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| RESEARCH ARTICLE

Algorithmic Trading and Challenges on Retail Investors in Emerging Markets

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| ABSTRACT
Mixed views on automated trading in the extant literature lead to ongoing debates on algorithmic trading (AT) and high-frequency trading (HFT). This study elaborates on the rising ethical issues and regulatory challenges of algorithmic trading and high-frequency trading in emerging markets. While developed capital markets are dominated by institutional investors, emerging markets consist of a large proportion of retail investors who may suffer from aggravated liquidity asymmetry and stock price turbulence due to HFT and AT. Furthermore, we review current regulations of HFT in the U.S. and European markets and provide a framework of regulatory enforcements on AT and HFT for investor protection in emerging markets. This study cautions policymakers in emerging markets that legal and regulatory monitoring of AT and HFT activities is especially necessary.

| KEYWORDS
Algorithmic Trading; High-Frequency Trading; Financial Regulation; Investor Protection; Financial Stability; Emerging Markets

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1. Introduction

Financial markets in past decades have witnessed rapid technological development in the electronic trading system. During this transformation, algorithmic trading (AT) and high-frequency trading (HFT) based on high-speed networks and rapid responsive algorithmic computation have become the key infrastructure in the modern financial market. With computer algorithms that automatically decide order parameters, AT and HFT can optimally decide when to initiate the transaction and trade on the desired price or quantity of the order without much human involvement in this process.

In the last decade, HFT activity made up 49% of the trading volume on the American equity markets and roughly 40% of all equity trading on the European market (Kauffman et al. (2015). Moreover, developed markets' technological prowess has increased their impact on other emerging markets, enabling AT and HFT practices to spread into emerging markets.

While AT and HFT could implement effective market-making functions, many scholars, financial professionals, and policymakers are concerned that markets highly involved in AT and HFT may suffer from unexpected volatility and liquidity shortfalls, especially after the *Flash Crush* in the US equity market in 2010, an event that a $4.1 billion trade on the New York Stock Exchange caused the Dow Jones index to decline by nearly 1,000 points before returning to its initial level, all over fifteen minutes.

Joint investigations by the U.S. Securities and Exchange Commission (SEC) and the Commodity Futures Trading Commission (CFTC) subsequently indicate that computer-driven automated trading may significantly alter market microstructures and lead to extreme price movements, sparking significant controversy on AT and HFT (Menkveld, 2016).

In this paper, we illustrate the evolving ethical concerns and regulatory difficulties associated with algorithmic trading and high-frequency trading in emerging markets. While institutional investors dominate developed capital markets, a major share of investors in emerging nations is retail investors. We argue that retail investors may experience exacerbated liquidity asymmetry

and stock price volatility as a result of HFT and AT. We also examine the present AT-related regulations in the American and European markets and offer a regulatory enforcement framework on AT and HFT to protect retail investors in emerging markets. This paper warns policymakers in emerging markets that it is crucial to closely monitor AT and HFT activity on a legal and regulatory level.

2. Literature Review: Current debates on AT and HFT

2.1 Positive views on HFT as the automated market maker

Proponents of HFT firstly highlight the efficient role of HFT in market making and liquidity supply. For example, using data from the automated trading program in Dzeutsche Boerse, Hendershott, and Riordan (2013) empirically document that algorithmic traders play a more active role in monitoring market liquidity dynamics than human market makers, thus reducing liquidity risk. They also discover that HFTs spend liquidity when it is inexpensive and supply liquidity when it is costly, lowering the volatility of liquidity.

Based on direct observations from Dutch stocks trading on Chi-X Europe, Menkveld (2013) provides empirical evidence of how the presence of AT decreases bid-ask spreads. Investigating order aggressiveness, Hagströmer et al. (2014) find that HFT balances the tradeoff between the cost of waiting and the cost of crossing the bid-ask spread more than non-HFT does. They also document that HFT supplies liquidity by posting more orders at the best quotes when the market is more volatile.

Furthermore, Brogaard et al. (2014) find that HFT trades oppositely to transitory pricing errors but is consistent with the way of permanent price movements. Subsequently, they conclude that HFT facilitates stock price discovery. Similarly, Conrad et al. (2015) suggest that the presence of high-frequency quotes reduces the cost of trading by improving the efficiency of price discovery. Besides, Brogaard et al. (2018) find that HFT is not the major cause of extreme stock price movements and HFT supply liquidity during high stock price volatility time by absorbing order imbalances.

2.2 Negative views on HFT as the cause of volatility or opportunistic arbitrager

On the other hand, scholars suggest that market making from HFT and AT can impose market vulnerability in liquidity shortfalls (e.g., Madhavan, 2012; O'hara, 2015). Financial theorists model the equilibrium for markets consisting of both high-frequency traders with higher speed in completing trades and ordinary traders with slower speed of achieving transactions.

Specifically, Cartea and Penalva (2012) document that HFT increases the microstructure noise of prices with induced trading volume. They show that HFT activity raises the price impact of liquidity deals proportionally to the size of the trade and boosts stock price volatility and trading volume. Hoffmann (2014) characterizes a model as a limit order market where higher frequency traders extract rents on their faster trading speed. He finds that ordinary traders are never better off than identical traders regarding the information set in the same market because differences in trading speed generate a redistribution of market forces among the trader universe. If the proportion of high-frequency traders is not provided exogenously but rather is established in equilibrium by expensive investment, this will lead to a direct loss in social welfare.

Du and Zhu (2014) also investigate a theoretical framework on the trading density that leads to optimal investor benefits. They find that in a market with heterogeneous trading speeds, slow traders can only access the market occasionally with a delay, whereas fast traders can always trade in the open market. Therefore, fast traders favor the maximum practicable trading frequency, while slow traders typically favor a strictly lower frequency. A faster trading frequency under heterogeneous speeds and market power expedites price discovery but may result in more short-term volatility for stock prices. Bernales (2017) theoretically show that HFT imposes trading speed dispersion and adverse selection risk in the financial markets. Consequently, ordinary investors with a slower trading speed will be forced out due to illiquidity. As a result, Market quality and global wellbeing are generally reduced by traders who have an edge in trading speed.

Moreover, researchers also provide empirical evidence on the assertation that HFT is associated with financial instability. For example, Kirilenko et al. (2017) show that HFT aggravates the rapid and dramatic price movement during a flash crash. Furthermore, based on international evidence from 39 equity markets, Boehmer et al. (2021) suggest that AT leads to greater equity price volatility but better liquidity and greater pricing efficiency. However, they document that small stocks suffer the most from short-term volatility induced by AT. They also find that HFT-induced volatility cannot be attributed to more efficient price discovery or to the willingness of high-frequency traders to initiate trades and transactions when market volatility is high.

Moreover, studies show that HFT and AT are associated with deceptive trading strategies designed by predatory algorithms to mislead other market participants. For instance, AT may employ spoofing, which is the practice of adding and canceling a series of limit orders in hopes that other algorithmic traders will interpret the data incorrectly or slowly (O'hara, 2015). Another example of unethical use of HFT predatory algorithm is quote stuffing, where AT places large quantities of orders to buy or sell and then cancels them almost immediately. Egginton et al. (2016) find that quote-stuffing events result in higher trading costs represented by quoted and effective spreads with increased short-term volatility and illiquidity.

3. Regulations Review: EU and US Financial Markets

With the prevalence of AT and HFT in recent years, markets have experienced several volatile events, and the *Flash Crush* is the most notable among others. On May 6, 2010, all around fifteen minutes, a $4.1 billion trade on the New York Stock Exchange (NYSE) caused the Dow Jones Industrial Average to drop by over 1,000 points before rising to its original level. While the mechanism of this market turbulence is disputable in academia, a joint report by the U.S. Securities and Exchange Commission (SEC) and the Commodity Futures Trading Commission (CFTC) indicates that "the automated execution of a large sell order can trigger extreme price movements, especially if the automated execution algorithm does not take prices into account. Moreover, the interaction between automated execution programs and algorithmic trading strategies can quickly erode liquidity and result in disorderly markets" (SEC and CFTC, 2010, p. 6).

Besides, high volatility during the crash led to a liquidity crisis and a panic among investors over the stability of the market and the real value of financial product prices. Wild automated selling by algorithmic and automated computer transactions destroyed over one trillion dollars from the U.S. equities and derivatives markets over several minutes (Johnson, 2016). Subsequently, the European Union and the United States have introduced a number of corresponding regulatory measures aimed at curbing At and HFT and at preventing extreme price movements.

The European Securities and Markets Authority (ESMA) is obligated under *Markets in Financial Instruments Directive 2* (MiFID II) to create technological standards for implementing HFT regulations (Currie and Seddon, 2017). HFTs must be approved and overseen by regulatory authorities. The regulations demand that businesses trade on regulated markets in order to capture as many trades as feasible (regulated markets such as stock exchanges). The legislative documents for MiFID II and MiFIR were agreed upon by the European Parliament and the Council in 2014. These extensive regulatory actions are meant to boost algorithmic trading's transparency.

MiFID II allows regulated markets to impose a higher level of transaction fees or taxes for orders that frequently request immediate subsequent cancellation after submission, especially for investment participants with a high rate of order cancellation and for orders canceled by the high-frequency trading algorithm. Even before the introduction of MiFID II, some EU countries have already imposed higher fees or taxes on high-frequency trading.

The European Union fully implemented MiFID II in 2018. This legal act offers a series of regulations in the investment services sector to increase investor protection and fair competition. MiFID II strictly regulates the "Market Abuse" that may be involved in high-frequency trading. MiFID II expands the definition of "market abuse" and regards orders that are not intended for final execution but to mislead the market as market abuse, thereby limiting some of the opportunistic behaviors of high-frequency trading. Therefore, MiFID II especially tightens regulations on high-frequency trading and the practice of manipulating commodity prices (European Central Bank, 2019). In doing this, MiFID II advocates for managers of the exchange to identify and confirm in advance whether each trading participant is an algorithmic trader or a high-frequency trader.

In addition, MiFID II requires that investment entities participating in algorithmic trading must have effective information systems and risk management systems to ensure that their trading operations have matching capabilities and resilience, as well as the restrictive mechanism to ensure that they will not submit improper trading orders or transactions which may cause instability and volatility in financial markets. Any companies or individuals employing high-frequency trading technology are forced to implement pre-market testing for trading algorithms and to store the algorithmic trading strategies, data, and transaction records for retrospective investigation. In addition, investment companies that involve algorithmic trading practices should also have an effective backup plan and responsive arrangements to deal with potential risks when the trading system fails.

However, recent studies suggest that while rules such as MiFID II offer a technological means of monitoring HFT and other forms of trading, they are unable to comprehend the various algorithms' execution tactics (e.g., Currie and Seddon, 2017; Sadaf et al., 2021).

In the U.S., regulators make substantial efforts to develop and maintain technological tools to govern AT and HFT. For example, the SEC employs the Market Information Data Analytics System (MIDAS) to obtain detailed stock trading information. MIDAS can collect stock transaction data from 13 exchanges in the United States and obtain information on the order, cancellation, and execution of each stock transaction order. The time of transaction information can be accurate to microseconds, thus especially suitable for the supervision and implementation of high-frequency trading behaviors. Besides, the SEC passed a plan in 2016 to establish a Consolidated Audit Trail (CAT) system. The CAT is fundamentally a central repository for all national market system assets, including listed shares and options as well as over-the-counter equity securities, that will collect, aggregate, and store trade and order lifecycle data. Importantly, order lifecycle data must be submitted to the central repository each night for each trading day by exchanges, self-regulatory entities, and broker-dealers.

On the legislative side of AT and HFT in the U.S., the Commodity Futures Trading Commission (CFTC) released a notice of proposed rulemaking (the Regulation AT NPRM) on December 17, 2015. In addition to setting risk management standards for trading venues, clearing members, and algorithmic trading practitioners, this regulation also includes requirements for relevant trading institutions that utilize algorithms to register beforehand. In addition, clearing members and algorithmic traders should submit annual compliance reports to the exchange and go through yearly assessments. The Chief Compliance Officer of the relevant company should certify these compliance reports. The source code used by algorithmic trading must also be reviewed and restored properly for potential retrospective examination. Subsequently, CFTC published a supplemental notice of proposed rulemaking (the "Supplemental Regulation AT NPRM") on November 25, 2016, to amend specific provisions in the Regulation AT NPRM. Unfortunately, CFTC decided to withdraw the Regulation AT NPRMs and reject some of the policy approaches related to the regulation of automated trading contained therein in light of the feedback it received in response to the Regulation AT NPRM and Supplemental Regulation AT NPRM on July 15, 2020 (CFTC, 2020).

4. Findings

4.1 Impacts of AT and HFT on Retail Investors in Emerging markets

Compared to developed economies, the prevalence of retail investors and retail trading are distinguished features in emerging financial markets (e.g., Ling et al., 2022). Figure 1 presents the comparison of trading volume from institutional and retail investors between the Chinese market and the U.S. market. As observed from the figure, the majority of trades come from retail investors in China, and the percentage of retail trading in the U.S. has been lower but increasing over recent years.

Figure 1: Comparison of retail trading volume between China and the U.S.

Even in the U.S. market, studies show that retail investor perception of market trends is important since the pricing impact of retail selling orders becomes more pronounced when the VIX is high and when the market is bearish (e.g., Du, 2020).

Attributed to the nature of investor type in emerging markets, it is possible that the rising financial innovation technology (i.e., AT and HFT) will transform the mainstream market pattern for retail investors, institutions, listed corporations, and financial products to be aligned with. Therefore, it is especially important to understand the potential impacts of AT and HFT on retail investor trading behavior, market perception, and social welfare.

We argue that AT and HFT may deteriorate trading fairness in emerging markets consisting of a large proportion of retail investors. First, AT and HFT may hurt trading fairness by employing unethical techniques. Regulatory institutions in emerging markets typically do not have advanced monitoring mechanisms (i.e., CAT in the U.S.) to oversee the trading behavior of AT and HFT. As a result, HFT may take advantage of predatory and misleading trading strategies (e.g., spoofing) to reap profits from retail investors, who are mostly behavioral traders and market trend followers (Du, 2020).

Second, AT and HFT may impair trading fairness by creating liquidity asymmetry. Specifically, AT and HFT have a superior speed of competing for financial transactions than retail investors do. Therefore, AT and HFT can reply on high-speed responsive mechanisms to trade on valuable information and drive out retail investors' investment opportunities, even if that information is fundamental and publicly available. Subsequently, retail investors will always fall behind in the liquidity competition with AT and HFT. This situation is in contrast to the original purpose of HFT as an automated market maker or liquidity provider. Rather, AT may become a liquidity consumer and lead to liquidity shortfalls if the algorithms are set up to terminate when trading circumstances deteriorate, or there are fewer opportunities of making profits.

Moreover, AT and HFT may hamper trading fairness by aggravating the information asymmetry and adverse selection problem. According to Kirilenko et al. (2017), traders that are more responsive to signals may inadvertently choose to use stale quotes from slightly slower market makers, a practice known as "stale quote sniping" or "latency arbitrage." As a result, quicker traders can place trades at short time horizons in advance of price fluctuations. If speedier traders have access to better and more up-to-date knowledge regarding market trends and circumstances, slower traders will fall into the adverse selection problem (Hendershott and Riordan, 2013).

4.2 Actionable Recommendations

As we clearly identify the potential negative impacts of AT and HFT on retail investors in emerging markets, we provide several actionable recommendations for regulators on algorithmic monitoring and investor protection for the transformation of embracing AT and HFT in the future.

Most importantly, market supervisors in emerging economies should establish an effective governance mechanism to monitor and oversee AT and HFT. Especially, regulators should have the technological capability to identify, trace, and source trading activities made by AT and HFT. For identification, regulators should require AT and HFT to be officially registered as investment entities and to disclose (unnecessary to be fully revealed to the public) or file their trading algorithms for examination before entering the market. For tracing, regulators should incorporate with stock exchanges to actively supervise the dynamic of AT and HFT's trading behavior. Moreover, it is vital for regulators to temporarily cease algorithmic trading when the market is experiencing unexpected events such as the "*Flash Crush*." For sourcing, regulators must have sufficient tools to restore market microstructure data for retrospective investigations to determine unethical algorithmic trading strategies such as quote stuffing or spoofing.

From the perspective of AT and HFT, regulators should further encourage automated market-making activities with effective compensation schemes but prevent predatory trading algorithms. This is closely related to the previous point on the identification of "good" AT and "bad" AT. Only if "good" AT is fully compensated while "bad" AT is effectively punished automated trading algorithm developers will be well-motived to improve the quality of the market through innovations in financial technology.

For the retail investor side, we suggest that regulatory institutions should enhance investor education on the perception and understanding of AT and HFT as well as their associated market consequences. Specifically, investors should be fully noticed of the potential downside risks and high volatility if they choose to invest in a stock involved in AT and HFT. In doing so, regulators may utilize the staggering adaptation strategy to govern the process of the entrance of specific types of financial activities. For example, regulators in China take advantage of staggered deregulation on short-selling activities (Ling et al., 2022). For algorithmic trading, stock exchanges should allow certain numbers of stocks to be traded with AT or HFT; and gradually expand the list for pilot stocks to ensure the stability of the financial market.

Definitely, algorithms of AT and HFT will keep advancing with technological developments. Subsequently, more and more novel forms of AT and HFT will show up in the electronic trading ecosystem. Therefore, we also recommend that regulatory institutions in emerging markets could further promote advanced fintech tools such as blockchain technology and decentralized autonomous organizations (DAOs) as implements in regulating AT and HFT. As a result, the supervision of AT and HFT will have adaptative capabilities to such evolution.

5. Conclusion

AT and HFT are inevitable in future financial markets. However, little is known about whether this type of innovation will benefit or harm the interest of retail investors. We review the current regulatory development of AT and HFT monitoring in developed markets and provide an extended framework with institutional features suitable for employment in emerging markets.

While current literature has ongoing debates on the roles of AT and HFT as automated market makers or opportunistic arbitragers, this study cautions policymakers in emerging markets that regulatory monitoring of AT and HFT is especially necessary for retail investors' protection and trading fairness.

We are aware that our study has several limitations. Although our theoretical developments build on theories of financial market development and financial innovation, our analyses mainly draw on observations from the largest two markets in the world, financial markets in the U.S. and in China. While many financial markets share characteristics in general, their business practices and institutional backgrounds are heterogeneous. In this regard, the generalizability of our results may be limited. In light of the increasing occurrence of AT and HFT on a global scale, we hope that our regulatory suggestion can serve as conceptual guidance for future research to further explore the interplay of different forms of organizational and institutional arrangements with AT and HFT in emerging as well as in developed markets.

Finally, we provide some directions for future research. First, as mentioned above, researchers may further investigate how regulatory institutions can utilize modern fintech tools (e.g., decentralized finance) to design effective mechanisms to monitor and

govern predatory AT and HFT. Secondly, while currently AT and HFT are employed by institutional investors only, we expect that AT and HFT could also serve as third-party agencies or independent financial advisors which provide smart investment solutions for retail investors in the future. In this regard, future research can extend the literature by deepening into the positive role of AT and HFT in helping retail investors to compete with institutional investors. Finally, we observe that the effect of AT and HFT on social responsibility has been neglected surprisingly in the current literature. Therefore, we suggest that future studies could continue to examine the roles of algorithmic trading in corporate social responsibility and societal sustainability issues.

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