UNIVERSITY OF ESSEX

DEPARTMENT OF ECONOMICS

MSC IN FINANCIAL TECHNOLOGY (COMPUTER SCIENCE)

Essay For BE367 Big Data in Finance

Written By 2319416

Supervisor: Dr Ali Gencay Ozbekler

Lecturer: Dr Servanna Mianjun Fu

If You're Still Reading this Headline Your Already Too Late.....

High Frequency Trading: The Impact of Big Data and AI on Financial Markets

Introduction

Trading has evolved from simple bartering to complex financial markets, significantly influenced by the introduction of shares and dividends by the Dutch East India Company. This sparked increased demand and competition for shares Gelderblom, Abe de Jong, Jonker (2013). This evolution led to the establishment of the first Stock Exchange in London, marking a transition to sophisticated trading methods. Today, high-frequency trading (HFT), driven by big data and advanced algorithms, dominates financial markets, executing trades at speeds beyond human capabilities.

What is High-Frequency Trading

In the context of algorithmic trading, HFT is defined as "professional traders acting in a proprietary capacity that engage in strategies that generate a large number of trades on a daily basis" (Fu 2024). In plain English, high-frequency trading is characterized by the rapid execution of thousands of trades at speeds well surpassing human comprehension. HFT has dominated the financial trading landscape, accounting for over 75% of the trading volume (Hendershott, Jones, and Menkveld (2011.) This has allowed firms to automate their trading strategies and apply their strategies faster and more accurately than ever, to the point where less than 1% of today's trading volume was seen in the 1960s.

HFT has greatly benefited from the technological developments of the last ten years (Linton, 2018). Since HFT algorithms rely on the infrastructure to become faster to facilitate trades, stock exchanges have invested heavily in reducing latency to become more attractive to trading firms. In less than fifteen years, the London Stock Exchange Group's (LSEG) Matching engine latency has reduced from 0.6 of a second to 113 microseconds (Linton 2018). Furthermore, stock exchanges charge high premiums to enable colocation, allowing firms to place their servers in close proximity to exchange systems to further reduce latency and execute high-frequency trades even more effectively than their competitors who do not use these services.

High-Frequency Trading Methods

Market Making: HFTs leverage high-speed algorithms to continually offer buy and sell orders on stocks, capturing profits from the bid-ask spread. By analyzing vast market data in real-time, these algorithms optimize order execution and price settings, reducing tick sizes from $0.125 to $0.01 and disrupting traditional market monopolies (Brookings, IMF eLibrary).

Price Arbitrage: HFT algorithms evaluate theoretical values for securities like options to spot and exploit price discrepancies. These systems utilize AI and machine learning to quickly identify and act on arbitrage opportunities across markets before they disappear, thus securing profits and minimizing risks (IMF eLibrary).

Statistical Arbitrage: This strategy employs machine learning to detect inefficiencies between correlated stocks. Algorithms process massive datasets to predict and act on price

realignments in timeframes ranging from milliseconds to microseconds, far faster than traditional methods.

Semantic Trading: AI-driven algorithms analyze data from news, social media, and press releases to assess market sentiment. Using natural language processing, they execute trades based on the rapid interpretation of new information, staying ahead of human traders (Nasseri, A.A., Tucker, A., and de Cesare, S., 2015).

Direction-Based Trading: Algorithms predict short-term market movements by analyzing historical and real-time data. Employing machine learning, these strategies utilize momentum and contrarian approaches to anticipate stock and forex market directions, enhancing trading accuracy and timeliness (Mabrouk, N. et al., 2022; Khandani and Lo, 2007)

Pairs Trading: Involving two correlated securities, traders use AI to monitor and trade based on deviations in their price relationship. Machine learning and econometric models adjust strategies dynamically, ensuring trades capitalize on temporary inefficiencies (Chang et al., 2023)

Analysis: Benefits of High-Frequency Trading

Researchers Budish, Cramton, and Shin (2015) found detailed data on the profitability of high-frequency trading (HFT), particularly through ES-SPY arbitrage opportunities. From 2005 to 2011, an average trading day included about 800 arbitrage opportunities, each generating an average profit of $98.02, amounting to daily profits of around $79,000. On the higher end (99th percentile days), profits could reach approximately $554,000 per day. When adjusting for market share across all exchanges, average profits could be about $306,000 per day, or around $75 million annually. They also remarked on the provision of liquidity HFT brings to the market, highlighting that firms provide both liquidity and engage in stale-quote sniping (where numerous orders are rapidly placed and then cancelled on the exchange). While HFT contributes to liquidity provision, the researchers critiqued the underlying continuous limit order book market design, which creates arbitrage rents due to asymmetrically observed public information, thus harming overall liquidity. They argued that frequent batch auctions could perhaps enhance liquidity by eliminating unnecessary speed races and sniping, transforming competition into one based on price rather than speed.

Challenges of High-Frequency Trading

Despite the fact that HFT has transformed financial markets, it comes with several significant challenges. Market instability is a key concern, as evidenced by the 2010 "Flash Crash," where rapid HFT trades contributed to a sudden market drop and recovery within minutes, exposing vulnerabilities in market structure and the potential for sudden, sharp volatility (SEC report 2010). Regulatory challenges arise due to the speed and complexity of HFT, which can mask manipulative practices like quote stuffing. This was highlighted in 2013 when regulators fined a firm for sending thousands of spurious orders to create false market demand. Technology dependency introduces risks of significant disruptions, a case in point being the Knight Capital Group incident in 2012, where a software glitch led to a $440 million loss in just 30 minutes (SEC). Data management issues also play a crucial role; HFT systems depend on real-time, accurate data processing. Any latency or errors can skew

automated trading decisions, leading to potential losses and market inefficiencies (Eurex, 2013).

Lastly, increased competition in HFT has led to an arms race in technology, where marginal gains become harder to achieve, and the costs of infrastructure and technological innovation escalate, pushing smaller players out of the market and increasing market entry barriers (Budish, Cramton, and Shin, 2015) and a deterioration of overall market quality (Breckenfelder, 2019).

Conclusion

High-Frequency Trading has dramatically reshaped financial markets, offering substantial profitability and enhanced liquidity. However, it also presents challenges such as potential market instability and regulatory difficulties. Instances like the 2010 Flash Crash and the Knight Capital incident highlight these vulnerabilities. As HFT continues to evolve, it is crucial for regulatory frameworks to adapt and ensure market stability, fairness, and transparency, potentially by incorporating new models like frequent batch auctions that emphasize price competition over speed.

References

Gelderblom, Abe de Jong, Jonker(2013) 'The Formative Years of the Modern Corporation: The Dutch East India Company VOC, 1602–1623', The Journal of Economic History, vol. 73, no. 4, pp. 1050-1076. Available at: http://www.jstor.org/stable/24551011

Linton, Hara, Zigrand, Cliff, & Hendershott. (2011). Foresight: The Future of Computer Trading in Financial Markets (2012) Final Project Report. The Government Office for Science, London, 28–37, 42–59.

Linton (2018) ‘Implications of high-frequency trading for security markets’, Cambridge-INET Working Paper Series No: 2018/01 Cambridge Working Papers in Economics: 1802 [Preprint]. doi:10.1920/wp.cem.2018.0618

Fu (2024) ‘Lecture 8: High Frequency Trading’, BE367 Big Data in Finance. Essex: University of Essex, 14 March.

Hendershott, T., C. M. Jones, and A. J. Menkveld (2011). Does algorithmic trading improve liquidity? The Journal of Finance 66, 1ñ33.

Budish, Cramton and Shin (2015), "The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response", *Quarterly Journal of Economics*, 130 (4), 1547-1621

SEC (2010) Preliminary findings regarding the market events of May 6, 2010: Report of the staffs of the CFTC and SEC to the Joint Advisory Committee on Emerging Regulatory issues. Washington, D.C.: U.S. Commodity Futures Trading Commission.

King (2010). "London Stock Exchange smashes world record trade speed with Linux". Computerworld UK.

Chang et al. (2023) https://www.mdpi.com/2071-1050/12/17/6791

SEC (2013) 222nd edn, *SEC Charges Knight Capital With Violations of Market Access Rule*. 222nd edn. Washington, D.C.: U.S. Commodity Futures Trading Commission. https://www.sec.gov/news/press-release/2013-222

Khandani, A.E. and Lo, A.W., 2008. *What happened to the quants in August 2007?: Evidence from factors and transactions data* (No. w14465). National Bureau of Economic Research.

Al Nasseri, A., Tucker, A. and De Cesare, S., 2015. Quantifying StockTwits semantic terms' trading behavior in financial markets: An effective application of decision tree algorithms. *Expert systems with applications*, *42*(23), pp.9192-9210.

Eurex (2013) *High-frequency trading – a discussion of relevant issues* [Preprint]. Available at:https://www.eurex.com/resource/blob/48928/a8491907cad1a9c36fc9d26cc46deb15/data/presentation_hft_media_workshop_lon_en.pdf.

Breckenfeld, J. (2019) 2290th edn, Competition among high-frequency traders, and Market Quality. 2290th edn. Available at:https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2290~b5fec3a181.en.pdf