTC & SEC, 2010).

The decision market makers made to withdraw from the markets was largely in their own interest. They knew the consequence of withdrawing would mean that other investors would not get accurate prices for a wide range of stocks. Investors could have made trades on the incorrect

prices that the market makers offered, and from the data, it is clear to see that at least 20,000 trades were made with wildly incorrect prices. There could have been many more trades made within the 60% range that were not broken by the exchanges, in which case the investors making those trades would have lost money. Breaking trades beyond the 60% threshold merely reduced, not reversed, the financial loss caused by HFTs' withdrawal from markets.

The fact that some HFT algorithms required human intervention to shut down meant that a different course of action was possible. Rather than completely shutting down, market makers could have employed a backup strategy, such as using human traders to set prices. Even though human market makers are worse at providing liquidity and pricing than algorithmic market makers, they could still have employed a less efficient strategy at the expense of their own profit but to the benefit of all of the other market participants. Watching the market fall as they stood back to assess their own risks did not provide for the greatest good as the market maker should have done.

Market makers faced a tough decision between letting their algorithms continue trading in a downward spiral, or completely withdrawing from the market and removing liquidity to take time to reassess the situation. There could be an argument made for how withdrawing might have been the only choice that caused the least harm, with the knowledge of the situation that the HFTs had. After withdrawing, the CFTC and SEC report states market makers that would have "manually overridden their systems and continued providing liquidity were simply incapable of doing so in a timely manner due to the tremendous pressure caused by a flood of orders, executions, and market data that needed to be manually checked (CFTC & SEC, 2010)." Even if there was a need to manually check data, market makers could still have done so in a "timely

manner" by performing faster but less accurate data checks, thus restoring liquidity sooner. Utilitarianism would dictate that this response was the correct one since it would result in a better positive outcome for all market participants. Instead, market makers did not trade at all for an extended time and used stub quotes, which resulted in trades over 60% away from the original stock's price.

Reduced Confidence

Another effect that the flash crash had on markets was reduced confidence. Until the SEC report came out in October, investors could not explain what had happened so suddenly on May 6th. Uncertainty causes investors to put less money into stocks, as they fear another crash of similar or greater magnitude could wipe out their investments. Indeed, a New York Times report in September of 2010 explains that investors withdrew money from the market every week since the crash (Bowley, 2010). This causes problems in the stock market. Companies are not valued correctly, and are not appropriately awarded for their innovation. It also decreases liquidity, which as mentioned before is essential for efficient markets.

Conclusion

High frequency traders make up a large part of today's financial markets and provide important services to investors. However, in the flash crash of 2010, HFTs made morally incorrect decisions that sent markets tumbling 6% in just six minutes, sparking panic among investors and harming those who made trades during that time. I use utilitarianism to show that HFTs did not provide the greatest good to all, which is the core tenet of the ethical framework. This research into moral actions during the flash crash will help HFTs make the morally correct choice in times of crisis, or in future flash crashes, that will benefit the greater good. When these

sound decision-making processes are used, institutional investors as well as investors at home will be assured that they will not lose money in an anomaly like the flash crash of 2010.

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