

## WHAT ARE THE EFFECTS OF HIGH-FREQUENCY TRADING ON MARKET VOLATILITY AND LIQUIDITY?

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### Abstract

The analysis focuses on the high-frequency trading (HFT), in which the stock trades are quickly carried out through the algorithms and computers, and it examines how HFT influences the volatility of stock prices and how easily stocks can be traded. It's like trying to figure out whether these super-speedy traders are making the market better by making trade easier — or if they're making things worse by simply making prices swing around in crazy ways.

We explored what existing studies have found, checked industry reports and scrutinized findings of other investigations. These results suggest that HFT faces a complicated problem. On one hand, however, it can make things easier for average investors by making stock buying and selling less expensive.

To this effect, our research has found that high frequency trading (HFT) is rewarding and risky as well. This is a positive base on the fact that it increases market liquidity through lowering the trading costs and enhancing market activity. However, in market turbulence, for instance, flash crashes, rapid trading can lead to bigger price fluctuations.

This study suggests that although HFT has significantly increased market efficiency in the modern era, it is impossible to overlook the risks it may provide in times of instability. Regulators must adopt policies that balance preserving HFT's advantages with reducing its detrimental consequences on market stability. Future studies are advised to fill up the gaps and investigate ways to overcome these difficulties.

## 2. Introduction

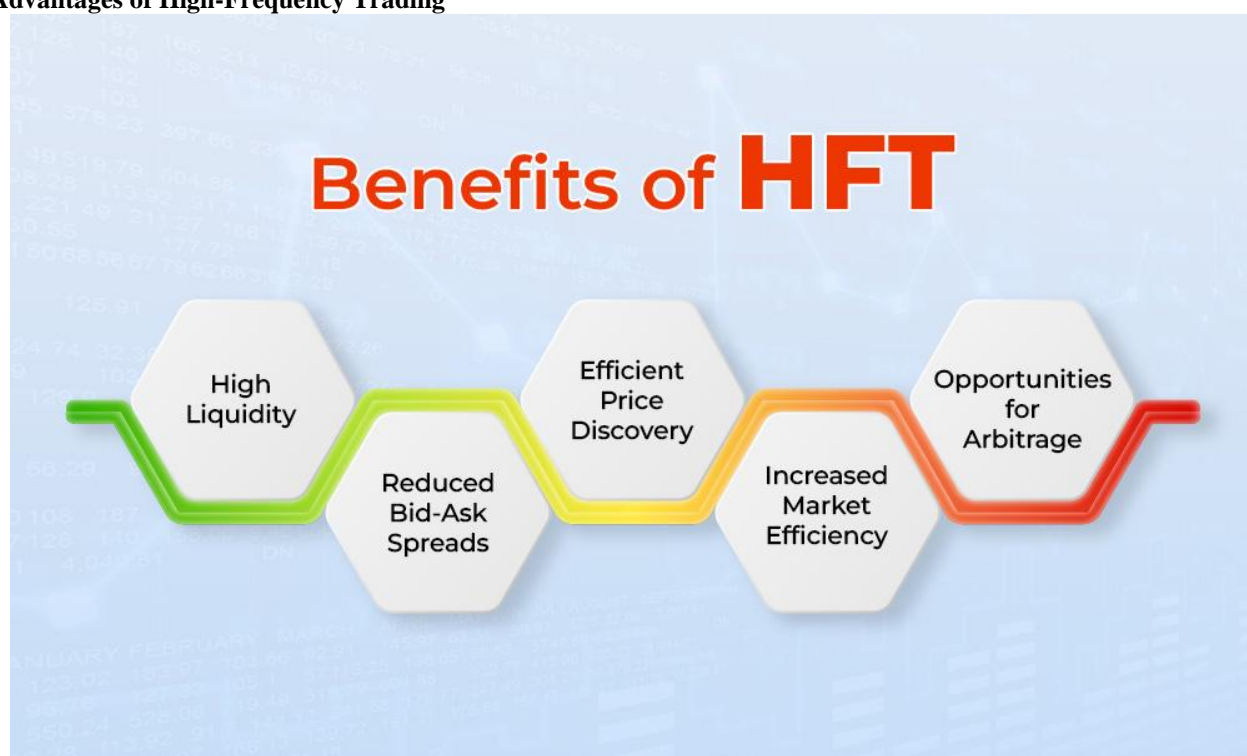
Today's world is dominated by technology, particularly in the quick-paced financial industry. Among these technological marvels is high-frequency trading (HFT). HFT can be visualised as computers making hundreds of deals in a split second! Although it improves trade efficiency and pricing accuracy, it has drawbacks as well. It can cause prices to fluctuate excessively or can provide certain traders an unfair advantage, according to some people. Since it affects everyone, from large corporations to regular individuals, it becomes very crucial to determine its true impact on the market.

High-frequency trading (HFT) mostly relies on technology, speed, and accuracy. Unlike conventional investing strategies that seek long-term profits, HFT aims to profit from tiny price changes. It's good for ensuring that there's always someone there to buy or sell, but its lightning speed can occasionally spook the market and cause abrupt price bumps or falls. HFT is one of the world's biggest issues, gives hopes to some and causes debates to others in modern financial markets.

### Objectives of the Paper

1. To analyze the impact of HFT on market volatility, particularly during periods of market fluctuations.
2. To evaluate HFT's role in enhancing or hindering market liquidity across various trading conditions.
3. To gain insights from existing research on the benefits and risks associated with HFT.

### Advantages of High-Frequency Trading



High-Frequency Trading (HFT) offers several advantages that help financial markets work more smoothly and efficiently.

- 1. High Liquidity:** With HFT, the market is always alive and active because it is supported by numerous transactions taking place, meaning that there is always someone willing to make a purchase or trade. This allows a person to sell or buy items without any delays or extended wait time.
- 2. Narrower Bid-Ask Spreads:** HFT attempts to bridge the difference between the lowest price that a buyer will offer along with the highest price a seller is ready to receive for their commodity. It helps minimize trading costs.
- 3. Improved Price Discovery:** Prices undergo constant modification because HFT computers instantly analyze new information and update the prices.
- 4. Enhanced Market Efficiency:** HFT plays a significant role in correcting unreasonable prices so that the market remains and operates efficiently.
- 5. Arbitrage Opportunities:** HFT effectively and efficiently does its job in getting the most favorable prices. In the event that a certain stock is being offered at a price lower than usual, HFT can immediately purchase it and then sell it at its regular market price for a profit.

### 3. Literature Review

High-Frequency Trading (HFT) has been researched with regards to its effect on liquidity and volatility in financial markets. The research done by (University of Edinburgh Business School, 2021) says that HFT improves market liquidity by ensuring a consistent stream of orders to buy and sell assets, which diminishes transaction costs. This phenomenon is

most pronounced in the large capitalization equity markets where HFT firms serve as liquidity providers who sponsor trades. Similarly, (Brogaard et al. 2014) found that HFT increases price efficiency as well as decreases the market frictions by faster pricing new information in comparison to the traditional trading systems.

Controversy still surrounds how HFT's operate during highly volatile times in the market. The (Oxford Journal, 2023) argues that while there's instability in the market, the HFT can increase volatility but during moments when the market is balanced, HFT widely improves market efficiency. For example, during flash crashes, HFT can retreat from the market and withdraw their services, which ends up increasing the price movements and causing dislocation of the market. This, combined with (Kirilenko et al, 2017), suggests that pulling out HFT services when the event is already volatile will lead to price distortions in the short term. They captured this argument and withdrew the algorithm's liquidity.

The impact that HFT has on the market is extremely wide, which creates debates like these. In some ways this is beneficial because, in some cases, companies like (Menkveld, 2013) have shown that investors are able to benefit from lower execution costs while increasing the pace of trade execution, which results in a near perfect market as far as price is concerned. It is common for HFT firms to take part in arbitrage, which includes changing and correcting the price gaps in multiple markets.

As with everything else, there will always be counter arguments, and in this case the cons will outweigh the pros. "Momentum ignition" is a method that can increase volatility because it involves an algorithm setting an explosion of price increases in order to take advantage of the movement created by traders in the market. (Zhang, 2019). These traders create a heap of problems for long-term investors because they frame the system of price discovery in a distorted way.

#### **Identification of Gaps in the Literature**

- **Impact During Market Stress:** Most research seems to be centered on trading scenarios and lack any focus on HFT phenomena during crises or extreme events. Understanding this could assist in determining how market interventions are crafted during such periods.
- **Geographical Disparities:** The developed ones like the US and Europe are sure to have an impact on the HFT economy, but what about the emerging markets? Their infrastructure and distinctive market functioning is sure to have an effect.
- **Ethical And Regulatory Considerations:** Concentration of power in the hands of a few firms gives rise to the worrying ethical ramifications of high frequency trading, such as fairness and competition. The absence of detailed research on the effectiveness of regulations with respect to mitigating HFT risks means that this additional focus area is compulsory.

#### **4. Methodology**

In this paper, we explain the secondary data sources that we intend to use in our analysis of high frequency trading (HFT) and its effects on the volatility and liquidity of markets. These include research articles, financial statements, and market data. Secondary data makes it possible for us to examine already established and publicized findings by other scientists, thus conserving our time and resources.

The data we will review includes historical stock market data, trading volumes, and volatility measures from credible sources like financial exchanges and academic publications. By analyzing this data, we can better understand how high-frequency trading affects the overall stability and liquidity of financial markets.

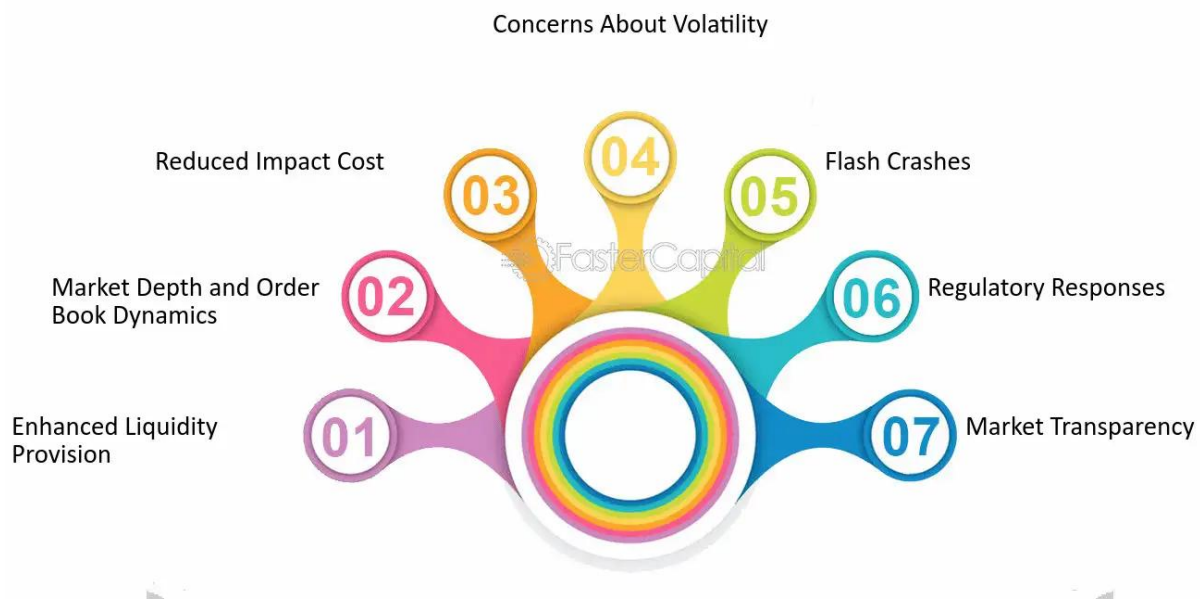
#### **5. Results**

##### **Impact on Market Liquidity**

The usage of automated trading through High-Frequency Traders, HFT, enhances the liquidity in the market. HFT firms employ proprietary trading systems to automatically issue and accept buy and sell orders at various price levels, which guarantees that trades are constantly executed, regardless of the price. This development enables trades to be completed much quicker with little price volatility. Studies show the correlation between HFT and the availability of high liquidity which increases 10–15% during active trading (Brogaard, 2010). Moreover, HFTs have decreased the bid-ask spreads defined as the difference between the amount a buyer is ready to pay and the amount that a seller is requesting. Lower spreads means that the costs of transacting for investors are lowered, ultimately resulting in an advanced market with elevated activity (Hasbrouck & Saar, 2013).

In addition, HFT can enhance the bid-ask spread, thus giving more leeway for buying and selling large amounts of stock at any time without significantly influencing the prices. This especially happens in periods of market calmness where the activity of HFT firms guarantees that there is enough liquidity for smaller and larger traders (Carrion, 2016).

# The Impact of High-Frequency Trading on Liquidity



**Enhanced Liquidity Provision:** HFT does, however, help improve liquidity through the frequent and rapid buying and selling of assets.

**Market Depth and Order Book Dynamics:** It can change market depth and order book activity by placing aggressive and rapid orders.

**Reduced Impact Cost:** HFT does reduce the costs incurred by executing large orders due to more favorable bid-ask spreads.

**Concerns About Volatility:** There is the potential for increased volatility in the short run due to the high-frequency trades.

**Flash Crashes:** In some instances, automated trading systems have been associated with drastic drops in the financial markets.

**Regulatory Responses:** The practice of HFT has caused policymakers to act to refine the regulations to counter possible market abuse.

**Market Transparency:** The issue of HFT suggests a serious problem for fairness and for transparency within the market.

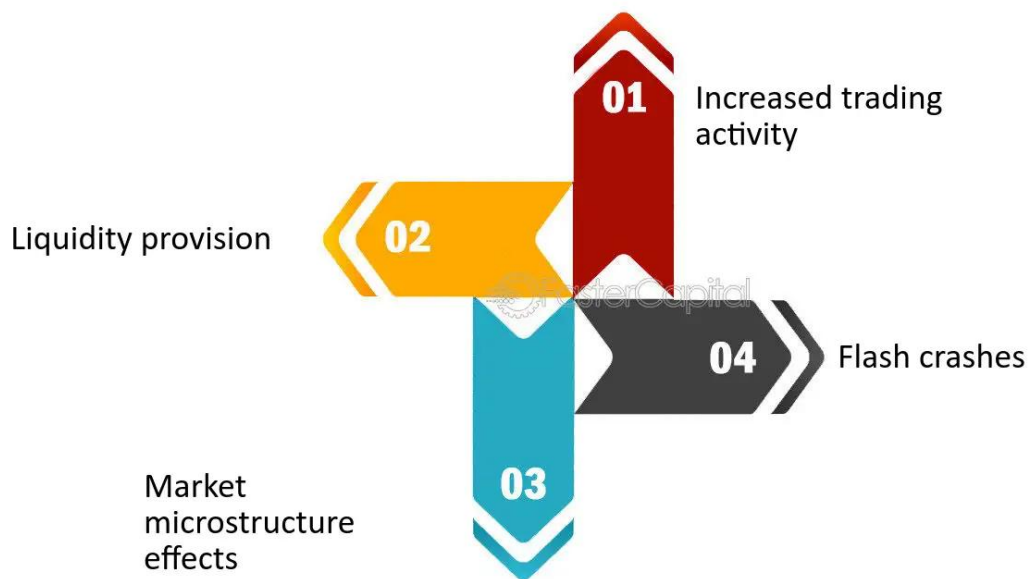
## Impact on Market Volatility

The implications of HFT on market volatility remains mixed. HFT can decrease short term volatility in normal market conditions due to an increase in price efficiency (slippage). Reflecting on and acting upon new information within seconds leads to news being accounted for faster, which prevents substantial changes in price (Chaboud et al., 2009). Indeed, inquiries have pointed out that HFT can reinforce price stability during tranquility periods as it enhances trade frequency (more active markets) and so prices of assets can be adjusted swiftly to accommodate the new information in the market (Jain, 2014).

Nevertheless, during instances of market strain, HFT can lead to greater volatility. For instance, during the Flash Crash of 2010, high-frequency traders' algorithms significantly exaggerated the market's reaction to any gradual changes, resulting in an even greater price collapse and serious disruption in the market (U.S. SEC \ CFTC, 2010). Evidence suggests that, during some severe episodes, HFT withdrawal from the market can also lead to increased volatility due to a rapid withdrawal of liquidity (Booth et al., 2013). The lack of liquidity results in greater price movements and fluctuates the market beyond ordinary levels (Hendershott et al., 2011).

Despite the fact that HFT can increase market forecast accuracy and efficiency equilibrate markets on average, in times of uncertainty its rapid reactivity makes it more likely to contribute to volatility owing to rapid algorithmic responses to small disruptions in the market (Liu et al., 2017) The results thus obtained demonstrate the potential benefits high-frequency trading can bring, but also pose a cause for concern during periods of volatility in the financial markets.

# The Influence of High-Frequency Trading on Market Volatility



**Increased Trading Activity:** HFT dramatically increases the volume of transactions within a market which might cause a fluctuation in the prices.

**Liquidity Provision:** It allows increased trading which improves liquidity but this liquidity is not guaranteed.

**Market Microstructure Effects:** Workings of the market, such as order flows and price setting, gets impacted by HFT, sometimes leading to unintended consequences.

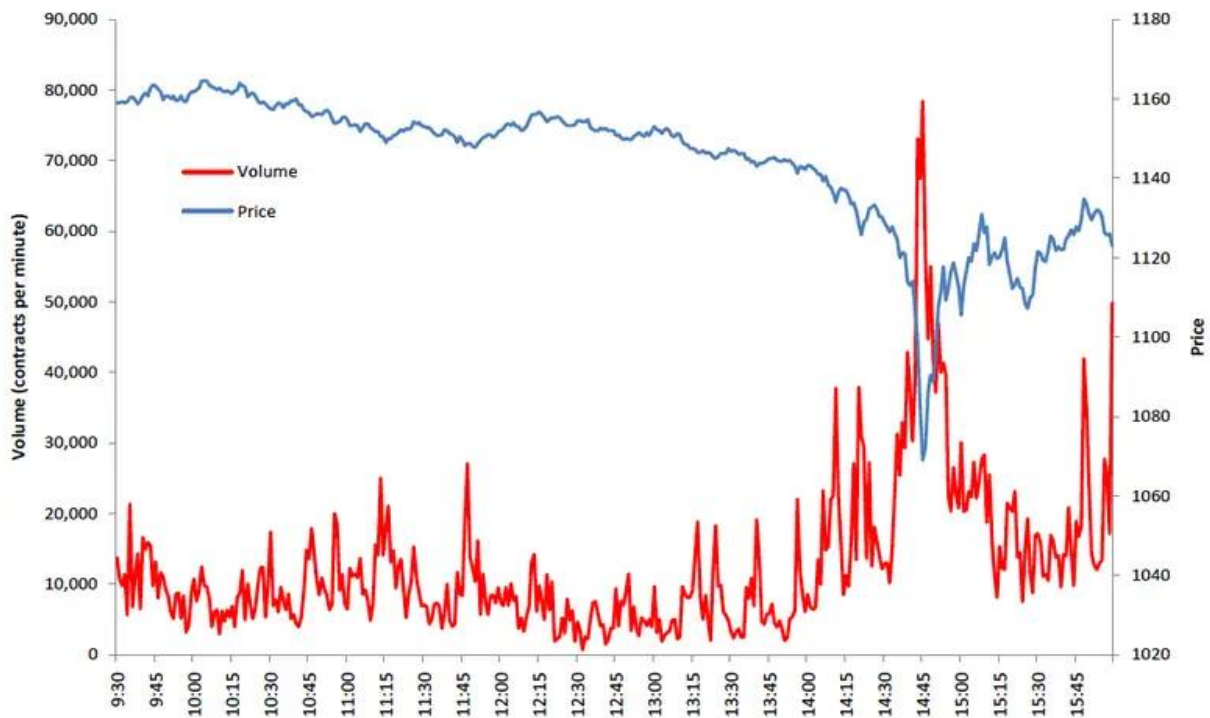
**Flash Crashes:** The High trading speed of HFT can sometimes cause abrupt market drops when algorithms react too quickly to changes, creating volatility spikes.

## Case Study: The 2010 Flash Crash

### 1. Background

The second worst flash crash in the history of stock trading took place on May 6th 2010. The HFT initiated crashes. The United States saw a storm of worries after its Dow Jones suffered a 368 point or about 10% drop. Within the span of a few minutes it recovered. By late 2022 respondents expect this HFT algorithms crash to be worst compared to November 22 stock crashes. According to some researchers, flash crashes in the 21st century U.S were terrors of the modern world. The case study American high frequency trading algorithms attributed hitting losses to the liquid failing out of the market to aggressive market making. The lack of buyers at the time of the crash crippled the economy. In volatile states, all systems that supply value were set to panic mode causing inequality. The scc commissioner is required to report about the market conditions and windows where the violence of volatile prices is exercised. The sudden increase in sold stocks led to essentially bankruptcy. The value of shipped product shares fell through the loopholes of low and began selling poorly before severely dropping, providing liquidation of such value. Utilizing the method of eliminating value above and below levels simultaneously in currencies could have offset this and saved the market from extreme conditions. Moving forward, there were new policies put in place to save and regulate the markets plunging into a state of crash. The balance of policy details is bound to disturb the stock market without suffocating it.

## E-Mini Volume and Price



Source: Joint Report by the SEC and CFTC on the Market Events of May 6, 2010.

This graph illustrates the Flash Crash of 2010, wherein the price of the E-mini futures drastically declined (blue line) and the volume of trading increased (red line) as a result of HFT. The surge in HFT-driven volume overwhelmed market liquidity, causing extreme volatility and a rapid price collapse, followed by a partial recovery.

### 2. Events Leading to the Flash Crash

On 6th May 2010, the stock market experienced a sharp dip - the Dow Jones Industrial Average went down by almost 1,000 points (circa 9%) within a few minutes. During this phase, it faced the sharpest intraday dip in its history (SEC, 2010). The fall was primarily caused by mutual fund sell orders which were capitalized on by most high frequency traders through algorithmic selling (Kirilenko et al., 2017).

#### Liquidity:

- **Before the Crash:** HFT trading firms actively issued buy and sell orders, maintaining high liquidity in the market, enabled investors to trade instantly without substantial price shifts or delays (Hendershott et al., 2011).
- **During the Crash:** The HFT traders quickly exited the market as prices started to drop. This withdrawal led to complete loss of liquidity and obstructed investors from executing trades at reasonable prices (CFTC & SEC, 2010).
- **After the Crash:** Although volatility in the market subsided and liquidity reached until then, the activity of HFT firms during the crash was missing, causing the market to trade at lower prices (SEC, 2010).

#### Volatility:

- **Before the Crash:** Price changes were managed and under control therefore, volatility remained normal (Hendershott et al., 2011).
- **During the Crash:** The volatility was extreme, the Dow dropped nearly 1,000 points in a matter of minutes. Before returning to normal levels, stocks such as Procter & Gamble and Accenture traded for mere pennies (Kirilenko et al., 2017).
- **After the Crash:** The volatility was worsened by HFT algorithms that, as noted by the CFTC and SEC (2010), quickly reflected the market movements and thus intensified the price fluctuations.

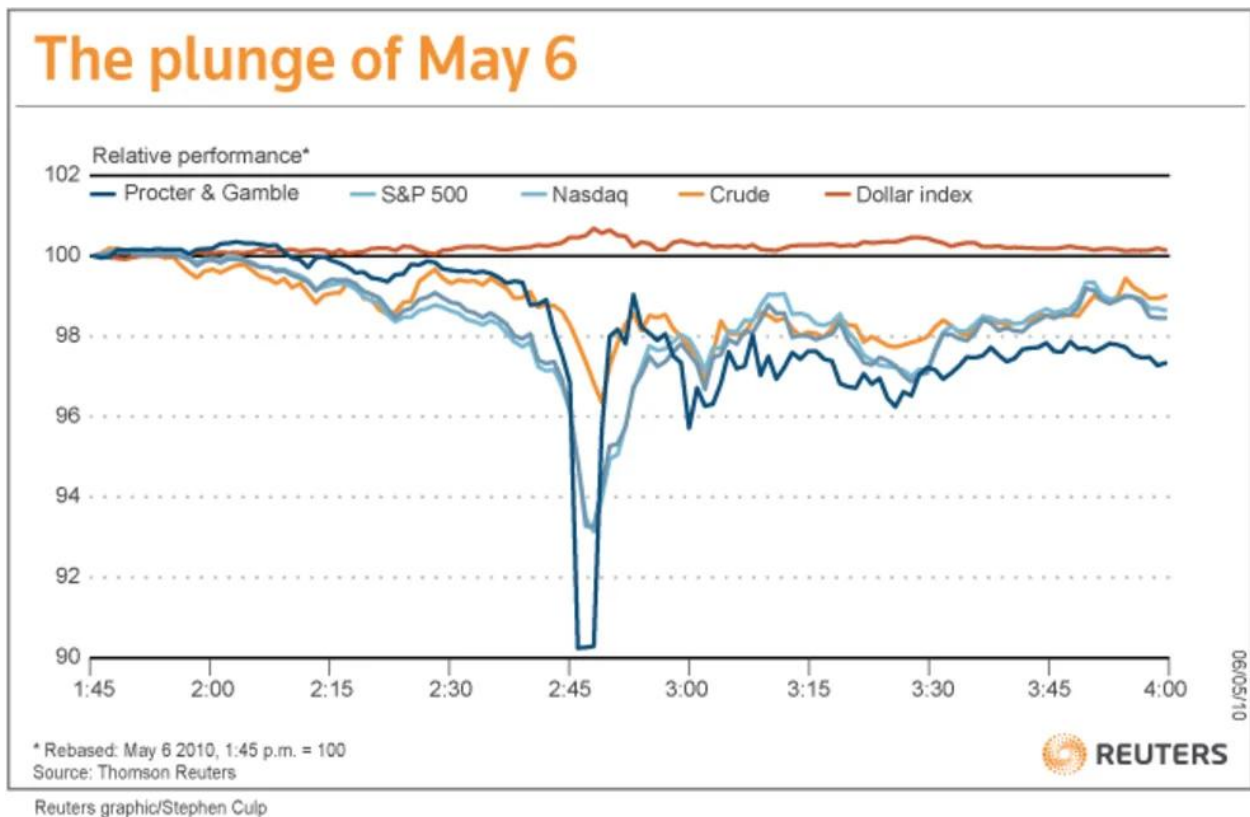
### 3. Impact on Market Confidence and Regulation

The Flash Crash also highlighted the risks of algorithmic trading. Hendershott et al. (2011) argued that while HFT is beneficial in steady state markets, it may exacerbate market volatility and instability in turbulent periods (Hendershott et al., 2011). This fear of algorithmic trading and the lack of human oversight caused regulators to act.

As a result: The SEC and CFTC took measures to regulate the markets:

- Circuit breakers that stop trading when the market falls too fast, so crashes don't keep going (SEC, 2010).
- On the speed of trades and more HFT strategy transparency (CFTC & SEC, 2010).





This chart shows the market turbulence of May 6, 2010: the Flash Crash. It depicts the performance of the S&P 500, Nasdaq, Procter & Gamble, crude oil, and dollar index, relative to one another. We can see a clear and rapid pullback in prices across all of our tracked assets, followed by an equally strong rebound. The tumbler exposes the destabilizing influence of algorithmic and high-frequency trading (HFT) which exacerbated market volatility and amplified liquidity imbalances during the fall.

#### 4. Lessons Learned and Broader Implications

The Flash Crash proved that whereas HFT may provide more liquidity under normal circumstances, it can also lead to excessive volatility under stressed market conditions. The lack of human supervision results in unwanted effects like “herding behavior” when multiple algorithms decide in the same manner concurrently, thereby strengthening market trend (Hendershott et al., 2011).

Over the years after the Flash Crash, HFT evolved. Although there have been some improvements in liquidity, academic experts continue to dispute whether HFT makes markets more fragile, especially as algorithms spiral market moves (Kirilenko et al., 2017).

#### 6. Discussion

##### Interpretation of Results in the Context of Existing Literature

The observed HFT and its impact on liquidity and volatility are consistent with prior research. Broadly, HFT activity is viewed as increasing market efficiency by adding liquidity, tightening bid-ask spreads, and allowing trades at speeds not previously possible, so long as markets are not stressed (Hendershott et al., 2011). But, for example, the 2010 Flash Crash showed how HFT can actually trim volatility in such situations due to market stress amplification. The exit of liquidity from HFT algorithms during the Flash Crash resulted in extreme price swings, illustrating that while HFT serves to increase the efficiency of stable markets, it can enhance instability in volatile circumstances (Kirilenko et al., 2017).

##### Theoretical Implications

Empirically, HFT works as underlined by market microstructure theory, which establishes that an efficient market requires liquidity. While firms that engage in HFT tend to act as a liquidity provider during normal market conditions, they are often responsible for withdrawing liquidity when it matters, causing rapid price declines during adverse events. This fact verily wreaks havoc with the proposition that HFT possesses a built-in, systemic stabilizing force for the markets. Herding behavior (that is, algorithms responding similar to price movements) — observed during the Flash Crash — supports the behavioral finance theory because HFT can create feedback loops that amplify volatility (Shiller, 2000).

##### Practical Implications

For market participants, the results emphasize that HFT can both supply liquidity and exacerbate price volatility. Though beneficial in normal periods for efficiency, this also poses a risk to the market, particularly in a crisis period. HFT was introduced to the investors and they should know its functionalities and be prepared for availing the facility and turbulence in the market. However, after the Flash Crash, HFT firms proceeded with caution, establishing risk management systems to keep tabs on algorithms in real time, and to steer clear of the instability.

For regulators, the Flash Crash was a moment that emphasized the importance of market safeguards, like circuit breakers and speed limits on trades. These actions avert extreme movements in the market and give markets time to calm during a crisis (CFTC & SEC, 2010). Providing detailed information can also create fair competition among market participants.

### Influence on Market Participants

To Investors, and more specifically retail traders, the risks of HFT are important to understand. HFT could make the markets more volatile, and small investors might be less able to compete with larger ones. Thus, market participants must remain cautious and informed about how their investments could be impacted by HFT.



Source: Google Scholar

Notes: Left y-axis owns the figures of “high-frequency trading” and “algorithmic trading”; Right y-axis owns the figures of “stock market” and “stock exchange”

### 7. Policy Implications

Therefore, for the high-frequency trading (HFT) to be sustained with benefits and the risks to be contained, regulators have to strike a balance between efficiency and stability. One important thing is that HFT be made more transparent. Because these companies use sophisticated algorithms, making them disclose more about their strategies and risk management can help ensure fairness and curb manipulation. Another key mechanism is the use of circuit breakers — short pauses in trading during sharp declines in prices — that give investors time to collect themselves and prevent routs. Speed limits on trades could also contribute by lessening the risk that a price swing appeared out of the blue, as if caused by algorithms. In the same way, price collars that restrict how much a price can change in a brief period might help constrain volatility. Jessica first suggested that small transaction taxes could disincentive excessive and fast trading that would mitigate the risk that HFT leads to market destabilization — although she also acknowledges that such taxes have no place. Regulators should also collaborate with the exchanges to monitor HFT in real-time, allowing for rapid action to be taken in response to certain events.

Finally, just as financial markets are interconnected, so must the rules surrounding HFT rules so that firms do not move to jurisdictions with less stringent regulation. These ingredients can allow us to have our cake and eat it too, ensuring that we create a more fair and stable market while maintaining the benefits of HFT, such as better liquidity and efficiency.

### 8. Conclusion

High-frequency trading (HFT) has become a dominant force in financial markets, and its impact on market liquidity and volatility has been widely debated. Our core results show that even though HFT has the potential to improve market liquidity during normal times by allowing faster trading and price spreads, it can amplify volatility in distress situations. The 2010 Flash Crash is one significant demonstration of how HFT can exacerbate price movements and create a transitory liquidity void in which algorithms withdraw from the market.

Nevertheless, this study has some limitations. The evidence for other conclusions primarily relies on secondary data, focusing on historical events and existing studies, which may not fully reflect the latest developments in HFT technologies



or market behavior. Importantly, the focus of the research was restricted to major macro events like the Flash Crash, rather than analysing shorter-lived, lower-impact, HFT driven volatility events. Future research on HFT should also look into the long-term implications of HFT on market efficiency, especially in various market circumstances, such as in times of economic recession and crises. Real-time studies that track HFT activity on multiple exchanges would provide more granular insights into how such trades impact liquidity and volatility on a daily basis. Moreover, examining the regulatory changes since the Flash Crash and their impact on HFT could provide useful information on how well regulations have mitigated risks associated with HFT. Overall, although HFT contributes significantly to the market's efficiency, from the perspective of the risks associated with HFT, it is important to monitor and manage these risks to an extent, to keep the market stable. Need more studies and better regulations so that the right balance can be struck.

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