Financial Economics Research; Vol.3, No.6; 2026
E-ISSN: 3006-3663 P-ISSN: 3006-3655
DOI: https://doi.org/10.70267/fer.v3n6.166172
Published by: Zeus Press

A Review of the Impact of High-Frequency Trading on Stock Market Quality: Perspectives on Liquidity, Volatility, and Price Discovery

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Abstract

High-frequency trading is a new phenomenon resulting from the integration of technology, finance, and the stock market. How to understand the impact of high-frequency trading on the quality of the stock market is a common concern of the academic community and regulatory authorities. Based on clarifying the concept of high-frequency trading and its strategy types, this paper systematically reviews domestic and foreign literature from the perspectives of liquidity, volatility, and price discovery. The study finds that under normal market conditions, high-frequency trading can narrow the price gap, provide liquidity, smooth out noise fluctuations, and accelerate the integration of information into prices, thereby improving market quality. However, in extreme market conditions, its liquidity supply rapidly retreats and presents the characteristic of "illusory liquidity", and the homogeneity of strategies and crowded trading may amplify fluctuations. The speed advantage leading to reverse selection and short-term trading orientation will also weaken the absorption of price by fundamental information. High-frequency traders are not a homogeneous group, and their impact direction depends on the strategy type and institutional environment. The long-term impact of high-frequency trading on the quality of China's stock market still needs further research.

Keywords

high-frequency trading, stock market quality, liquidity, volatility, price discovery

1. Introduction

High Frequency Trading (HFT) is a completely automated trading strategy characterized by large trading volumes but short holding periods. Events such as the May 6, 2010, "Flash Crash" in the U.S. stock market, the Everbright Securities trading error, and the Eton Securities case have gradually brought the impact of high-frequency trading on stock markets into the spotlight of academic research. The related studies can be broadly classified into three categories. The first category focuses on the impact of HFT on liquidity and short-term volatility, suggesting that it can be both a provider and a taker of liquidity [1,2]. The second category examines its impact on social fairness, arguing that the short-term profits of HFT traders come at the expense of ordinary investors and are not a Pareto improvement [1]. The third category discusses the existing regulatory policies in both domestic and foreign contexts [2,3], advocating for restrictions on frequent order cancellations and disruptions to market order [3,4]. However, scholars mostly discuss based on the quality of the securities market, welfare [1], and risk [5], lacking a comprehensive review with a unified framework covering liquidity,

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volatility, and price discovery. Moreover, the existing studies on the impact of the HFT market do not reach a consensus: Zhang [6] found that HFT promotes excessive stock price reactions and hinders price discovery. While Li [2] believes that HFT can eliminate market temporary inefficiencies and promote price discovery, the divergence stems from the differences in the time scale of research and the measurement method of price discovery. Moreover, research on regulation has largely relied on overseas data and primarily adopted normative analysis. Most studies predate the latest regulatory rules, such as the Regulations on the Administration of Program Trading in the Securities Market (2024), resulting in a lag in policy-related evidence. The policy evidence is lagging. Therefore, this paper examines the impact of HFT on the stock market and its institutional boundaries from the perspectives of liquidity, volatility, and price discovery.

2. High-frequency Trading and Stock Liquidity

Liquidity is a core indicator that reflects the quality of the market, directly determining transaction costs, price volatility, and the timeliness of order execution. Regarding whether high-frequency trading can truly enhance liquidity, the academic community has formed two opposing viewpoints: One holds that high-frequency trading, through faster quote adjustments and lower inventory risks, plays the role of a "new type of market maker", narrowing bid-ask spreads and increasing the depth of the order book; the other believes that it provides "illusory liquidity", as rapid order cancellation and reversal selection will force ordinary traders to withdraw, thereby damaging real liquidity.

2.1 High-frequency trading improves liquidity

High-frequency trading alleviates short-term liquidity imbalances and reduces transaction costs by generating a large number of buy and sell orders simultaneously, making it a net provider of liquidity [1]. Jarnecic and Snape [7] studied the order submission and cancellation strategies of high-frequency traders using the tick-by-tick data of FTSE-100 constituent stocks on the London Stock Exchange and concluded that high-frequency trading enhances liquidity. Hendershott et al. [8] used NYSE email traffic as a measurement and empirically verified that in the context of automatic quotation, the reduction in effective bid-ask spreads and the sharp decline in adverse selection enhanced the liquidity of large-cap stocks.

However, the conclusion that high-frequency trading enhances liquidity is contingent on the situation. In extreme market conditions, the opposite is true. Kirilenko et al. [9] analyzed the data during the Flash Crash, a period of intense selling pressure, and found that during periods of significant liquidity imbalance, high-frequency traders did not significantly alter their inventory dynamics to bear risks. Li et al. [10] also proposed the concept of "illusory liquidity", which refers to the liquidity that disappears as soon as the real demand arises, resulting from rapid order placement and cancellation by high-frequency traders. Both of these studies have verified that high-frequency trading is unable to provide liquidity in extreme situations.

2.2 High-frequency Trading Undermines Liquidity

Market-making high-frequency trading offers bilateral quotations, which act as liquidity providers. Arbitrage-based high-frequency trading, in an effort to execute transactions before the spread disappears, often consumes market liquidity through active orders. Ba and Wang [1] mentioned that high-frequency trading can influence the overall liquidity level of the market by acting as both a provider and a taker of market liquidity in different situations. Market-making high-frequency trading offers bilateral quotations and acts as a liquidity provider, while arbitrage-based high-frequency trading consumes market liquidity through active orders [10]. However, the act of arbitrage-based strategies in demanding liquidity does not inherently harm market quality. Only when high-frequency trading exacerbates information asymmetry and adverse selection, and increases bid-ask spreads, does it truly undermine market liquidity and quality.

Menkveld [11] used examples to illustrate that after the intervention of high-frequency trading, machines would instantly seize all assets when there was positive news, thereby causing adverse selection costs for the sellers. If the sellers raised the price, it would lead to a decrease in the market trading rate. Nawn and Banerjee [12] also pointed out that faster traders might make other traders fear adverse selection, thereby reducing the supply of limit orders and damaging liquidity. Zhang [6] further pointed out that the increase in trading volume and the narrowing of price differences brought about by high-frequency trading are merely superficial phenomena. In 2009, high-frequency trading accounted for 78% of the trading volume in the US stock market,

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far exceeding the reasonable level of 50%, indicating that a large number of transactions occurred among high-frequency traders, which did not necessarily constitute the true liquidity of the market. This "illusory liquidity" is essentially an increase in adverse selection costs, and ordinary traders' withdrawal led to this.

3. High-frequency Trading and Stock Volatility

Volatility measures the magnitude, frequency and path of price changes and is another core dimension for evaluating market quality. Not all volatility is detrimental to market quality: fluctuations driven by new information are an indication of the normal functioning of the price discovery mechanism, while fluctuations caused by noise trading, imbalance in order flow and price errors fall into the category of excessive volatility. Regarding the relationship between high-frequency trading and volatility, the literature has also formed two opposing judgments: one holds that speed advantage will amplify the excessive reaction of prices to new information and lead to crowded trading; the other believes that high-frequency trading makes price adjustments more continuous and smooth, compressing the fluctuations caused by noise [10, 13].

3.1 High-frequency Trading Increases Volatility

One viewpoint holds that high-frequency trading amplifies the magnitude of fluctuations and prolongs their duration. The mechanisms behind this are as follows.

The first is the overshoot and retracement mechanism. High-frequency traders act preemptively before news or large order information is fully priced, pushing prices above the equilibrium level in a short period. Once the information is fully absorbed by the market, prices reverse and form a more amplified overshoot-like oscillation. Zhang [6] discovered a significant positive correlation between high-frequency trading activities and stock price volatility. It is also stronger in large-cap stocks, stocks with a high proportion of institutional holdings, and during periods of high market uncertainty. This indicates that the real-time nature of high-frequency trading may instead lead to excessive reactions. Additionally, the information sources and strategies of high-frequency traders are highly homogeneous. They trade in the same direction almost simultaneously in response to the same signal, and the imbalance in order flow is difficult to be promptly offset, leading to crowded trading. Brogaard et al. [14] found that after macro news was released, HFT actively traded in the direction of the news and passively provided reverse liquidity. The trading congestion caused by homogeneous news and signals led to significant price fluctuations.

The second is the amplification under extreme events. During stress events such as flash crashes, the price decline can evolve into a significant jump within a short period due to the interaction between automated sell orders and order losses. High-frequency traders did not suppress such jumps through reverse trading. Kirilenko et al. [9] conducted an account-level study on flash crashes, showing that the E-mini stock index futures experienced a significant decline and rebound within minutes. The most active high-frequency intermediary trading mode did not change during the decline, resulting in price fluctuations.

3.2 High-frequency Trading Reduces Volatility

Another viewpoint holds that high-frequency trading makes price fluctuations more stable, reducing the noise component in price swings. The basis for this view also comes from two dimensions.

First, some scholars believe that high-frequency trading promotes the continuity and timeliness of quote adjustments, and prices no longer absorb shocks in a violent and discontinuous manner. Hasbrouck and Saar [15] constructed the RunsInProcess indicator to measure high-frequency trading activities, indicating that it does not harm the interests of long-term investors and can enhance stability in general situations. Brogaard et al. [14] believe that high-frequency traders also play a role of counter-trend buffering, buying when prices are temporarily under pressure and selling when they temporarily rise, smoothing out price swings caused by order flow shocks, and this behavior still exists on the most volatile trading days.

Second, high-frequency traders promote cross-market consistency. Menkveld [11] discussed market fragmentation along with high-frequency trading and found that in the situation where order flows are dispersed across multiple trading venues, the cross-market trading of high-frequency traders enables the price of the same asset to adjust synchronously, avoiding the back-and-forth oscillations caused by the correction of price misalignment between different venues, and thereby reducing market volatility.

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However, similar to the analysis of liquidity, high-frequency traders are not a homogeneous group. Order flow-driven high-frequency trading is more inclined to amplify instantaneous deviations, while information-driven and cross-market arbitrage high-frequency trading play a more stabilizing role. The impact of these two strategies on the volatility pattern is opposite [16]. And the current evidence mainly comes from electronic markets in Europe and the United States and the foreign exchange market. The trading system differences in China's stock market determine that the conclusion needs to be inferred with caution [4].

4. The Impact of High-Frequency Trading on Price Discovery

4.1 High-frequency Trading Promotes Price Discovery

High-frequency trading promotes price discovery mainly through two mechanisms: Firstly, by quickly identifying and processing public information, it enables information to be integrated into prices more quickly. Secondly, through cross-market arbitrage to correct instantaneous pricing errors, it drives prices to converge towards fundamental value.

High-frequency trading algorithms can quickly absorb and reflect public information, promoting the integration of information into prices. High-frequency traders react much faster to macro news, company reports, and order book changes than ordinary traders. They can make deals before the information is fully digested by the market, thereby accelerating the speed at which information integrates into prices. Brogaard et al. [14] used account-level data from Nasdaq to decompose prices into permanent price shocks and instantaneous pricing errors, and found that the order directions of high-frequency traders were generally consistent with permanent price shocks and opposite to instantaneous pricing errors, thereby promoting stock prices to converge towards fundamental value. At the same time, this study found that the number of limit orders was much greater than market orders, promoting price discovery [17]. Hendershott and Riordan [18] also found that algorithmic traders react to events faster than human traders, and are more inclined to actively execute deals when the bid-ask spread is narrow, accelerating the speed at which information integrates into prices.

Directional trading based on instantaneous pricing errors in high-frequency trading also plays a role in cross-market price equilibration. Instantaneous pricing errors are temporary deviations caused by noise. High-frequency traders actively execute deals based on their speed and information processing advantages, earning return profits from the regression, objectively promoting prices to converge towards fundamental value. Menkveld [11] pointed out that the cross-market arbitrage of high-frequency traders makes the prices of the same asset adjust synchronously in different locations, avoiding price misalignment. Wei et al. [16] also found that information-driven and arbitrage-oriented high-frequency trading can capture the direction of changes in the intrinsic value of assets and correct pricing deviations, significantly improving the efficiency of permanent price discovery.

4.2 High-frequency Trading Hinders Price Discovery

However, some scholars are concerned that the speed advantage of high-frequency trading will interfere with the absorption of fundamental information by the price through adverse selection, information noise from limit orders, and short-term trading orientation.

The speed advantage may exacerbate adverse selection and instantaneous price errors. High-frequency traders push prices above the equilibrium level in the short term by responding to information in advance, and then reverse the position when the information is fully absorbed by the market, resulting in instantaneous pricing errors. Zhang [6] found that the more active the high-frequency trading activities are, the stronger the overreaction of stock prices to fundamental news is, and the ability of prices to absorb fundamental information actually decreases.

The short-term trading orientation of high-frequency traders makes them pay less attention to the fundamentals of enterprises. Kirilenko et al. [9] found that the net positions of high-frequency traders always fluctuate around zero and have very short holding periods, indicating that their trading is not based on the judgment of the long-term value of the enterprise but relies on the rapid response to short-term signals for profit, lacking the motivation to process fundamental information. Budish et al. [19] further pointed out that

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in the continuous trading system, high-frequency trading is essentially an arms race centered on speed, and traders compete to complete transactions before the update of quotations while neglecting the analysis of fundamentals. When a large number of transactions are concentrated on extremely short-term order flow signals, the response of prices to fundamental information is correspondingly weakened, and the long-term efficiency of price discovery is damaged.

The evidence of price discovery also shows that high-frequency traders are not a homogeneous group: information-driven and cross-market arbitrage types promote price discovery, while order flow-driven types amplify instantaneous pricing errors. The conclusion varies depending on the strategy type.

5. High-frequency Trading and Market Regulation

5.1 International Experience in Regulating High-frequency Trading

The "flash crash" incident in the United States in 2010 marked a watershed in global regulation of high-frequency trading. Since then, the United States has introduced rules for market access by brokers and mechanisms to intervene in stock price fluctuations, strengthening real-time monitoring and post-event accountability. Germany, on the other hand, enacted the "High-Frequency Trading Act" in 2013, establishing registration and reporting obligations for high-frequency traders. The EU's "Financial Instruments Market Directive II" implemented in 2018 set specific rules for algorithms and high-frequency trading, requiring high-frequency traders to fulfill market-making obligations and meet the upper limit of order execution ratio.

In terms of regulatory tools, international practice has formed a three-layer framework of information regulation, behavior regulation, and market structure regulation: Information regulation focuses on registration, reporting, and algorithm transparency, behavior regulation focuses on spoofing and order abuse such as blocking orders, and market structure regulation focuses on frequent collective bidding, speed reduction barriers to compress speed arbitrage space. Aquilina et al. [20] found that delayed arbitrage accounted for approximately 20% of trading volume and constituted about one-third of price shocks, indicating that post-event accountability is difficult to completely cure the problem. Zhang and Ibikunle [21] discovered that although collective bidding reduced adverse selection costs and suppressed delayed arbitrage, it simultaneously lost liquidity and information efficiency, indicating that structural regulation is not without cost and requires a balance between suppressing speed competition and maintaining liquidity. Overall, international regulation has shown a trend of shifting from post-event penalties to pre-market market structure design.

5.2 Domestic Regulatory Policies for High-Frequency Trading

The regulatory approach towards high-frequency trading in China has evolved from emergency control to systematic establishment. During the abnormal stock market fluctuations in 2015, the CSRC employed temporary measures such as restricting intraday opening, increasing margin and fees to curb programmatic speculation. In 2019, the revised Securities Law's Article 45 established the reporting system for programmatic trading for the first time at the legal level. The 2022 Futures and Derivatives Law extended this to the derivatives market [22]. Starting from October 2023, the Shanghai and Shenzhen North Exchanges expanded the reporting system from convertible bond pilot programs to stocks, funds, and other varieties, establishing an access arrangement of "report first, then trade". In 2024, the CSRC issued the "Trial Management Regulations for Programmatic Trading in the Securities Market", making overall arrangements.

From the perspective of regulatory orientation, domestic regulation is based on the actual market situation where the majority of investors are small and medium-sized, adhering to the principles of seeking benefits and avoiding harm, and highlighting fairness. Zhong and Qian [22] suggested improving algorithm disclosure and establishing an algorithm marking mechanism. Liu [23] advocated including some high-frequency trading behaviors within the regulatory scope of market manipulation and improving pre- and in-process supervision. Li et al. [10] reminded of seeking a balance between liquidity supply and volatility prevention. China's regulatory approach to high-frequency trading has shifted from emergency control to regular, refined institutional governance.

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6. Conclusion and Future Research

High-frequency trading is profoundly altering the operation mode of the stock market. This paper focuses on the three core dimensions of market quality and, by reviewing the literature, discovers that the impact of high-frequency trading is not one-sided but systematically differentiates according to market conditions and strategy types: In the liquidity dimension, generally, high-frequency trading assumes the role of "new market makers" to narrow the spread and increase depth. In extreme market conditions, its liquidity supply rapidly retreats, presenting the characteristic of "illusory liquidity". In the volatility dimension, continuous quotations and cross-market arbitrage help to smooth out noise fluctuations, while homogeneous strategies and crowded trading may amplify overshoots and extreme fluctuations. In the price discovery dimension, information-driven and arbitrage-based high-frequency trading accelerates the integration of information into prices, while order flow-driven and short-term-oriented strategies weaken the absorption of fundamental information by prices. High-frequency traders are not a homogeneous group. This judgment runs through all three dimensions and is also the key to reconciling the differences in existing research conclusions.

The ultimate impact is on regulation. International regulation has shifted from post-event penalties to pre-market structural design, but collective bidding and other structural tools are not without cost. Our country's regulation is based on the actual situation of a market where the majority are small investors. It has evolved from emergency control in 2015 to systematic governance under the "Regulations on the Management of Programmed Trading in the Securities Market" in 2024, adhering to seeking benefits and avoiding harms and highlighting fairness.

However, most existing research conclusions are based on data and institutional environments from mature markets in Europe and America. The extrapolation of these conclusions to China's stock market requires caution. Direct evidence regarding China's high-frequency trading still lacks. Future research can delve deeper in three directions: Firstly, using new data from the program trading reporting system to conduct causal identification; Secondly, differentiating between strategy types and market conditions to delineate the boundary of the mechanism by which high-frequency trading affects market quality; Thirdly, evaluating the actual effects of different regulatory tools in China's institutional environment to provide evidence for differentiated regulation.

In any case, as the openness of China's capital market and trading technology continue to improve, the role of high-frequency trading in the market will become increasingly important. Conducting solid theoretical and empirical research based on the uniqueness of China's market microstructure and investor structure will not only help regulators strike a balance between curbing speed competition and maintaining market quality, but also enable China's stock market to move steadily and reach its goals in the "high-frequency" era.

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Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

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