The Flash Crash: The Impact of High-Frequency Trading on the Stability of Financial Market

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Abstract. The growing prevalence of High-Frequency Trading (HFT) in financial markets has sparked intense debate over its impact on market stability. This paper aims to research the adverse effects that come along with HFT's enhancement of liquidity and price discovery efficiency. It contrasts the hardware infrastructure and execution speeds of high-frequency automated trading against manual trading and analyzes how the liquidity bubbles provided by HFT contribute to market volatility. This paper then concludes with three main points. First, HFT can pose a threat to market stability. Second, specific HFT strategies may mislead other market participants and lead to price distortions. Lastly, HFT may exacerbate market participation inequality, posing a market fairness challenge. Based on these findings, this paper recommends that regulatory authorities and policymakers pay closer attention to the potential risks of HFT and implement measures to maintain market stability and fairness.

Keywords: HFT; Growth statistics; Flash Crash.

1. Introduction

High-Frequency Trading (HFT) emerged as a revolutionary term in the financial lexicon. Rapid trading at lightning speed has garnered significant attention due to its profound influence on the markets and has ignited extensive debates on its implications for market stability. This paper aims to research the adverse effects that come along with HFT's enhancement of liquidity and price discovery efficiency. It contrasts the hardware infrastructure and execution speeds of high-frequency automated trading against manual trading and analyzes how the liquidity bubbles provided by HFT contribute to market volatility. This paper utilizes a wide range of journal articles that revolve around the 2010 Flash Crash in the stock market and the 2014 Flash Crash of the U.S. Treasury Bond. The two case studies, as well as the supporting statistics on the utilization of HFT, will be used to argue against the popularization of HFT in the financial market.

Through this research, the paper concludes that HFT can induce severe market volatility in a short time frame, posing a threat to market stability. Moreover, specific HFT strategies may mislead other market participants and lead to price distortions, further undermining market efficiency and stability. Additionally, due to its technological advantages and speed in information gathering, HFT may exacerbate inequality among market participants, posing a challenge to market fairness. Therefore, regulatory authorities and policymakers need to pay closer attention to the potential risks of HFT and implement measures to maintain market stability and fairness, thereby ensuring a healthier and more sustainable financial environment. The impact of HFT firms on market stability can be controlled by strengthening communication between HFT firms and regulatory departments, as well as by improving the technological capabilities of the regulatory departments.

HFT, due to its high technological and financial barriers to entry, can destabilize markets by creating a disproportionate concentration of power among a limited number of participants, thereby fostering a system of inequality and susceptibility to abrupt market fluctuations.

2. Overview of HFT

HFT's genesis traces back to the early 2000s, dovetailing the rise of digital trading. It is algorithmic trading marked by rapid speeds, elevated turnover rates, and a high ratio of orders to trades.

Embracing algorithms and lightning-fast networks, HFT platforms can conduct millions of trades in split seconds, offering unparalleled market liquidity. However, HFT also brings potential volatility and systemic vulnerabilities [1]. By the decade's end, HFT accounted for a significant portion of U.S. equity trading volume. One report indicated that HFT accounted for approximately 60% of all U.S. equity trading volume around 2009-2010 [2]. This was the peak of its prominence in terms of market share. The shifts and Regulations that occurred after 2010 impacted the HFT landscape to some extent, and its strategies expanded into global markets. By the end of 2020, the percentage of HFT accounted for between 24% and 43 % of the European Equity Market [3]. As more firms entered the HFT space, the market started to become saturated, and the profit margins began to decline. The concerns about market stability (e.g., the Flash Crash in May 2010) led to increased scrutiny and regulatory changes.

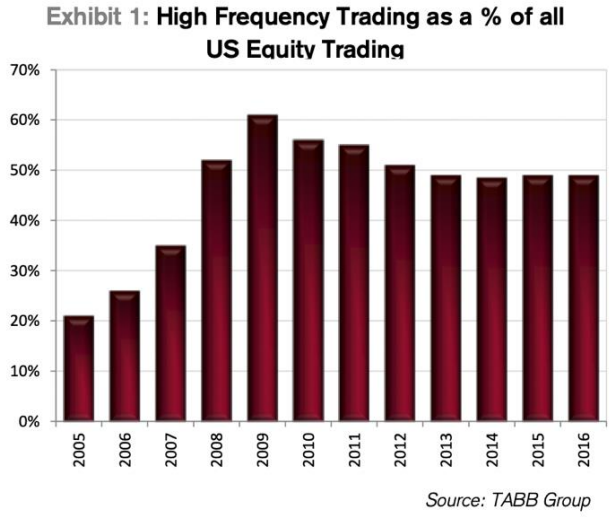

Fig 1. Mavromovic, 2023.

After the Flash Crash, the U.S. Securities and Exchange Commission (SEC) took several regulatory steps to enhance market stability. Key measures included implementing "circuit breakers" to temporarily halt trading during extreme volatility and introducing "Limit Up-Limit Down" rules to prevent trades outside specified price bands. The SEC also eliminated "stub quotes" and introduced new rules for better transparency and risk management controls for brokers and dealers. These actions aimed to protect investors, increase market transparency, and reduce the risk of similar future events [4]. By the 2020s, while HFT was still a significant force in the U.S. markets, its exponential growth had eased down. The industry saw consolidation, with several firms merging or being acquired, as increased competition and reduced profit margins took their toll. Additionally, the overall percentage of trades attributed to HFT in the U.S. equity market had reportedly decreased somewhat from its peak, but it still constituted a significant portion around 51% [5]. Therefore, HFT still occupies a very large share even in the present day, and it is necessary to strictly update the regulatory system in a timely manner to avoid the possibility of market crashes caused by HFT strategies.

HFT is intensely competitive and focuses on speed, algorithms, and low costs to gain an edge. Firms invest in cutting-edge technology and proprietary strategies to outperform rivals and seek differentiation that comes through specialization in trading strategies, asset classes, or unique technological solutions. Leading firms, like Citadel Securities and Virtu Financial, have risen not merely due to the size of their capital but also due to their innovative algorithmic strategies and relentless pursuit of technological advancement. Firms, as such, have reshaped trading paradigms, but they have also catalyzed concerns about market dominance and fairness [6].

3. HFT and Market Instability

HFT's influence isn't limited to just speed. It has the potential to magnify market anomalies. Moreover, HFT algorithms, driven by similar market indicators, might at times produce herd-like

behavior, potentially exacerbating market downturns or inflating bubbles. The 2010 'Flash Crash' serves as a stark example. Within minutes, the Dow Jones dropped over 1,000 points, only to recover those losses within another mere minutes. Although HFT did not directly cause flash crashes, the continual buying and selling of orders by automated trading systems worsened price drops and increased market instability [7]. The "Flash Crash" of May 6, 2010, was one of the most rapid and severe disruptions in U.S. stock market history. Within a span of 36 minutes, major indices plummeted dramatically, only to recover most of their losses shortly afterward [2]. The episode raised concerns about the robustness and stability of the modern, highly electronic, and interconnected financial markets.

Here is a detailed breakdown of what happened: At 2:32 p.m. (EDT), Waddell & Reed Financial initiated the sale of an unusually large volume of 75,000 E-Mini S&P 500 futures contracts. This sale began to heavily influence the market by 2:45 p.m., driving down the E-Mini price due to the lack of buyers. A minute later, automated trading algorithms and high-frequency traders exacerbated the situation by rapidly buying and reselling contracts. This surge in activity set off stop-loss orders, furthering the price decline. By 2:47 p.m., this turmoil had spilled over to the individual stocks of the S&P 500, causing a domino effect on various instruments and exchanges. Within these two minutes, the DJIA plummeted, losing almost 6% of its value. Liquidity issues arose at 2:48 p.m. as some market makers retreated. However, by 2:49 p.m., a trading halt on the E-Mini triggered a rebound, helped by bargain hunters and the end of the original massive sell order. By 3:00 p.m., most losses were reclaimed. Another notable incident was the sudden volatility of the US Treasury bond market on October 15, 2014 [7], which was again linked to HFT activities. In October 2014, the U.S. Treasury bond market witnessed an unexpected "Flash Rally," where yields on the 10-year U.S. Treasury note fell and then quickly rebounded within minutes without any apparent fundamental news prompting the shift. Subsequent investigations indicated that while high-frequency traders didn't initiate the move, they exacerbated it, leading to feedback loops of rapid trading and reducing liquidity during heightened volatility [8].

These incidents not only highlight the potential vulnerability of the financial market but also underscore the destabilizing role that HFTs can play. They act as stark reminders that regulators must be proactive rather than reactive in monitoring market activities. Enhanced oversight mechanisms and timely interventions are crucial to maintain market integrity and investor confidence. Thus, the episodes make a compelling case for ongoing, comprehensive regulatory scrutiny to ensure market stability and fairness.

4. High Barriers to Entry in HFT

HFT requires significant capital to achieve economies of scale and cover the costs of technology, research, and infrastructure. The economies of scale enjoyed by industry giants like Citadel Securities and Virtu Financial allow them not only to invest in cutting-edge technology but also to attract top-tier talent in fields such as quantitative research, software engineering, and data analytics. These elements create a positive feedback loop, wherein these major players can further refine their algorithms and trading strategies, thereby maintaining their competitive edge. As a result, smaller firms find it exceedingly difficult to compete with industry giants, given the financial and technological resources required to even enter the playing field. Moreover, the rapid pace of technological innovation means that HFT companies must continually reinvest in their systems to integrate the latest advancements, from more powerful servers to enhanced machine-learning algorithms. Failing to do so could result in obsolescence, as trading advantages can be measured in milliseconds. Therefore, the HFT sector has essentially evolved into a high-stakes game where only those with deep pockets and a relentless focus on innovation can sustain their operations and profitability. [7].

Beyond its monetary might, technological superiority reigns supreme in HFT, and it requires advanced technology to execute trades in a matter of milliseconds or even microseconds. This

includes ultra-fast computers, sophisticated algorithms, and co-location services (placing one's trading systems close to the exchange's systems to reduce latency). This requires not only cutting-edge infrastructure but also algorithms that are capable of navigating the complex market terrain and rapidly adjusting to new data. Leading HFT firms employ some of the best minds in the fields of quantitative research, software development, and finance. They continually adapt and innovate their strategies in response to changing market conditions, and they invest heavily in research and continuously back-test their strategies using historical data to ensure profitability and to understand potential risks. The ongoing evolution in artificial intelligence and machine learning would also further reinforce this [9], making it even harder for the average individual investor to adopt HFT.
With a higher entry barrier by the day, HFT could pose seriously negative effects on the world of trading, as the sheer cost of the entry barrier would effectively bar the vast majority of investors, individuals, or entities. At the end of the day, it can be expected that only large entities can possess the prerequisites required to enter the arena of HFT. Consequently, the HFT arena sees a concentration of influence, where elite entities dictate market trends, overshadowing traditional traders and potentially skewing market fairness.

5. Concentration of Power & Inequality in HFT

Ideally, a market thrives on diverse participation. However, the HFT landscape contradicts this principle. The technological and financial hegemony of a select few firms intensifies market disparity. This raises questions about the 'invisible hand' of the market, as the overwhelming influence of these firms can steer market directions, overshadowing smaller players. Within a fraction of a second after financial reports are released, HFT firms are able to obtain this information act before major news outlets publish the financial results, and then the stock price would drop or increase significantly within less than a second. This speed of trading is generally not accessible to ordinary investors. Its ability to act on news within a fraction of a second raises several important issues with questions of market fairness. As the speed advantage is not accessible to ordinary investors, this rapid trading can distort the process of price discovery and also affect market liquidity and volatility. As a result, high-frequency traders gain access to information milliseconds ahead of other market participants through their speed advantage and unfairly influence the market and make profits [10].

Furthermore, this concentration of power may give rise to collusion risks, where major players, intentionally or inadvertently, act in ways that benefit a clique at the expense of the broader market. It can also be misused for market manipulation through tactics like quote stuffing (flooding the market with orders to gain speed advantage), layering and spoofing (placing and canceling orders to mislead traders), and momentum ignition (artificially creating rapid price movements [12]. This concentrated authority further leads to reduced competition, limiting opportunities for smaller market participants to innovate or thrive, and it often culminates in a stifling of creativity and dynamism as the larger players set the rules of the game, marginalizing others who could bring fresh perspectives and novel solutions. This also creates an environment where unethical practices such as insider trading, could potentially go unchecked or unchallenged. Such an ecosystem not only compromises market integrity but also undermines the core principles of fairness and transparency that are essential for a healthy, functioning marketplace.

6. Possible Solutions & Regulation

Given the interconnectedness of today's global markets, international cooperation is pivotal. Regulatory disharmony might lead to 'regulatory arbitrage,' where firms migrate to lenient jurisdictions, thereby circumventing stricter regulations.

Addressing HFT's double-edged sword requires judicious regulation. Proposals range from introducing 'speed bumps' to dampening HFT's speed advantage to overhauling market structures entirely. Regions like the EU, with its MiFID II regulations, aim to enhance transparency, investor

protection, and market integrity in the European Union's financial markets. It also focuses on standardizing the regulatory framework for financial markets across EU member states, creating a more competitive and integrated environment [11].

The regulatory rules in the United States often do not reach the level of transparency of MiFID II, but this does not mean that the U.S. financial regulatory system is inadequate in terms of transparency. They simply have different methods and focus on how to balance transparency, flexibility, innovation, and other factors. Therefore, the impact of HFT firms on market stability can be controlled by strengthening communication between these firms and regulatory agencies, as well as by improving the technological capabilities of the regulatory departments.

Regulatory bodies could require companies using HFT strategies to disclose their algorithms more extensively to them, with the understanding that the collected algorithms will only be used to assess their impact on structural market stability. This would protect the privacy of these companies while also identifying potential risks. HFT companies should also regularly conduct stress tests on their own algorithms to determine how they would perform under extreme market conditions. Additionally, financial regulatory authorities should enhance their capabilities to use machine learning and big data analytics for real-time detection of unusual trading activities, taking swift action when risks may reach critical thresholds.

7. Conclusion

HFT stands at the crossroads of admiration and skepticism. Its dazzling speed and precision, which exemplify technological triumphs, contrast with its potential to precipitate market tumults. The discourse on HFT is not about sheer mechanics but its broader implications on market equity, stability, and the very ethics of trading. As financial markets evolve, with technology playing an increasingly central role, managing, and potentially harnessing the might of HFT becomes a critical concern for regulators, traders, and stakeholders at large. This paper has argued that the current uses of HFT create price distortions, destabilize the financial market, and create hollows in market fairness practices.

While this paper adequately addresses the challenges that the financial market has been facing in the context of HFT, it still lacks in providing viable solutions for policymakers and regulatory bodies to effectively make amends to the potential market unfairness and volatility. Future research should focus on how these preventative measures can be taken to balance market powers and more efficiently regulate the financial market.

References

[1] K. Z. Zaharudin, M. R. Young, and W. Hsu, “High-frequency trading: Definition, implications, and controversies,” Journal of Economic Surveys, vol. 36, no. 1, pp. 75–107, 2021. doi:10.1111/joes.12434

[2] A. Mavromovic, “We’re all high frequency traders now,” Credit Suisse, https://smallake.kr/wp-content/uploads/2017/10/HFT_world.pdf (accessed Aug. 25, 2023).

[3] J. Breckenfelder, “Competition among high-frequency traders and market liquidity,” CEPR, https://cepr.org/voxeu/columns/competition-among-high-frequency-traders-and-market-liquidity.

[4] D. M. Serritella, “High speed trading begets high speed regulation: sec response to flash crash, rash,” *University of Illinois Journal of Law, Technology & Policy*, vol. 2010, no. 2, pp. 433–444, 2010.

[5] HKIMR, HKIMR, Hong Kong, Hong Kong, rep., 2021

[6] E. Boehmer, D. Li, and G. Saar, “The competitive landscape of high-frequency trading firms,” *The* Review *of* Financial *Studies*, vol. 31, no. 6, pp. 2227–2276, 2018. doi:10.1093/rfs/hhx144

[7] A. KIRILENKO, A. S. KYLE, M. SAMADI, and T. TUZUN, “The flash crash: High-frequency trading in an electronic market,” *The Journal of Finance*, vol. 72, no. 3, pp. 967–998, 2017. doi:10.1111/jofi.12498

[8] Z. S. Levine, S. A. Hale, and L. Floridi, "The October 2014 United States treasury Bond Flash crash and the contributory effect of Mini Flash crashes," *PLOS ONE*, vol. 12, no. 11, 2017. doi:10.1371/journal.pone.0186688

[9] A. Shkilko and K. Sokolov, "Every cloud has a silver lining: Fast trading, microwave connectivity and trading costs," *SSRN Electronic Journal*, 2016. doi:10.2139/ssrn.2848562

[10] A. J. Menkveld, "The economics of high-frequency trading: Taking stock," *Annual Review of Financial Economics*, vol. 8, no. 1, pp. 1–24, 2016. doi:10.1146/annurev-financial-121415-033010

[11] D. Busch, "MIFID II: Regulating high frequency trading, other forms of algorithmic trading and direct electronic market access," *Law and Financial Markets Review*, vol. 10, no. 2, pp. 72–82, 2016. doi:10.1080/17521440.2016.1200333

[12] J. Arnoldi, "Computer Algorithms, market manipulation and the institutionalization of high frequ ency trading," *Theory, Culture & Society*, vol. 33, no. 1, pp. 29–52, 2015. doi:10.1177/026 3276414566642