Market Making or Market Manipulators of High-Frequency Trading ?

Ethics & Trust in Finance
Global edition 2024-2025

First Prize (ex-aequo)

Bessie O'Dell
United Kingdom

Strategy & Delivery Manager, UK AI Security Institute, London (United Kingdom)*

* The views expressed herein are those of the author and do not necessarily reflect those of the Organization she is affiliated with or of the Jury.

Introduction

On the morning of 6 May 2010, the UK was focused on gearing up for its general election day, which ultimately resulted in a hung parliament – the first time that a single political party had not achieved a majority in the House of Commons since 1974 (The Editors of Encyclopaedia Britannica, 2025). Across the Atlantic, Wall Street was focused on the mounting Greek debt crisis, and an "unusually turbulent" day for the markets (The U.S. CFTC & U.S. SEC, 2010, p. 1). However, neither of these geopolitical events were to be the triggering factor for a near 1,000-point dive in share prices that day. At 2:42pm EDT, the Dow Jones Industrial Average began to fall rapidly. At one point, it lost almost 9% of its value, in what came to be known as the trillion-dollar "flash crash". Shockingly, the broad US securities markets shot down by nearly 1 trillion dollars (Poirier, 2012). As a result, for a period of time, financial instruments no longer reflected the underlying value of the companies, and "system control was lost" (Vecellio, 2014, p.1).

What, or who, was held to blame for this dramatic loss? Regulators, the press, public commentators, and financial analysts all pointed to the practice of High-Frequency Trading (HFT). This is an umbrella term for a type of algorithmic trading method in which a large number of securities orders for anything from stocks and shares to cryptocurrency are traded with latencies as low as 10 milliseconds (Jones, 2013; Salkar et al., 2021). In this instance, regulators determined that the catalyst for the “flash crash” was a single high frequency (HF) trader in Kansas City, who was described as “either lazy or sloppy” in executing a large trade on the E-Mini futures market (Poirier, 2012, p. 445; The U.S. CFTC & U.S. SEC, 2010). However, this was not a standalone event. Two years later, an HFT software error at Knight Capital had them “buying high” and “selling low” many times per second, resulting in the company losing $10 million per minute, and $440 million in total (Popper, 2012).

In the following years, the ethical status of HFT was scrutinized. Within the academic community, commentators referred to HFT as “highly influential”, yet “ethically questionable” or “unfair” (McNamara, 2016; Sobolev, 2020, p.101). This was in part because of the potential for HFT practices to result in disproportionate and negative market impacts, such as market volatility and systemic risk. Several academic papers also called into question the “fairness” and ethicality of HFT due to the type of trading and market access strategies used, and the scramble by HFT firms to be the fastest at executing trades (see Angel & McCabe, 2013; Cooper et al., 2016; Davis et al., 2013; Roncella & Ferrero, 2021; Welcman, 2022). However, there have been mixed opinions regarding whether the impacts of HFT are deliberate or a “moral oversight”, and furthermore, whether that fact matters or not from an ethical standpoint (see Hendry, 2015, p.5; Reeves, 2012).

Conversely, some reviewers have argued that there is no wrongdoing or moral misdemeanor at all, and that HFT is either morally neutral, or net positive. In the words of one advocacy group, the speed and efficiency of computerized trading has allowed HFT firms “to be the most cost-effective financial intermediary that have ever existed.” Moreover, as a direct result, “spreads are now tighter and trading costs lower than ever before”, saving investors’ money every time they trade (The Modern Market Initiative, 2014, n.p.). Elsewhere, one academic observer has suggested that “HFT is no more intrinsically morally problematic than taking a taxi instead of walking” (McNamara, 2016, p. 99).

Literature on the ethics of HFT has tended to cluster temporally around real-world events. This includes major market occurrences, such as the “flash crash”, and related regulatory changes, such as the SEC’s ban on stub quotes, and publication of rules relating to single stock circuit breakers (SEC Rule 610(d) of Regulation NMS; SEC Limit up-limit down rule, 17 C.F.R. § 242.600). As such, ethical commentary to date has firstly, tended to be retrospectively framed around events that have already taken place, and secondly, not been substantially updated since around 2015. This is despite the fact that market quality breakdowns are not an uncommon occurrence, and that discussions about regulating HFT are ongoing, both in the US and globally (see CFA Institute Research and Policy Center, 2019; C. Gao & Mizrach, 2016; Medina, 2022).

What is currently missing from the literature is an updated perspective on HFT ethics that considers more recent developments, including technological advances. Such an appraisal is necessary, in light of conversations around the development and use of HFT and laser intersatellite links (LISLs) such as Starlink (Singh & Gadre, 2024), and of Artificial Intelligence (AI) and its subcomponent Machine Learning (ML) (Cohen, 2022; Kearns, 2023). HFT as a discipline inherently sits at the confluence of two complicated areas of study: high frequency finance and computer science (Aldridge, 2013, p.12). Therefore, ethical evaluations of HFT ought to be attuned to developments in both areas, rather than be focused stagnantly on past financial events and technologies.

This paper aims to revitalize discussions on the ethics of HFT by incorporating insights from recent technological advancements, which have outpaced much of the existing literature. It begins by examining how past technological developments have shaped the speed and structure of HFT, laying the foundation for current debates. Next, the paper explores emerging technologies, including AI, ML, and LISLs, and assesses their potential impact on HFT. To evaluate the ethical implications of these advancements, the paper applies various philosophical and theoretical frameworks, including consequentialism, deontology, virtue ethics, and justice theory. It then examines how these new technologies could make HFT practices more or less ethical, emphasizing their potential to produce both positive and negative market effects. Finally, the paper underscores the inherent complexity of ethical analysis of HFT, highlighting the need for rigorous theoretical and methodological frameworks that can adapt to evolving financial technologies.

The Evolution of HFT

HFT developed as the result of decades of technological advancements, including the spread of computerized trading and the increasing use of electric communications networks. In 2005, the rise of HFT gained additional momentum when exchanges started to offer incentives for companies to add liquidity to the market. Exchanges were themselves encouraged by SEC-backed regulation designed to modernize and strengthen US equity markets (Regulation National Market System, Exchange Act Release No. 34-51808, 70 Fed. Reg. 37,496, 37,532 n.300 [2005]; see McGowan, 2010). Some of the largest HFT firms globally in 2025 included Citadel Securities, Hudson River Trading (HRT), Jane Street, Susquehanna International Group (SIG), and Jump Trading, all of which were based in the US.

HFT is itself an umbrella term for a range of strategies ranging from statistical arbitrage and index arbitrage to market making. What these strategies have in common is the need for speed – fast information exchange, and fast execution of trades. Therefore, when ethical commentators are evaluating HFT, what they often end up evaluating is actually low-latency trading (LLT), meaning strategies that respond to market events in milliseconds (Hasbrouck & Saar, 2013), although this term is hardly ever recognized.

HFT is lucrative. In itself, HFT has a potential Sharpe ratio, a measure of reward to risk (Sharpe, 1998), that is much higher than traditional buy-and-hold financial strategies. For example, historically the performance of the median HFT firm had a four-factor annualized alpha of 22.02%, with a Sharpe ratio (4.30) more than 13 times higher than the Sharpe ratio of the S&P 500 (0.31) (Baron et al., 2019; Fama & French, 2002). Yet it should also be noted that more recent empirical work has not been conducted, and there are reports of HFT experiencing a decline in earnings, volume traded and market shares over time (Serbera & Paumard, 2016). HFT also has a large market size, valued at $10.36 billion in 2024, and is projected to grow at a Compound Annual Growth Rate (CAGR) of 7.7% from 2025 to 2030 (Grand View Research, 2024).

The profitability of HFT is the primary factor driving firms' demand for speed. Under the current rules outlined in the SEC's Regulation NMS for equities trading, multiple exchanges in different locations are allowed to list and trade the same equity products. To ensure execution at the best available price across these exchanges, market makers are therefore required to monitor and compare the publicly available prices for the same security on different exchanges, executing trades at the best price for investors. Due to these strict requirements, market-making firms prioritize speed above other aspects of trading.

In order to achieve the speed required for HFT, financial firms use complex algorithms to analyze prices across multiple financial markets (McGowan, 2010), cutting-edge technology such as fiber optic cables, and powerful execution computers with custom-built hardware known as Field Programmable Gate Arrays to execute orders. A striking example of how valuable high-tech is to HF traders is provided by Michael Lewis in his 2014 book *Flash Boys*. In it, he describes how, at a cost of $300 million and in a bid to "sell speed" to HFTs, a company called Spread Networks laid an ultra-low latency fiber optic cable connecting Chicago and New Jersey (Lewis, 2014; Smith, 2022). The discovery of this fact led Canadian financial executive Brad Katsuyama – described as a man who "took on Wall Street and won" – to establish Investors Exchange (IEX) in response to "unfair" HFT practices (Thomas, 2016).

How New Technologies Might Impact HFT

There have been a number of ethical studies of HFT in recent years, but the majority are now somewhat dated (see Angel & McCabe, 2013; Cooper et al., 2016; Davis et al., 2013; McNamara, 2016; Roncella & Ferrero, 2021; Sobolev, 2020). During the past decade, substantial efforts have been made to develop technologies such as LISLs and separately, AI and ML. These efforts ought to be analyzed for their potential impact on HFT, whether they are already in use, or only in development, and then reflected in the literature on HFT ethics.

In her 2013 book on HFT, algorithmic strategies, and trading systems, Aldridge (2013, p. 208) emphasizes how ML is often cited as one of the most concerning developments associated with HFT. She notes that this concern was shared by a Commodity Futures Trading Commission (CFTC) subcommittee, which determined that the use of ML was an undesirable practice in HFT. Aldridge, however, disagrees with this conclusion, maintaining that ML is nothing more than a series of nested analyses. To illustrate her point, she notes that "at the time this book was written, no ML algorithm was capable of intelligence beyond its immediate trading application and was certainly not threatening to humans".

HFT is already an extension of algorithmic trading, where computer programs are used to automate one or more stages of the trading process, from pre-trade data analysis and trading signal generation for buy and sell recommendations, to trade execution (Nuti et al., 2011, p. 61). Given this fact, HF traders already write and deploy ML algorithms to execute their strategies. The concern articulated by Aldridge thus appears to be about the risk of increasingly autonomous AI models , and by extension, the over-reliance of HFT trading on AI for HFT trading. In 2025, this concern is far more tangible than it was in 2013. Since then, ML and AI more broadly have made sweeping advances across a range of domains. For example, AI models are now capable of solving complex mathematical problems at college level; Google's Minerva model, built in 2022 and trained on 2.7 billion petaflop , is one such model. Generative AI-assisted coding is also becoming common-place, including within finance (Becker et al., 2023; Chen et al., 2023; Poldrack et al., 2023). Additionally, AI researchers and companies have recently begun to develop increasingly autonomous AI systems that can pursue complex goals with limited direct supervision. These too, could be implemented into HFT practices (Acharya et al., 2025; Shavit et al., 2023).

Any technology which improves the time latency inherent in HFT could be utilized by HF traders to gain a competitive advantage. One of the more promising technologies for this purpose, at least in theory, is LISLs, a type of satellite-to-satellite free space optic (Chaudhry & Yanikomeroglu, 2021). This includes two of the largest proposed satellite constellations, Starlink and Project Kuiper, which are in development but not yet in use. Currently, HFT utilizes fiber optic cables, which are fast, but ultimately limited by special relativity: the speed of light (see MacKenzie, 2021).

Due to current US regulations, HFT firms are required to prove that they have traded at the "best execution" price for the investor (see SEC Rule 611 of Regulation NMS; FINRA Rule 5310). Additionally, under SEC Rule 10b-5, it is illegal for market makers to pay brokers directly to receive the customer order flow. By extension, HFT firms therefore have to trade across the 18 equities exchanges currently located throughout the US (Adinolfi, 2024), which means there will always be a time delay (latency) due to the speed of light in the transfer of information via optical fiber between HFT firms, exchanges, and finally brokers. As such, HFT is "exquisitely sensitive" to the length and transmission capacity of the cables connecting computer servers to the exchanges' systems and to the location of the microwave towers that carry signals between computer data centers (MacKenzie, 2021).

In theory, LISLs offer a more direct line of travel for information than non-linear optical fiber. With LISLs, there is a straight line between computer server 1 to the satellite, and then to computer server 2). This advantage is increased by the fact that light travels more slowly through optical fiber than it does through free space, due to refraction (Agrawal, 2012; Saleh & Teich, 2008). Thus LISLs could in theory provide a faster exchange of information in HFT.

However, LISLs are also limited by physics in the sense that transmission speed cannot reach or exceed the speed of light. Any advantage from LISLs comes from their geographical positioning and direct line-of-sight transmission. Yet since data must travel up to the satellite and back down again, the total transmission distance may exceed that of terrestrial microwave networks. For example, Starlink satellites orbit approximately 342 miles (550 km) above earth (Mann & Pultarova, 2021). If the satellite route is longer than the direct path between two microwave towers, any potential speed advantage could be negated.

The Importance of Theoretical Frameworks

Worries about unethical behavior are a recurring issue in the finance industry (Huber & Huber, 2020). In part, this is due to historic examples of bad practice, such as sub-prime mortgage lending by financial institutions, and the subsequent global financial crisis. However, it is also the case where some financial practices are labelled as "unethical" or "unfair" because they are unpalatable to the general public. As articulated by Hendry, (2015, p. 4), many people "have very little understanding of finance", and therefore throughout history "its practitioners and their core activities – lending, borrowing and speculative trading – have been seen as morally distasteful".

Yet ethics is about more than distaste. It is both a branch of philosophy (broadly, "the study of living well as a human being"; (Driver, 2022, n.p.), and a system of moral norms and principles. It is this system of moral principles which guides individuals and organizations in determining how to behave. That said, there are numerous and sometimes conflicting accounts of ethics and more specifically of morality (see Driver, 2022). As such, the first task of an ethical commentator is to define the subject, frame the main issues, and identify the relevant ethical principles. This is especially important within the "barely formed" yet "highly diverse" field of study that is finance ethics (Boatright, 2013, Preface).

This paper does not seek to prescribe the use of any single framework for normative analysis. Rather, it seeks to underscore the importance of framing the main issues in order to evaluate the moral status of HFT strategies (see McNamara, 2016). It also aims to highlight how the use of different theories can implicate different ethical issues and sometimes lead to different moral conclusions. After all, a theoretical framework or set of frameworks is "the foundation from which all knowledge is constructed (metaphorically and literally)" and is something which both "provides a grounding base or an anchor" for analysis, and can make explicit the commentator's stance on a particular topic (Cairney, 2013; Grant & Osanloo, 2014, p. 12).

An important point to note here is the lack of subject-specific frameworks for finance ethics generally, and for HFT in particular. In his seminal work on the topic, Boatright (2013) detailed how ethical issues in finance were often perceived as merely legal or regulatory matters. This was certainly reflected in HFT literature and reporting at the time, and the same is still true in 2025. Given this reality, most informed writing on the topic of HFT ethics has instead turned to the broader field of philosophy for guidance. Academic commentators have drawn conclusions on the ethicality of HFT based on frameworks provided by moral philosophy, which is viewed as "the foundation of financial ethics" (Bhala, 2019, p. 2). This includes normative ethics, the branch of moral philosophy that is concerned with the criteria for what is right and what is wrong.

All three of the major approaches of normative ethics are salient frameworks to use in evaluating the ethics of HFT. Firstly, consequentialism is the view that normative properties depend only on consequences (Sinnott-Armstrong, 2023). Secondly, deontology is best understood as standing in opposition to consequentialism. Broadly, it prescribes that the morality of an action is judged by the action's adherence to a rule or rules (Alexander & Moore, 2024). Thirdly, virtue ethics emphasizes the "virtues" or moral character (Hursthouse & Pettigrove, 2023). In addition, some scholars have identified justice, in particular distributive justice, as an important framework, given that it addresses the different distributions of benefits and burdens across members of society. Justice in this context is not to be confused with justice as a virtue.

Can Technology Make HFT More Just and Efficient?

Not all commentators agree that HFT is "unethical" or "unfair" in itself. Instead, they contend that HFT trading practices are morally neutral, or net positive. It has been noted that the core function of the financial sector is to "secure the most efficient allocation of financial capital across the productive economy", after which a second core function is "the maintenance of free, efficient and perfectly competitive markets" (Hendry, 2015, p. 6). Evidence shows that HFT contributes to these efforts, thereby benefiting both institutional and retail investors.

For example, the US-based Seven Pillars Institute Seven Pillars Institute for Global Finance and Ethics highlights that the number and volume of trades using HFT strategies ensures a liquid market, without which there would be larger bid/ask spreads, with investors potentially less satisfied with the prices they obtain from their trades (Kara, 2020; Wagner, n.d.). HFT traders can also act as makeshift market makers "who buy and sell when no one will" (Wagner, n.d.). Furthermore, HF traders account for a significant part of overall price formation and liquidity provision in modern securities markets, which are achieved by firms' significant IT investments (Clapham et al., 2023).

From a consequentialist perspective, HFT may thus be seen as ethically justifiable, because it leads to overall market efficiency and better economic outcomes. Similarly, HFT can be defended through the lens of distributive justice on the basis that it increases access to markets by reducing transaction costs, allowing a broader range of investors to participate. According to Rawlsian principles of fairness, an economic system should be structured to benefit the least advantaged members of society (Rawls, 1958, 1971). HFT could be regarded as consistent with Rawlsian fairness, given that the increased liquidity it provides reduces the trading and transaction costs for small investors due to greater market efficiency (Kara, 2020; Wagner, n.d.).

So will technological advancements impact the market fairness and efficiency that is expected of HFT? Firstly, academics have highlighted that although the current academic literature considers HF traders as "the present-day de facto market makers", HFT strategies have moved away from passive market-making over time (Banerjee & Roy, 2023, p. 102184). There is no saying whether emerging technologies will stop or reverse this trend. Nonetheless, the use of technologies that result in increased execution speed for HF traders would almost certainly lead to tighter quoted spreads and better execution prices for investors, contributing to greater market liquidity than at present.

Viewed through the lens of utilitarian ethics, this change could be seen as moral, because it enhances overall market efficiency and benefits a broad range of market participants. If increased liquidity and tighter spreads reduce trading costs for retail and institutional investors alike, then the aggregate welfare gains may justify the "technological arms race" taking place in HFT. However, if these benefits are disproportionately captured by elite trading firms with access to superior technology, a Rawlsian distributive justice perspective might challenge the fairness of such an outcome (Heath, 2005; Lamont & Favor, 2017). From this viewpoint, an equitable financial system would ensure that the least advantaged market participants also benefited from technological advancements, rather than widening the gap between HF traders and slower investors.

Moreover, the magnitude of effect that these technologies will have on market spreads is difficult to project. While empirical evidence suggests that HFT has historically narrowed bid-ask spreads (Brogaard et al., 2022) further improvements may encounter diminishing returns. Additionally, some researchers argue that increased speed could contribute to market fragmentation, potentially offsetting the efficiency gains by introducing liquidity imbalances and heightened volatility (Biais & Foucault, 2014). Therefore, the ethical implications of emerging HFT technologies remain contingent on how these advancements shape market structure and accessibility.

How New Technologies Could Make HFT Less Ethical

Gaining an Unfair Advantage

Currently, one of the most

contentious ethical concerns in HFT is whether or not certain strategies amount to "cheating" or otherwise providing an unfair advantage (see Dalko & Wang, 2020; Ferrell, 2000). For example, quote stuffing – the practice of placing and then rapidly cancelling large volumes of orders – can distort price signals and mislead competitors (Egginton et al., 2016). Similarly, commentators have already raised concerns about the practice of Payment for Order Flow (PFOF), whereby market makers compensate brokers for routing trades to a specific exchange, which is prohibited in both the UK and EU, but not in the US (Battalio & Loughran, 2008; Eigelshoven et al., 2021; J. Gao et al., 2019).

Although some commentators view HFT tactics as deliberate market manipulation, others argue that ethical lapses in finance often stem from "moral oversight" rather than from an explicit intent to deceive. As one particularly scathing media critique puts it, HFT tactics are "at worst cheating and at best a performance-enhancing drug that hasn't been fully examined by regulators" (Reeves, 2012, p. 1). Conversely, Hendry (Hendry, 2015, p. 5) suggests that many financial wrongdoings arise not from malicious intent, but from actions that "don't seem wrong to those engaged in them at the time."

Emerging AI-driven trading models add another layer of complexity to this debate. For example, in future autonomous AI agents may independently discover and exploit legal loopholes, engaging in strategies such as quote stuffing, spoofing , and latency arbitrage without direct human intervention. More concerning is the possibility that AI models could generate entirely new trading strategies, some of which may be ethically dubious yet still legally permissible. The lack of human oversight, transparency, and interpretability in AI-driven HFT (see below) could exacerbate these risks, making it difficult for regulators to identify intentional misconduct. The distinction between "cheating" or deliberately gaining an unfair advantage versus simply competing within the rules of modern financial markets would then become crucial. If an AI agent autonomously engaged in an ethically questionable strategy, but the firm using it remained unaware, would this still constitute cheating?

The answer to this question would depend on the theoretical framework being used. Here are two examples to illustrate the point. Firstly, unequal access contradicts Rawlsian principles of fairness, which require equal access to financial opportunities. Yet secondly, from a deontological perspective, it is cheating that is inherently wrong, regardless of whether the perpetrator is a human or an autonomous AI agent (Alexander & Moore, 2024; Cervantes et al., 2020; Martinho et al., 2021). Kantian ethics holds that moral actions must be universalizable and respect the autonomy of rational beings. If "do not cheat" is a moral imperative, then an AI agent engaging in deceptive trading practices should be considered unethical. However, AI agents do not currently possess rational will or moral autonomy in the Kantian sense (Brożek & Janik, 2019), meaning that they cannot themselves be morally responsible for their actions. Instead, responsibility falls on the human agents who design, deploy, and oversee these systems.

Market Impact

Some researchers argue that AI-driven trading could enhance market efficiency by improving liquidity and price discovery, which would be a positive development (Liu et al., 2025). However, empirical findings suggest that AI-powered strategies also amplify market volatility (IMF, 2024; Liu et al., 2025). This dual effect raises important ethical concerns: should financial markets prioritize efficiency at the cost of stability, or should safeguards be implemented to ensure that AI-driven trading does not exacerbate systemic risks?

Similarly, as LISLs become integrated into HFT, one must consider whether they will exacerbate market instability. In short, the answer is no, or at least, not substantially. To all intents and purposes, the latency (time delay) observed in HFT is already so small that it is approaching a point where speeds can only get faster by a few milliseconds. If LISLs are used in HFT, they are therefore unlikely, for example, to exacerbate "flash crashes" in a way that has substantially more impact on the financial market. As an example, Knight Capital (noted above) did not lose $440 million in 10 milliseconds, the current lowest latency of HFT; the firm lost this sum over 45 minutes. In preventing disorderly market behavior what matters most is not so much speed, but having human oversight in place; for example, an individual operating a manual "kill switch" to cease all trading.

Interpretability and Transparency

Another significant ethical challenge in HFT relates to interpretability (Gilpin et al., 2018; Linardatos et al., 2020). Advanced AI-driven trading strategies operate as black-box systems, making it difficult to determine whether a trade was executed with intent to manipulate the market (Pasquale, 2015). Unlike traditional algorithmic trading, where human traders can justify their strategies – for example, when a trader writes code for a linear regression model - AI-driven decisions may be untraceable or unexplainable, making it nearly impossible to prove intent in cases of suspected market manipulation.

One illustration is "spoofing", which is illegal in the US under the Commodity Exchange Act Section

4c(a)(5)(C). To distinguish between legitimate trading strategies and manipulative practices, this provision requires proof of intent to cancel the bid or offer before execution in order to establish a violation. This raises a fundamental question for regulators: without interpretability mechanisms, how can accountability be enforced when trading decisions are dictated by AI models rather than human judgment?

Regulation and Human Oversight

The use of technologies such as advanced autonomous AI and ML could therefore require the introduction of new legislation. Such legislation could include mandating human oversight during the use of autonomous AI, or a prohibition on its use unless or until research can better explain the inner workings of AI models: for example, through mechanistic interpretability, meaning the reverse engineering of computational mechanisms and representations learned by neural networks to turn them into algorithms and concepts that humans can understand (see Bereska & Gavves, 2024).

Likewise, when it comes to LISLs, new regulation might be required, for example to mandate firms' usage of manual kill switches. This introduction of further regulation in itself could be ethically wrong. For example, Cooper and colleagues suggest that "in the financial markets almost any regulation, other than the most basic, tends to create a moral hazard and increase information asymmetry". Since "the market's job is, at least in part, price discovery", they argue that "simplicity of regulation and restraint in regulation are virtues to a greater extent than in other areas of finance" (Cooper et al., 2016, p. 1).

Conclusion

The ethical implications of HFT have been historically well-documented, but ought to remain a subject of debate as new leading technologies emerge, of which AI, ML, and LISLs are examples. While HFT has been praised for its role in improving liquidity, reducing spreads, and enhancing market efficiency, it has also been criticized for "unfair" trading practices and for exacerbating market instability. The integration of faster and increasingly autonomous trading systems introduces new ethical and regulatory challenges, particularly regarding fairness, accountability, and human oversight.

This paper provides some preliminary examples of the ways in which such technologies might reshape ethical discussions, while emphasizing that evaluations of HFT are highly dependent on the theoretical framework being applied. For example, a consequentialist perspective might justify HFT's benefits in terms of overall market efficiency, while a Rawlsian justice approach might raise concerns about disparities in access to financial opportunities. Meanwhile, a deontological perspective might call into question whether certain HFT practices, such as quote stuffing or PFOF, inherently violate ethical principles, irrespective of their outcomes.

Ultimately, the ethics of HFT and its technological evolution cannot be fully assessed through a single theoretical lens. Moving forward, ethical discussions on HFT must continue to evolve, incorporating empirical research, interdisciplinary perspectives, and updated methodologies. The challenge is not simply to understand whether HFT is ethical today, but to ensure that HFT's continued evolution can be guided by ethical principles that foster a trustworthy and sustainable financial system in future.

References

Acharya, D. B., Kuppan, K., & Divya, B. (2025). Agentic AI: Autonomous Intelligence for Complex Goals–A Comprehensive Survey. *IEEE Access*. Retrieved from https://ieeexplore.ieee.org/abstract/document/10849561/

Adinolfi, J. (2024, December 31). *2024 was another record-breaking year for the options market*. MarketWatch. Retrieved from https://www.marketwatch.com/story/2024-was-another-record-breaking-year-for-options-trading-whats-on-tap-for-the-industry-in-2025-8f4a097c

Agrawal, G. P. (2012). *Fiber-optic communication systems*. John Wiley & Sons. Retrieved from https://books.google.co.uk/books?hl=en&lr=&id=yG-Q4n1-r2eQC&oi=fnd&pg=PR15&dq=-Fiber%E2%80%90Optic+Communication+Systems&ots=P_A5P1jHrs&sig=boLYeWrzeFZTuH58ap-NF6xEJQKE

Aldridge, I. (2013). *High-Frequency Trading: A Practical Guide to Algorithmic Strategies and Trading Systems*. John Wiley & Sons

Alexander, L., & Moore, M. (2024). Deontological Ethics. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy* (Winter 2024). Metaphysics Research Lab, Stanford University. Retrieved from https://plato.stanford.edu/archives/win2024/entries/ethics-deontological/

Angel, J. J., & McCabe, D. (2013). Fairness in Financial Markets: The Case of High Frequency Trading. *Journal of Business Ethics*, *112*(4), 585–595

Baron, M., Brogaard, J., Hagströmer, B., & Kirilenko, A. (2019). Risk and return in high-frequency trading. *Journal of Financial and Quantitative Analysis*, *54*(3), 993–1024

Battalio, R. H., & Loughran, T. (2008). Does Payment For Order Flow To Your Broker Help Or Hurt You? *Journal of Business Ethics*, *80*(1), 37–44

Becker, B. A., Denny, P., Finnie-Ansley, J., Luxton-Reilly, A., Prather, J., & Santos, E. A. (2023). Programming Is Hard - Or at Least It Used to Be: Educational Opportunities and Challenges of AI Code Generation. *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1*, 500–506. https://doi.org/10.1145/3545945.3569759

Bereska, L., & Gavves, E. (2024). *Mechanistic Interpretability for AI Safety—A Review* (arXiv:2404.14082). arXiv. https://doi.org/10.48550/arXiv.2404.14082

Bhala, K. T. (2019). The philosophical foundations of financial ethics. In *Research Handbook on Law and Ethics in Banking and Finance* (pp. 2–24). Edward Elgar Publishing. Retrieved from https://www.elgaronline.com/edcollchap/edcoll/9781784716530/9781784716530.00009.xml

Biais, B., & Foucault, T. (2014). HFT and market quality. *Bankers, Markets & Investors*, *128*(1), 5–19

Boatright, J. (2013). *Ethics in Finance*. John Wiley & Sons

Brogaard, J., Li, D., & Yang, J. (2022). Does High Frequency Market Manipulation Harm Market Quality? *SSRN Electronic Journal*. Retrieved from https://doi.org/10.2139/ssrn.4280120

Brożek, B., & Janik, B. (2019). Can artificial intelligences be moral agents? *New Ideas in Psychology*, *54*, 101–106. Retrieved from https://doi.org/10.1016/j.newideapsych.2018.12.002

Cairney, P. (2013). Standing on the shoulders of giants: How do we combine the insights of multiple theories in public policy studies? *Policy Studies Journal*, *41*(1), 1–21

Cervantes, J.-A., López, S., Rodríguez, L.-F., Cervantes, S., Cervantes, F., & Ramos, F. (2020). Artificial Moral Agents: A Survey of the Current Status. *Science and Engineering Ethics*, *26*(2), 501–532. Retrieved from https://doi.org/10.1007/s11948-019-00151-x

CFA Institute Research and Policy Center. (2019). *High-Frequency Trading*. Retrieved from https://rpc.cfainstitute.org/policy/positions/high-frequency-trading

Chaudhry, A. U., & Yanikomeroglu, H. (2021). *Laser Inter-Satellite Links in a Starlink Constellation* (arXiv:2103.00056). arXiv. Retrieved from https://doi.org/10.48550/arXiv.2103.00056

Chen, B., Wu ,Zongxiao, & and Zhao, R. (2023). From fiction to fact: The growing role of generative AI in business and finance. *Journal of Chinese Economic and Business Studies*, *21*(4), 471–496. Retrieved from https://doi.org/10.1080/14765284.2023.2245279

Clapham, B., Haferkorn, M., & Zimmermann, K. (2023). The Impact of High-Frequency Trading on Modern Securities Markets. *Business & Information Systems Engineering*, *65*(1), 7–24. Retrieved from https://doi.org/10.1007/s12599-022-00768-6

Cohen, G. (2022). Algorithmic trading and financial forecasting using advanced artificial intelligence methodologies. *Mathematics*, *10*(18), 3302

Cooper, R., Davis, M., & Vliet, B. V. (2016). The Mysterious Ethics of High-Frequency Trading. *Business Ethics Quarterly*, *26*(1), 1–22. Retrieved from https://doi.org/10.1017/beq.2015.41

Dalko, V., & Wang, M. H. (2020). High-frequency trading: Order-based innovation or manipulation? *Journal of Banking Regulation*, *21*(4), 289–298. Retrieved from https://doi.org/10.1057/s41261-019-00115-y

Davis, M., Kumiega, A., & Van Vliet, B. (2013). Ethics, finance, and automation: A preliminary survey of problems in high frequency trading. *Science and Engineering Ethics*, *19*(3), 851–874. Retrieved from https://doi.org/10.1007/s11948-012-9412-5

Driver, J. (2022). Moral Theory. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy* (Fall 2022). Metaphysics Research Lab, Stanford University. Retrieved from https://plato.stanford.edu/archives/fall2022/entries/moral-theory/

Egginton, J. F., Van Ness, B. F., & Van Ness, R. A. (2016). Quote Stuffing. *Financial Management*, *45*(3), 583–608. Retrieved from https://doi.org/10.1111/fima.12126

Eigelshoven, F., Ullrich, A., & Parry, D. (2021). Cryptocurrency Market Manipulation-A Systematic Literature Review. *ICIS*. Retrieved from https://www.researchgate.net/profile/Felix-Eigelshoven/publication/354995772_Cryptocurrency_Market_Manipulation_A_Systematic_Literature_Review/links/617705340be8ec17a9303d70/Cryptocurrency-Market-Manipulation-A-Systematic-Literature-Review.pdf

Fama, E. F., & French, K. R. (2002). The Equity Premium. *The Journal of Finance*, *57*(2), 637–659. Retrieved from https://doi.org/10.1111/1540-6261.00437

Ferrell, A. (2000). A Proposal for Solving the Payment for Order Flow Problem. *S. Cal. L. Rev.*, *74*, 1027

Gao, C., & Mizrach, B. (2016). Market quality breakdowns in equities. *Journal of Financial Markets*, *28*, 1–23. Retrieved from https://doi.org/10.1016/j.finmar.2016.03.002

Gao, J., Liu, L., Gao, P., Zheng, Y., Hou, W., & Wang, J. (2019). Intelligent Occlusion Stabilization Splint with Stress-Sensor System for Bruxism Diagnosis and Treatment. *Sensors (Basel, Switzerland)*, *20*(1). Retrieved from https://doi.org/10.3390/s20010089

Gilpin, L. H., Bau, D., Yuan, B. Z., Bajwa, A., Specter, M., & Kagal, L. (2018). Explaining explanations: An overview of interpretability of machine learning. *2018 IEEE 5th International Conference on Data Science and Advanced Analytics (DSAA)*, 80–89. Retrieved from https://ieeexplore.ieee.org/abstract/document/8631448/

Grand View Research. (2024). *High Frequency Trading Market Size | Industry Report, 2030*. Retrieved from https://www.grandviewresearch.com/industry-analysis/high-frequency-trading-market-report

Grant, C., & Osanloo, A. (2014). Understanding, selecting, and integrating a theoretical framework in dissertation research: Creating the blueprint for your "house". *Administrative Issues Journal*, *4*(2), 4

Hasbrouck, J., & Saar, G. (2013). Low-latency trading. *Journal of Financial Markets*, *16*(4), 646–679. Retrieved from https://doi.org/10.1016/j.finmar.2013.05.003

Heath, J. (2005). Rawls on global distributive justice: A defence. *Canadian Journal of Philosophy Supplementary Volume*, *31*, 193–226

Hendry, J. (2015). Ethics in Finance: Why is it such a problem? *Ethical Finance*

Huber, C., & Huber, J. (2020). Bad bankers no more? Truth-telling and (dis)honesty in the finance industry. *Journal of Economic Behavior & Organization*, *180*, 472–493. Retrieved from https://doi.org/10.1016/j.jebo.2020.10.020

Hursthouse, R., & Pettigrove, G. (2023). Virtue Ethics. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy* (Fall 2023). Metaphysics Research Lab, Stanford University. Retrieved from https://plato.stanford.edu/archives/fall2023/entries/ethics-virtue/

IMF. (2024, October 15). *Artificial Intelligence Can Make Markets More Efficient—And More Volatile*. IMF. Retrieved from https://www.imf.org/en/Blogs/Articles/2024/10/15/artificial-intelligence-can-make-markets-more-efficient-and-more-volatile

Jones, C. M. (2013). What do we know about high-frequency trading? *Columbia Business School Research Paper*, *13–11*. Retrieved from https://safe-frankfurt.de/fileadmin/user_upload/editor_common/Events/Summer_Academy/SA2016_Jones-HFT-Survey-SSRN-id2236201-2013.pdf

Kara. (2020, March 13). *High Frequency Trading (1): Empirical Assessment*. Seven Pillars Institute for Global Finance and Ethics. Retrieved from https://sevenpillarsinstitute.org/high-frequency-trading-1-empirical-assessment/

Kästner, L., & Crook, B. (2024). Explaining AI through mechanistic interpretability. *European Journal for Philosophy of Science*, *14*(4), 52. Retrieved from https://doi.org/10.1007/s13194-024-00614-4

Kearns, W. R. (2023). Enhancing empathy in text-based teletherapy with emotional state inference. *Disserta-*

tion Abstracts International: Section B: The Sciences and Engineering, *84*(10-B), No-Specified. APA PsycInfo <2022 to September Week 1 2023>

Lamont, J., & Favor, C. (2017). Distributive Justice. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Winter 2017). Metaphysics Research Lab, Stanford University. Retrieved from https://plato.stanford.edu/archives/win2017/entries/justice-distributive/

Lewis, M. (2014). *Flash boys: A Wall Street revolt*. WW Norton & Company. Retrieved from https://books.google.com/books?hl=en&lr=&id=UcIkAwAAQBAJ&oi=fnd&pg=PA1&dq=the+flash+boys&ots=wgOcrbXxxm&sig=VOK1VUc4HsZ6lUwliOJJxZJMqbc

Linardatos, P., Papastefanopoulos, V., & Kotsiantis, S. (2020). Explainable ai: A review of machine learning interpretability methods. *Entropy*, *23*(1), 18

Liu, Z., Zhang, K., & Miao, D. (2025). Evolving Financial Markets: The Impact and Efficiency of AI-Driven Trading Strategies. In Z. Shi, M. Witbrock, & Q. Tian (Eds.), *Intelligence Science V* (Vol. 720, pp. 301–312). Springer Nature Switzerland. Retrieved from https://doi.org/10.1007/978-3-031-71253-1_22

MacKenzie, D. (2021). *Trading at the Speed of Light: How Ultrafast Algorithms Are Transforming Financial Markets*. Princeton University Press. Retrieved from https://doi.org/10.1515/9780691217796

Mann, A., & Pultarova, T. (2021). Starlink: SpaceX's satellite internet project. *Space. Com, Updated 28 May*

Martinho, A., Poulsen, A., Kroesen, M., & Chorus, C. (2021). Perspectives about artificial moral agents. *AI and Ethics*, *1*(4), 477–490. Retrieved from https://doi.org/10.1007/s43681-021-00055-2

McGowan, M. J. (2010). The Rise of Computerized High Frequency Trading: Use and Controversy. *Technology Review*, *016*

McNamara, S. (2016). The law and ethics of high-frequency trading. *Minn. JL Sci. & Tech.*, *17*, 71.

Medina, E. (2022, July 21). *Should High Frequency Trading be Regulated?* HU Econ Review. Retrieved from https://www.economicsreview.org/post/should-high-frequency-trading-be-regulated

Nuti, G., Mirghaemi, M., Treleaven, P., & Yingsaeree, C. (2011). Algorithmic trading. *Computer*, *44*(11), 61–69.

Pasquale, F. (2015). *The Black Box Society: The Secret Algorithms That Control Money and Information*. Harvard University Press. Retrieved from https://doi.org/10.4159/harvard.9780674736061

Poirier, I. (2012). *High-Frequency Trading and the Flash Crash: Structural Weaknesses in the Securities Markets and Proposed Regulatory Responses*. *8*.

Poldrack, R. A., Lu, T., & Beguš, G. (2023). *AI-assisted coding: Experiments* *with GPT-4* (arXiv:2304.13187). arXiv. Retrieved from https://doi.org/10.48550/arXiv.2304.13187

Popper, N. (2012, August 2). *Knight Capital Says Trading Glitch Cost It $440 Million*. New York Times. Retrieved from https://dealbook.nytimes.com/2012/08/02/knight-capital-says-trading-mishap-cost-it-440-million/

Rawls, J. (1958). Justice as fairness. *The Philosophical Review*, *67*(2), 164–194.

Rawls, J. (1971). Theories of social justice. *Political Science, Nd*. Retrieved from https://polisci.wustl.edu/files/polisci/imce/l32_331.pdf

Reeves, J. (2012, February 24). High-Frequency Trading Is High-Tech Cheating. *InvestorPlace*. https://investorplace.com/2012/02/high-frequency-trading-is-high-tech-cheating/

Roncella, A., & Ferrero, I. (2021). The Ethics of Financial Market Making and its Implications for High-Frequency Trading. *Journal of Business Ethics*, *181*(1), 139–151. Retrieved from https://doi.org/10.1007/s10551-021-04901-5

Saleh, B. E., & Teich, M. C. (2008). *Fundamentals of photonics* (Vol. 332). Wiley New York. Retrieved from https://www.academia.edu/download/64338420/Fundamental%20of%20photonics%20-%20P0-Introduction.pdf

Salkar, T., Shinde, A., Tamhankar, N., & Bhagat, N. (2021). Algorithmic Trading using Technical Indicators. *2021 International Conference on Communication Information and Computing Technology (ICCICT)*, 1–6. Retrieved from https://doi.org/10.1109/ICCICT50803.2021.9510135

Serbera, J.-P., & Paumard, P. (2016). The fall of high-frequency trading: A survey of competition and profits. *Research in International Business and Finance*, *36*, 271–287.

Sharpe, W. F. (1998). The Sharpe Ratio (Fall 1994). In P. L. Bernstein & F. J. Fabozzi (Eds.), *Streetwise* (pp. 169–178). Princeton University Press. Retrieved from https://doi.org/10.1515/9781400829408-022

Shavit, Y., Agarwal, S., Brundage, M., Adler, S., O'Keefe, C., Campbell, R., Lee, T., Mishkin, P., Eloundou, T., & Hickey, A. (2023). Practices for governing agentic AI systems. *Research Paper, OpenAI*. Retrieved from https://cdn.openai.com/papers/practices-for-governing-agentic-ai-systems.pdf

Singh, V., & Gadre, A. (2024). On the Feasibility of Laser Inter-satellite Links for Low-latency High Frequency Trading. *Proceedings of the 2nd International Workshop on LEO Networking and Communication*, 37–42. Retrieved from https://doi.org/10.1145/3697253.3697272

Sinnott-Armstrong, W. (2023). Consequentialism. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy* (Winter 2023). Metaphysics Research Lab, Stanford University. Retrieved from https://plato.

stanford.edu/archives/win2023/entries/consequentialism/

Smith, A. (2022, July 29). *Lessons learned from Flash Boys*. The Trade. Retrieved from https://www.thetradenews.com/lessons-learned-from-flash-boys/

Sobolev, D. (2020). Insider Information: The Ethicality of the High Frequency Trading Industry. *British Journal of Management*, *31*(1), 101–122. Retrieved from https://doi.org/10.1111/1467-8551.12366

The Editors of Encyclopaedia Britannica. (2025). British general election of 2010. In *Encyclopedia Britannica*. Retrieved from https://www.britannica.com/topic/British-general-election-of-2010

The Modern Market Initiative. (2014). *HFT is Today's Innovative and Efficient Market Intermediaries*. Retrieved from https://www.modernmarketsinitiative.org/hft-is-todays-innovative-and-efficient-market-intermediaries/&ved=2ahUKEwj_mp_Ek4yMAxWBQkEAHZp7LccQF-noECAwQAQ&usg=AOvVaw2PJ36G-4p4LpNCLXw4NzDGZ

The U.S. CFTC & U.S. SEC. (2010). *Findings Regarding the Market Events of May 6, 2010*. Retrieved from https://www.sec.gov/news/studies/2010/marketevents-report.pdf

Thomas, Z. (2016, June 26). How one man took on Wall Street and won. *BBC News*. Retrieved from https://www.bbc.com/news/business-36544970

Vecellio, G. J. (2014). High Frequency Trading, Accident Investigation, and the 6 May 2010 Stock Market Flash Crash. *The MITRE Corporation*.

Wagner, R. (n.d.). *High Frequency Trading—Financial Ethics*. Seven Pillars Institute for Global Finance and Ethics. Retrieved 16 March 2025 from https://sevenpillarsinstitute.org/case-studies/high-frequency-trading/

Welcman, Y. (2022). *Ethical Use of Algorithms in Times of Uncertainty and Crisis: The Case of High-Frequency Trading* (SSRN Scholarly Paper 4179166). Retrieved from https://doi.org/10.2139/ssrn.4179166