United States Senate Committee On

HOMELAND SECURITY & GOVERNMENTAL AFFAIRS

Chairman Gary Peters

AI IN THE REAL WORLD

Hedge Funds' Use of Artificial Intelligence in Trading

HSGAC Majority Staff Report

June 2024

Summary: Hedge funds' use of artificial intelligence and machine learning (AI/ML) technologies to inform trading decisions, which has been a practice by many for decades, raises several concerns as this technology evolves, including inadequate disclosures to clients and the potential for increased risks to market stability. Federal regulators have not clarified how existing frameworks apply to the use of these technologies and need to more fully consider potential gaps in existing and proposed regulations.

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I. Executive Summary

Over the last several decades, private sector development and use of artificial intelligence (AI) has increased dramatically. Greater computing power and more data has led to AI use in nearly every sector, including the financial services sector. Sophisticated investors within the financial services sector, such as hedge funds, have long used advancements in technology to aid in trading. Hedge funds are responsible for over $5 trillion in assets under management (AUM) in the U.S. and have experienced near continuous growth since the 1990s with an over $3 trillion increase in AUM in the last ten years. In recent years, however, hedge funds have increasingly used AI to inform key aspects of trading decisions. Increased use and reliance on AI in the financial services sector, and in particular by hedge funds, can lead to increased risks to investors and for financial markets. Regulators have begun to assess these risks. However, this work is in its infancy. While Securities and Exchange Commission (SEC) Chairman Gary Gensler has warned that a financial crisis triggered by AI is "nearly unavoidable" within the next decade, proposed rules by the SEC and others have not yet been finalized and there is no cross-sector applicable baseline standard yet established for use of AI in the financial services sector, and, in particular, to inform trading decisions.

To better understand the risks associated with developing uses of AI, including by hedge funds, U.S. Senator Gary Peters, Chairman of the Senate Homeland Security and Governmental Affairs Committee (HSGAC), directed Majority Committee staff to examine developments in the financial services sector's use of AI and the current regulatory framework. The Committee has held several hearings regarding the increasing role of AI, including the use of AI in federal acquisition and government operations, as well as broader uses and risks associated with AI. Chairman Peters has also led bipartisan efforts to encourage responsible development, use, and oversight of AI. Chairman Peters' *Advancing American AI Act*, *AI Training Act*, and *AI Scholarship for Service Act* each became law in the 117th Congress. Chairman Peters has now introduced, the S. 2293 *AI Leadership to Enable Accountable Deployment (AI LEAD) Act*, S. 1564 *AI Leadership Training Act*, and the S. 1865 *Transparent Automated Governance (TAG) Act*. Together, these laws and this new legislation encourage the responsible development and deployment of AI by the federal government.

As a part of this investigation, Chairman Peters received information from six hedge funds, each with different structures and who utilize AI in different ways: Citadel LLC, Renaissance Technologies, Bridgewater Associates, AI Capital Management, Numerai, and WorldQuant. The Committee also received information from relevant federal regulators, including the SEC, Federal Reserve, Financial Industry Regulatory Authority (FINRA), Commodity Futures Trading Commission (CFTC), and Federal Stability Oversight Counsel (FSOC), as well as from experts in this field.

The report finds that hedge funds' use of AI and machine learning (AI/ML) technologies to assist in trading decisions, which has been a practice by some for years, raises several concerns as this technology evolves, including the risk of inadequate disclosures to clients and the potential for increased threats to market stability. The report also finds that hedge funds and regulators use a variety of non-overlapping and unclear terms to define systems that appear to be, or utilize, AI, which makes it difficult to understand what types of systems are in use and how

existing and proposed regulations will apply in various use cases. This may also complicate efforts to audit and assess hedge funds' review processes and human moderation efforts to ensure safety and accuracy. The report also finds that regulators have not yet clarified how existing frameworks apply to the use of these technologies and need to more fully consider potential gaps in existing and proposed regulations. Finally, the report finds that the use of AI for trading purposes amplifies traditional investment industry risks, including, risks associated with triggering uniform movements by significant numbers of investors, also known as herding, which existing risk mitigation measures, such as Limit Up-Limit Down safeguards, may not sufficiently protect against. This report focuses on the use of AI by hedge funds to inform trading decisions. However, the risks identified in this report represent concerns that have the potential to negatively impact individuals and investors across the financial services sector, including, for example, private funds, mutual funds, and other investment advisors. While hedge funds fall under a different regulatory framework than other investment vehicles and financial services entities, recommendations in this report should be considered across the financial services sector.

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AI encompasses many different types of technology, including the subcategory of machine learning (ML), which refers to analyzing and learning from identified patterns. While experts project that "AI could contribute up to $15.7 trillion to the global economy in 2030" and has a growing number of potentially beneficial uses from health care to manufacturing to agriculture, it also has the ability to enhance biases in its programming and distort or disrupt existing structures, including financial markets. In addition, its complex nature makes explaining its decision-making difficult, and at times impossible. As such, depending on its uses, hedge funds may not be able to fully identify or sufficiently disclose to investors or regulators, decisions made by advanced AI systems. In addition, AI use to inform trading decisions may result in inaccurate application of information, and its interconnectivity makes AI systems vulnerable to market manipulation. Together, these amplified risks may lead to market instability. For example, in 2010, technology similar to, but less powerful than, today's AI, such as algorithmic and high frequency trading, caused serious financial market instability, resulting in a "flash crash" that caused the Dow Jones index to lose more than nine percent of its value temporarily wiping out close to a trillion dollars in the span of minutes before stabilizing and closing down three percent.

Investment vehicles, like hedge funds, are regulated by the SEC and the CFTC. Hedge funds that meet specific requirements must register with regulators and disclose information about their funds and practices. These disclosures help investors make informed decisions and allow regulators to assess potentially fraudulent or other prohibited activities and identify systemic risks. SEC and CFTC have recently begun to examine the use of AI by investment vehicles, such as hedge funds, and to identify risks presented by such use. One such example is the recent SEC proposed rule that would require investment advisors to identify and neutralize conflicts of interest that arise when using AI-related technology. Despite these recent steps, regulators have yet to fully clarify how existing regulations apply to hedge funds' use of AI in trading and there are yet to be established baseline standards specifically on the use of AI for trading purposes.

As more hedge funds and other investment vehicles use AI, and as AI's development and potential use cases advance, the risks identified in this report will increase. For example, generative AI (GAI) has the ability to create new content and could be used by hedge funds and other investors to generate trading strategies and advice. This technology enhances the concerns related to traditional AI. AI generated images and information, such as the May 2023 AI generated image of an explosion at the Pentagon that led to a drop in stock market indices, can also pose serious risks to market stability. Congress and regulators need to ensure the public has a better understanding of how current regulations apply to AI technology and establish baseline guardrails applicable to all, to address risks related to the use of AI technology in the financial services sector.

II. Findings of Fact and Recommendations

FINDINGS OF FACT

1. **Hedge funds use different terms to name and define their AI-based systems.** In conversations with Majority Committee staff, hedge funds explained that they utilize AI and ML to help inform several aspects of trading decisions. These uses include conducting research, pattern identification, and portfolio construction. When describing the systems used to help make trading decisions, hedge funds used a variety of terms to name their systems, such as expert systems, algorithmic systems, and optimizers. While the systems used by the hedge funds that Majority Committee staff spoke with all fall under the definition of AI set out by Congress in the National Defense Authorization Act of 2019, several companies told Majority Committee staff they do not consider these technologies to be AI.

2. **Hedge funds do not have uniform requirements or an understanding of when human review is necessary in trading decisions.** All six hedge funds Majority Committee staff spoke with said that humans review their AI systems and trading decisions. However, some hedge funds largely rely on these systems, while others told Majority Committee staff they believe human intuition is required when making trading decisions, and none defined a specific point in time where that intervention must exist.

3. **Existing and proposed regulations concerning AI in the financial sector fail to classify technologies based on their associated risk levels.** Absent such classification, the public lacks clarity on the degree and scope of risks related to AI/ML strategies deployed for specific use cases.

4. **Executive Order 14110 exempts independent regulatory agencies from the EO's definition of agencies.** In October 2023, President Biden issued Executive Order 14110 to guide the establishment of AI safety and security standards. This exemption means that independent regulatory agencies, like the SEC and CFTC, are exempt from requirements within the EO and only "encouraged" to take specific actions. In March 2024, OMB issued final guidance on how to implement the EO, along with other AI legislation and EOs, that includes independent agencies in the definition of agencies. However, this guidance only focuses on how agencies should treat their use of AI rather than how to approach regulating the private sector's use of AI.

5. **Regulators have begun to examine regulations for potential gaps in authority, but have not sufficiently clarified how current regulations apply to hedge funds' use of AI in trading decisions.** Regulators told Majority Committee staff that existing regulations and obligations apply to hedge funds and investment advisers' use of AI. However, it is unclear how the existing framework specifically applies to the use of AI. While regulators have recently begun to examine current regulations for potential gaps and identify areas where current practices are insufficient to properly apply existing regulations to the use of AI, they have only done so in a select few instances. One such

example is SEC's Fall 2023 proposed rule on conflicts of interest and predictive data analytics.

6. **AI's inherent complexity and lack of explainability can frustrate compliance obligations, including the ability to provide adequate disclosures to clients.** AI systems are sometimes referred to as 'black boxes' because their intricate decision-making process is difficult, and at times impossible, to understand or explain. Their complex and opaque nature makes it difficult to ensure that hedge funds are able to fully explain their trading decisions. Under existing statutory and regulatory obligations, qualifying hedge funds must make certain disclosures to regulators and clients about their trading decisions. While companies disclose to investors some information regarding their use of AI technologies, these disclosures are high level and do not include details on how systems are reviewed.

7. **Hedge funds perform accuracy and safety reviews at different points and do not disclose to investors how or when they perform these reviews.** Each company Majority Committee staff spoke with built testing and reviews into their development processes, including reviews for accuracy and effectiveness. However, these reviews occurred at different times, intervals, and with different individuals. While companies disclose to investors some information on their use of AI technologies, these disclosures are limited and may not convey when and how AI technologies are employed, how their systems are developed, or how they test and review their systems for safety and accuracy.

RECOMMENDATIONS

1. **Create common definitions for hedge funds' systems that utilize AI.** SEC and CFTC should define guidelines and standards for how hedge funds name and refer to trading systems that utilize AI. SEC and CFTC should also require hedge funds to identify systems that fall under the FY 2019 National Defense Authorization Act definition of "artificial intelligence."

2. **Create AI operational baselines and establish a system for accountability in AI deployment.** SEC and CFTC should create operational baselines for the use of AI by hedge funds to inform trading decisions. These baselines should address testing and review of AI systems, legal and regulatory compliance, and the role of human moderation. SEC and CFTC should impose best practices and version control frameworks for algorithms and AI technologies that require companies to manage and track changes to deployed technologies.

3. **Require internal risk assessments that identify levels of risk for various use cases.** SEC and CFTC should develop a risk assessment framework, adhering to principles in National Institute of Standards and Technology's *AI Risk Management Framework*, to address risks AI technologies pose to internal operations and larger financial market security. The risk assessment should identify and label the varying levels of risk – high-risk, intermediate-risk, and low-risk – exhibited by such technologies, and SEC and

CFTC should require companies to report AI technologies that correspond with these risk levels. SEC and CFTC should also require that hedge funds verify they have conducted an internal assessment and keep assessment documents on file for a select number of years for auditing purposes.

4. **Codify EO 14110 and OMB Guidance and extend to independent agencies.** Congress should codify EO 14110 to ensure consistent application of AI policy. This should include passing Chairman Peters' *AI LEAD Act*, which would codify the Chief AI Officer position at federal agencies, and the *AI Leadership Training Act*, to ensure agency leadership is appropriately trained to understand the risks of the technology. In codifying EO 14110, Congress should extend the definition of 'agency' to cover independent agencies, like the SEC and CFTC, which would require, rather than encourage, independent regulatory agencies to evaluate how current regulations apply to the use of AI.

5. **Clarify authority of current regulations.** SEC and CFTC should clarify the application of existing regulations to AI related technologies. SEC and CFTC should also continue to examine potential gaps in regulations and propose rules to address unique concerns posed by AI and AI related technologies. These examinations should include risks to both investors and larger financial market impacts.

6. **Disclose necessary information on use and reliability of AI technologies.** Companies should more clearly disclose to their investors what AI technology is used and for what purposes. Disclosures should include how hedge funds review their AI systems, including, but not limited to, what systems are tested for, how frequently they are tested, and the results of such tests. Hedge funds should also continuously monitor their AI systems for safety and accuracy and disclose their monitoring process to clients.

7. **Require standardized audits of AI trading systems and audit trail disclosures for investors**. SEC and CFTC should require hedge funds to audit AI trading systems on a standardized basis and establish clear and specific guidelines for how these audits should be conducted and recorded. Hedge funds should also create and maintain, for a determined period of time, audit trails for trades that utilize AI systems at any point in the trading decision-making process.

III. Introduction

Technology, including artificial intelligence (AI), has long been used by investors and in the financial services sector. AI has the potential to greatly benefit individual investors and the larger economy. However, more complex uses of AI, in all their evolving forms, also come with risks. In 2010, a "flash crash" caused the Dow Jones index to lose more than nine percent of its value temporarily wiping out close to a trillion dollars in the span of minutes before stabilizing and closing down three percent. According to analyses by federal regulatory agencies and experts, the crash resulted from the confluence of stressed market conditions, challenges to data integrity, and a large mutual fund's use of an automated execution algorithm, a technological precursor to AI.[1] A number of experts also attribute failures related to algorithmic trading as partly responsible for a flash crash of the British pound in October 2016.[2] Last year, Securities and Exchange Commission (SEC) Chair Gary Gensler stated that it was "nearly unavoidable" that the next financial market crash would be caused by AI, arguing that such a threat necessitated regulatory action to address both underlying AI models and their use.[3]

Within the investment services sector, hedge funds, private investment vehicles that are subject to fewer regulatory controls than other types of investment vehicles, and that engage in complex high-risk trading, are among those entities that are accelerating use of more complex approaches to AI for trading. While recent technological advancements have provided benefits to the industry, the accelerated use of sophisticated AI technology creates increased risks for investors and markets. Some federal regulators have begun to take action to address AI and AI-related concerns in financial markets. For instance, in August 2023, SEC proposed a new rule to address potential conflicts of interest related to the use of AI and AI related technology.[4] However, currently, there is no regulatory guidance or a universally applicable baseline standard that specifically applies to hedge funds' use of AI, and it is unclear how existing regulations apply to the use of AI by hedge funds in trading decisions.[5]

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[1] Commodity Futures Trading Commission and Securities and Exchange Commission, *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* (Sept. 30, 2010) (stating that "the interaction between automated execution programs and algorithmic trading strategies can quickly erode liquidity and result in orderly markets); *See also* Betsy Reed, *The 2010 'flash crash'; how it unfolded*, Guardian (Apr. 22, 2015) (www.theguardian.com/business/2015/apr/22/2010-flash-crash-new-york-stock-exchange-unfolded) (stating "The market rapidly regained its composure and eventually closed [three percent] lower"); *See also* Eric M. Aldrich et al., *The Flash Crash: A New Deconstruction* (Mar. 26, 2017) (stating "corrupt data caused uncertainty among algorithmic traders, and that uncertainty rationally caused them to withdraw liquidity, particularly during a rapidly moving market").

[2] Rob Davies, *What caused the pound's flash crash?*, Guardian (Oct. 7, 2016) (https://www.theguardian.com/business/2016/oct/07/what-caused-pound-flash-crash-brexit-fallen-sterling).

[3] Stefania Palma and Patrick Jenkins, *Gary Gensler urges regulators to tame AI risks to financial stability*, Financial Times (Oct. 15, 2023) (https://www.ft.com/content/8227636f-e819-443a-aeba-c8237f0ec1ac).

[4] Securities and Exchange Commission, Conflicts of Interest Associated with the Use of Predictive Data Analytics by Broker-Dealers and Investment Advisers, 88 Fed. Reg. 53960 (Oct. 10, 2023) (proposed rule) (hereinafter "SEC Proposed Rule on Conflicts of Interest Associated with the Use of Predictive Data Analytics").

[5] *See* Letter from Securities and Exchange Commission Investor Advisory Committee to Chair Gary Gensler, Securities and Exchange Commission (Apr. 6, 2023) (https://www.sec.gov/files/20230406-iac-letter-ethical-ai.pdf); *See also* Aquila Capital, *Artificial Intelligence: Chances and challenges in quantitative asset management*, Hedge Fund Journal (Mar. 2018).

At the direction of U.S. Senator Gary Peters, Chairman of the Senate Homeland Security and Governmental Affairs Committee, Majority Committee staff examined the development and use of AI by hedge funds for making investment decisions. This report finds that the current applicable federal framework insufficiently addresses both the complex approaches to AI and its various uses by hedge funds, as well as related risks to clients. The report also finds that the risks of future impacts resulting from AI use in investment decisions go beyond potential harm to individual investors and could have an impact on wider financial stability.

Analysts, advisors, and researchers have found that, as one of the largest leaps in technological development in decades, AI has the capacity to transform certain industries while simultaneously boosting economic productivity.[6] Some experts project that "AI could contribute up to $15.7 trillion to the global economy in 2030," and that economic gains could lead to a 14.5 percent increase in gross domestic product (GDP) in North America.[7] AI has a growing list of real-world applications including in healthcare (*e.g.*, medical imaging), education, manufacturing, agriculture (*e.g.*, geotechnical engineering), the petroleum industry, and in transportation systems. In the financial sector, it is currently being used to predict economic outcomes and forecast market trends.[8] However, as discussed further below in Section V, use of more complex approaches to AI in the financial sector, absent any uniform basic guiding principles and industry-wide rules, increases risks to both individual investors and markets.

As part of this investigation, Majority Committee staff met with the following hedge funds: Citadel LLC, Bridgewater Associates, Renaissance Technologies, AI Capital Management, WorldQuant, and Numerai. In addition, Majority Committee staff spoke with relevant federal regulatory agencies, including the SEC, Federal Reserve (Fed), Financial Industry Regulatory Authority (FINRA), Commodity Futures Trading Commission (CFTC), and Federal Stability Oversight Counsel (FSOC), as well as experts in this field.

A. Historical Development and Uses of AI

Congress, in the National Defense Authorization Act of 2019 (FY 2019 NDAA), includes under the umbrella of AI:

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[6] PricewaterhouseCoopers LLP, *Sizing the prize: What's the real value of AI for your business and how can you capitalize?* (2017) (https://www.pwc.com/gx/en/issues/analytics/assets/pwc-ai-analysis-sizing-the-prize-report.pdf); Financial Industry Regulatory Authority, *Artificial Intelligence (AI) in the Securities Industry* (June 10, 2020) (https://www.finra.org/rules-guidance/key-topics/fintech/report/artificial-intelligence-in-the-securities-industry); Department of Treasury Financial Stability Oversight Council, *Financial Stability Oversight Council Annual Report* (2023) (https://home.treasury.gov/news/press-releases/jy1991).

[7] PricewaterhouseCoopers LLP, *Sizing the prize: What's the real value of AI for your business and how can you capitalize?* (https://www.pwc.com/gx/en/issues/analytics/assets/pwc-ai-analysis-sizing-the-prize-report.pdf) (2017).

[8] DonHee Lee and Seong No Yoon, *Application of Artificial Intelligence-Based Technologies in the Healthcare Industry: Opportunities and Challenges*, International Journal of Environmental Research and Public Health (Dec. 24, 2020); Rusul Abduljabbar et al., *Applications of Artificial Intelligence in Transport: An Overview*, Sustainability (Jan. 2, 2018); Abdolhossein Hemmati-Sarapardeh et al., *Applications of Artificial Intelligence Techniques in the Petroleum Industry* (2020) (ISBN: 978-0-12-818680-0); Sparsh Sharma et al., *A Survey on Applications of Artificial Intelligence for Pre-Parametric Project Cost and Soil Shear-Strength Estimation in Construction and Geotechnical Engineering*, Sensors (Jan. 11, 2021).

> (1) Any artificial system that performs tasks under varying and unpredictable circumstances without significant human oversight, or that can learn from experience and improve performance when exposed to data sets.
> (2) An artificial system developed in computer software, physical hardware, or other context that solves tasks requiring human-like perception, cognition, planning, learning, communication, or physical action.
> (3) An artificial system designed to think or act like a human, including cognitive architectures and neural networks.
> (4) A set of techniques, including machine learning, that is designed to approximate a cognitive task.
> (5) An artificial system designed to act rationally, including an intelligent software agent or embodied robot that achieves goals using perception, planning, reasoning, learning, communicating, decision making, and acting.[9]

More commonly, AI is understood as a technology that artificially fabricates human capabilities to carry out activities like speech recognition, visual perception, decision-making, language translation, and data modeling.[10]

Though growing potential uses and capabilities of this technology are relatively recent, the origins of AI trace back to the 1940s. The period following World War II is often considered the catalyst for technological developments that led to the creation of early computers and the subsequent development of AI.[11] As early as 1950, cryptanalyst and mathematician Alan Turing posed the question, "Can a machine think?" and published a paper describing principles that demonstrate that digital computers can "mimic the actions of a human [making computations] very closely."[12] Early AI systems focused on "broad-based" reasoning methods that operated "with little or no domain or task experience" such as heuristic searches, problem decompositions, and means-ends analysis.[13] AI evolved considerably between the 1950s and the 1970s with large amounts of funding for academic institutions from the Defense Department's Defense Advanced Research Program Association (DARPA).[14]

While AI systems have dramatically improved over past decades through advances in technology, numerous limiting factors persist. One major limitation includes the "black box" effect, which refers to the inability to explain how a system works or identify its processes and a lack of explainability "or the ability to be clear about what the machine learning models are

[9] National Defense Authorization Act of 2019, Pub. L. 115-232, Sec. 238(g).
[10] Harikumar Pallathadka et al., *Applications of artificial intelligence in business management, e-commerce, and finance*, Materials Today: Proceedings (accessed Dec. 14, 2023).
[11] Alan M. Turing, *Computing Machinery and Intelligence*, Mind, vol. 49, 1950, pp. 433-460 (1950).
[12] Alan M. Turing, *Computing Machinery and Intelligence*, Mind, vol. 49, 1950, pp. 433-460 (1950); J. McCarthy et al., *A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence*, Darmouth (Aug. 31, 1955).
[13] Richard Fikes and Tom Garvey, *Knowledge Representation and Reasoning — A History of DARPA Leadership*, AI Magazine (June 2020).
[14] Rockwell Anyoha, *The History of Artificial Intelligence*, Harvard Kenneth C. Griffin Graduate School of Arts and Sciences (https://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/) (Aug. 28, 2017).

doing and how they make decisions."[15] The recent boom in AI began in the early 2010s, as access to larger volumes of data and improvements in computer graphics card processors developed concurrently.[16]

AI in its current form leverages large data sets to understand underlying relations between separate sets of data in order to generate specific outcomes. AI's ability to successfully execute more complex computer programs stems from a data coding technique and subfield of AI called machine learning.[17] Machine learning (ML) refers to "a computer program's performance [that] improves with experience with respect to some class of tasks and performance measures."[18] ML "learns" from problem-specific training data and algorithms to "find hidden insights and complex patterns without explicitly being programmed … especially in tasks related to high-dimensional data."[19] However, in comparison with deep learning models discussed below, ML algorithms have a simple structure and utilize a decision tree model to solve problems.

Recent AI developments use a more sophisticated type of ML, called deep learning (DL) which requires significantly less human intervention to learn and process information. DL models constitute complex neural networks with multiple layers of intertwined nodes. These models are built on algorithms that have been trained on significantly larger data sets than traditional machine learning. Algorithms that support deep learning models are capable of learning from errors in real time and independently adjust performance. Generative AI (GAI), a newer and still developing aspect of this technology, involves wholly automated content creation, such as audio, video, or text prompted by user generated requests.[20]

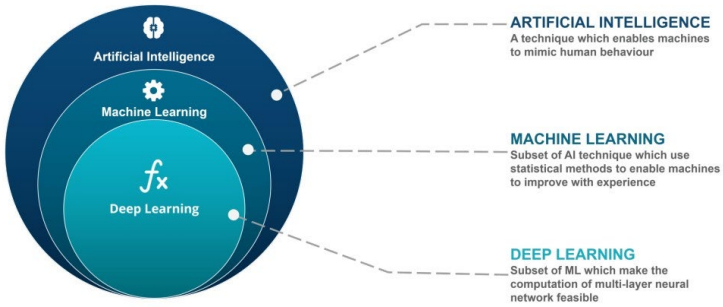

Figure 1. Differences between Artificial Intellgience, Machine Learning, and Deep Learning[21]

[15] Sara Brown, *Machine learning, explained*, Massachusetts Institute of Technology Sloan School of Management (https://mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained) (Apr. 21, 2021).
[16] *How AI came to rule our lives over the last decade*, CNN (Dec. 23, 2019) (https://www.cnn.com/2019/12/21/tech/artificial-intelligence-decade/index.html); Council of Europe, *History of Artificial Intelligence* (accessed July 10, 2023) (https://www.coe.int/en/web/artificial-intelligence/history-of-ai).
[17] Christian Janiesch et al., *Machine learning and deep learning*, Electron Markets (Apr. 8, 2021).
[18] *Id*.
[19] *Id*.
[20] Government Accountability Office, *Science & Tech Spotlight: Generative AI* (GAO-23-1067820) (Jun. 13, 2023).
[21] Karan Aggarwal et al., *Has the Future Started? The Current Growth of Artificial Intelligence, Machine Learning, and Deep Learning*, Iraqi Journal for Computer Science and Mathematics (Jan. 2022).

B. AI in the Financial Services Sector

AI/ML systems have widespread uses in the financial services sector, including applications in investment management, credit underwriting, regulatory compliance, central banking, marketing, and cybersecurity.[22] AI/ML's increasing popularity for these uses is, in part, due to the technologies' ability to "forecast macro-economic and financial variables, meet customer demands, provide payment capacity, and monitor business conditions."[23] AI/ML technologies have also been used for regulatory compliance purposes including to analyze consumer behavior, combat money-laundering, detect fraud, identify changes to regulatory obligations, stress test models, and conduct risk management.[24]

These technologies have also been used by financial institutions for "communication with financial service providers (for example, chat bots), investing (for example, robo-advisor), borrowing (for example, automated mortgage underwriting), and identity verification (for example, image recognition)."[25] Artificial neural networks can also be used to predict trends in the stock market. Researchers have found that the use of such networks in certain AI trading models can "provide an opportunity to achieve profits exceeding the market average."[26]

C. Types of Automated Trading Systems

Financial services sector firms and hedge funds, have long used automated trading systems to increase efficiencies.[27] In addition to interpreting data, automated trading systems utilize algorithms to allow "the software running the algorithm the authority to autonomously initiate buy and sell orders for securities." While these technologies have the capability to autonomously initiate buy and sell decisions, not all do.[28] Investment management firms, such as hedge funds, can create these models either in-house or use third party systems, like those offered by FINRA registered brokers.[29] Three primary forms of this technology that predate recent more sophisticated AI trading models include algorithmic trading, high-frequency trading, and quantitative trading. As described below, trading systems that incorporate neural networks and machine learning techniques rely on significantly larger data sets and less human involvement and operate much more rapidly and on a larger scale. These systems can be used independently or in combination.

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[22] El Bachir Boukherouaa et al., *Powering the Digital Economy: Opportunities and Risks of Artificial Intelligence in Finance*, International Monetary Fund (Oct. 22, 2021).
[23] *Id*.
[24] *Id*.
[25] *Id*.
[26] Gil Cohen, *Artificial Intelligence in Trading the Financial Markets*, International Journal of Economics and Business Administration (Feb. 10, 2022).
[27] El Bachir Boukherouaa et al., *Powering the Digital Economy: Opportunities and Risks of Artificial Intelligence in Finance*, International Monetary Fund (Oct. 22, 2021).
[28] Vishal Parikh and Parth Shah, *Stock Prediction and Automated Trading*, International Journal of Communication Systems (2015).
[29] Greg Williams, *Trading places: the rise of the DIY hedge fund*, Wired (https://www.wired.com/story/trading-places-the-rise-of-the-diy-hedge-fund/) (Apr. 2, 2017).

The technology described below, all commonly in use by hedge funds, meets the definition of AI set out in the FY19 NDAA described above. However, hedge funds Majority Committee staff spoke with as part of this investigation told the Committee that they have long used these types of technology and do not consider these technologies 'AI.'[30]

Algorithmic Trading

Algorithmic trading (algo-trading) uses large historical data sets to predict future trends in the stock market. This type of trading utilizes computer programs to place a trade dependent on defined instructions.[31] The algorithms utilize "pricing, quantity, timing, and other mathematical models" to buy and sell orders when conditions meet the parameters.[32] In this model, the program automatically monitors indicators and identifies trading opportunities.[33] However, buy and sell (B&S) decisions related to investments made under this model are not typically made automatically by the program. In most cases, individuals still make the final decision.[34] Some hedge funds have recently begun hiring programmers who compete to derive the most profitable code to use in algo-trading.[35] Algorithmic trading has its limitations, including that reliance on historical data to predict future market conditions cannot account for real-time market disruptions.[36]

High-Frequency Trading

High-frequency trading (HFT) seeks to capitalize on rapid and high-volume orders across multiple markets.[37] Algorithmic trading and high-frequency trading are often categorized similarly, as they are both "a type of trading model where computer [programs] perform trades in a matter of milli, micro or nanoseconds, [and] are designed to be self-dependent."[38] High-frequency trading and algorithmic trading differ mostly in the context of how trades are initiated. High-frequency trading typically generates B&S decisions without human intervention. This tactic has been viewed as one that is generally more controversial than traditional algo-trading, as HFT programs often "work on an if-then basis" and "do not [analyze] in full ... the scale of an

[30] Renaissance Technologies LLC, Briefing with Senate Committee on Homeland Security and Governmental Affairs Majority Staff (July 26, 2023); Bridgewater Associates, LP, Briefing with Senate Committee on Homeland Security and Governmental Affairs Majority Committee (Sept. 7, 2023); Citadel Advisors LLC, Briefing with Senate Committee on Homeland Security and Governmental Affairs Majority Staff (Nov. 30, 2023).
[31] Marc Lenglet, *Conflicting Codes and Codings: How Algorithmic Trading Is Reshaping Financial Regulation*, Theory, Culture & Society (Dec. 2, 2011).
[32] Tim Vipond, *Algorithms (Algos) – Algorithmic trading and the Bridgewater Hedge Fund*, Corporate Finance Institute (accessed June 10, 2024) (https://corporatefinanceinstitute.com/resources/career-map/sell-side/capital-markets/what-are-algorithms-algos/#:~:text=The%20process%20is%20referred%20to,emotional)%20impact%20on%20trading%20activities).
[33] T. Salkar et al., *Algorithmic Trading using Technical Indicators*, Institute of Electrical and Electronics Engineers (Aug. 12, 2021).
[34] *Id.*
[35] Numerai, Home Page (https://web.archive.org/web/20230918160238/https:/numer.ai/fund).
[36] *See* Jon Danielsson, *Artificial intelligence and financial stability*, Vox EU (Oct. 27, 2023); Jon Danielsson et al., *Artificial intelligence and systemic risk*, Journal of Banking and Finance (Aug. 2021).
[37] Carlos Jorge Lenczewski Martins, *The Role of Automation in Financial Trading Companies*, Journal of Management and Financial Sciences (2019).
[38] *Id.*

event."[39] As such, an HFT program "may see a panic in the market as a good situation to profit, and by making transactions, generate even more panic for other human traders."[40]

The most famous example of high-frequency trading strategies causing market harm beyond individual investors is the May 2010, Flash Crash. On May 6th, the market experienced shocks related to HFTs that led the Dow Jones Industrial Average to lose more than nine percent of its value temporarily wiping out close to a trillion dollars in the span of minutes before stabilizing, and closing down three percent.[41] Currently, there are "no rules or laws [to] limit the use of trading algorithms" either with respect to algo, HFT, or quantitative trading.[42]

Quantitative Trading

Quantitative trading (quant trading), like algo-trading, utilizes computer programs and algorithms to identify trading opportunities. However, unlike algo-trading, which typically relies on large data sets and historical trend analysis, quant trading models rely on technical analysis utilizing mathematical and economic theory.[43] This means algo-trading more consistently relies on historical stock data while quant trading employs more diverse data sets to determine B&S opportunities.[44]

Like algo-trading, quant trading relies on historical data – but, quant trading models are constructed using statistical software (like Stata and R) that apply a variety of datasets to determine statistically significant variables.[45] Regression analysis and econometrics are applied to determine a final quant trading model.[46] Quant trading strategies are not commonly used to execute final decisions on investments, and as such, differ in that respect from high-frequency trading strategies.[47]

AI and ML Trading Systems

Hedge funds and other investment vehicles are increasingly utilizing complex AI-based tools to develop trading systems and improve investment decisions.[48] AI-based trading systems

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[39] *Id*.
[40] *Id*.
[41] *Id*.
[42] *Id*.
[43] Carlos Jorge Lenczewski Martins, *The Role of Automation in Financial Trading Companies*, Journal of Management and Financial Sciences (2019); Ernest P. Chan, *Quantitative Trading: How to Build Your Own Algorithmic Trading Business* (2021).
[44] Van-Dai Ta et al., *Prediction and Portfolio Optimization in Quantitative Trading Using Machine Learning Techniques*, Association for Computing Machinery (2018).
[45] Van-Dai Ta et al., *Prediction and Portfolio Optimization in Quantitative Trading Using Machine Learning Techniques*, Association for Computing Machinery (2018); Tanya Beder and Cara M. Marshall, *Financial Engineering: The Evolution of a Profession* (2011).
[46] Van-Dai Ta et al. *Prediction and Portfolio Optimization in Quantitative Trading Using Machine Learning Techniques*, Association for Computing Machinery (2018).
[47] Carlos Jorge Lenczewski Martins, *The Role of Automation in Financial Trading Companies*, Journal of Management and Financial Sciences (2019).
[48] *See* Section VI.

differ from other technology-based trading systems because of their unique ability to, almost instantaneously, factor in learned patterns of "good" and "bad" trading decisions.[49] The incorporation of neural networks and machine learning techniques is what primarily differentiates traditional HFTs from AI-based trading strategies.[50] Unlike traditional algorithmic trading models that rely on human judgment to uncover patterns in high volumes of data, neural networks are more advanced and require less human involvement through "self-training component[s]" to allow models to optimize data in real-time.[51]

Applying ML/DL to big data has become a popular method for building computerized networks that predict financial asset trends for trading purposes.[52] In financial markets, ML/DL allows computers "to develop [their] own rules through pattern recognition," thereby increasing efficiency in information processing.[53] Present-day algorithms leverage market activity and pricing data in forecasting, but implementing ML/DL techniques to analyze alternative data allows firms to consider additional factors like satellite imagery, weather predictions, social-media sentiment, company acquisitions, and movement of shipment containers to apply to financial models for analysis and decision making.[54]

	Algorithmic Trading	High-Frequency Trading	Quantitative Trading	AI and ML Trading Systems
Uses large historical data sets	✓	✓	✓	✓

[49] Gil Cohen, *Algorithmic Trading and Financial Forecasting Using Advanced Artificial Intelligence Methodologies*, Mathematics (Sept. 12, 2022).
[50] *AI Trading – What is AI Trading & How It's Used in Stock Trading*, Nasdaq (Dec. 4, 2023) (https://www.nasdaq.com/articles/ai-trading-what-is-ai-trading-how-its-used-in-stock-trading); Danijel Jevtic et al., *Artificial Intelligence for Trading Strategies*, Cornell University (Apr. 16, 2022) (https://arxiv.org/pdf/2208.07168.pdf).
[51] Sumit Chanda, *How neural networks are used in the investment world*, Economic Times (Sept. 7, 2022) (https://economictimes.indiatimes.com/markets/stocks/news/how-neural-networks-are-used-in-the-investment-world/articleshow/94043039.cms?from=mdr).
[52] Gil Cohen, *Artificial Intelligence in Trading the Financial Markets*, International Journal of Economics and Business Administration (Feb. 10, 2022).
[53] Danijel Jevtic et al., *Artificial Intelligence for Trading Strategies*, Cornell University (https://arxiv.org/pdf/2208.07168.pdf) (Apr. 16, 2022).
[54] DonHee Lee and Seong No Yoon, *Application of Artificial Intelligence-Based Technologies in the Healthcare Industry: Opportunities and Challenges*, International Journal of Environmental Research and Public Health (Dec. 24, 2020); Rusul Abduljabbar et al., *Applications of Artificial Intelligence in Transport: An Overview*, Sustainability (Jan. 2, 2018); Abdolhossein Hemmati-Sarapardeh et al., *Applications of Artificial Intelligence Techniques in the Petroleum Industry* (Aug. 26, 2020) (ISBN: 978-0-12-818680-0); Sparsh Sharma et al., *A Survey on Applications of Artificial Intelligence for Pre-Parametric Project Cost and Soil Shear-Strength Estimation in Construction and Geotechnical Engineering*, Sensors (Jan. 11, 2021).

Utilizes computer programs to place trades dependent on set parameters	✓	✓	✓	✓
Can generates buy and sell (B&S) decisions without human intervention		✓	✓	✓
Relies on rigorous technical and mathematical analysis and econometrics			✓	✓
Employs unique and diverse data sets (nontraditional economic data)			✓	✓
Factors in learned patterns of behavior through self-training components				✓
Incorporate machine learning (ML) and neural networks (NN)				✓
Figure 2. Types of Automated Trading Systems				

IV. Oversight of AI in the Financial Services Sector

There is currently no comprehensive federal or state regulatory framework that addresses the use of AI systems by hedge funds or the financial services sector as a whole.[55] Further, it is not fully clear how existing regulations are applicable to the use of AI in hedge funds' trading decisions.[56] However, in recent years, federal agencies and independent regulators have begun taking steps to address concerns regarding the increased use of AI across economic sectors, including in the financial services sector. As discussed further below in this section, the report finds that the current applicable federal legal framework, together with recent regulatory actions, insufficiently address the evolving uses of AI in the financial services sector, including by hedge funds in trading decisions. This includes insufficient action to address disclosure obligations to investors and systemic risks.

This report also finds that regulators are not sufficiently coordinating their efforts to address concerns related to AI. Majority Committee staff spoke to the SEC, the Federal Reserve, FINRA, CFTC, and FSOC, and, while regulators explained that it was a priority to "speak collectively," each agency appeared to take a different approach to addressing AI and related

[55] Congressional Research Service, *Artificial Intelligence: Overview, Recent Advances, and Considerations for the 118th Congress* (R47644) (Aug. 4, 2023).
[56] *See* Letter from Securities and Exchange Commission Investor Advisory Committee to Chair Gary Gensler, Securities and Exchange Commission (Apr. 6, 2023) (https://www.sec.gov/files/20230406-iac-letter-ethical-ai.pdf); *See also* Aquila Capital, *Artificial Intelligence: Chances and challenges in quantitative asset management*, Hedge Fund Journal (Mar. 2018).

risks associated with the accelerated use of AI in the financial services sector.[57] For example, FINRA released its first report warning of risks related to the use of AI in the investment industry in 2020 and told the Committee that it is "focused on this issue and [it] is going to continue to look at it."[58] However, CFTC staff told Majority Committee staff that the CFTC had very recently issued a Request for Comment to gather information on the use of AI from industry participants, an initial step in understanding the risks related to the use of AI.[59] Additionally, SEC has already begun to take steps to address concerns related to the use of AI to inform trading decisions through its proposed rule on conflicts of interest.[60]

Regulators told the Committee they take a principles-based "technology-neutral" approach when developing regulations and recommendations for regulations.[61] SEC staff explained that any recommendations are guided by the Commission's regulatory authorities and not the types of technology firms may use.[62] However, agencies have the ability to address risks posed by the use of AI that follows a "technology-neutral" approach, as demonstrated by the below discussed SEC conflicts of interest rule.

A. Current Framework

The SEC and the CFTC have joint responsibilities with respect to regulating the activities of investment firms. SEC is charged with protecting investors and "maintaining fair, orderly, and efficient markets, and facilitating capital formation."[63] CFTC is responsible for "promot[ing] the integrity, resilience, and vibrancy of the U.S. derivatives market through sound regulation."[64] SEC has jurisdiction over securities market participants (such as firms that issue securities, investment advisers and investment companies), securities markets and market utilities (such as stock exchanges and clearinghouses), and securities products.[65] CFTC's authorities include oversight trading organizations, clearing organizations, data repositories, and intermediaries.[66]

Hedge funds come in a variety of structures and formats but can commonly be understood as "asset management vehicles that generally pool accredited investors' money

[57] Board of Governors of the Federal Reserve System, Briefing with Senate Committee on Homeland Security and Governmental Affairs Committee Majority Staff (Jan. 8, 2024) (hereinafter "Federal Reserve Briefing").
[58] Financial Industry Regulatory Authority, Briefing with Senate Committee on Homeland Security and Governmental Affairs Committee Majority Staff (Jan. 30, 2024) (hereinafter "FINRA Briefing").
[59] Commodity Futures Trading Commission, Briefing with Senate Committee on Homeland Security and Governmental Affairs Committee Majority Staff (Jan. 18, 2024) (hereinafter "CFTC Briefing").
[60] SEC Proposed Rule on Conflicts of Interest Associated with the Use of Predictive Data Analytics.
[61] Securities and Exchanges Commission, Briefing with Senate Committee on Homeland Security and Governmental Affairs Committee Majority Staff (Jan. 31, 2024) (hereinafter "SEC Briefing"); CFTC Briefing.
[62] Written Response from Securities and Exchanges Commission to Senate Committee on Homeland Security and Governmental Affairs Chairman Gary Peters (June 4, 2024).
[63] Securities Act of 1933, Pub. L. 117-263; Securities Exchange Act of 1934, Pub. L. 117-328.
[64] Commodity Exchange Act, Pub. L. 117-286.
[65] Securities Exchange Act of 1934, Pub. L. 117-328.
[66] Commodity Exchange Act, Pub. L. 117-286, Sec. X(a)(b); *See also* Congressional Research Service, *Who Regulates Whom? An Overview of the U.S. Financial Regulatory Framework* (R44918) (Oct. 13, 2023).

together and invest it on their behalf for a fee."[67] However, unlike pooled investment funds that are available to the general public, hedge funds are private and less regulated. In exchange for limited registration requirements, the hedge funds may only raise capital from investors that have a high net worth or the expertise necessary to understand the investment strategies used by hedge funds and potential risk of financial loss.[68] Other common characteristics among hedge funds include requiring high minimum investment capital, relying on investment strategies that carry heightened risk, and aiming to achieve higher than usual returns for investors.[69] While hedge funds and hedge fund managers are exempt from certain regulatory requirements, they are still "subject to the same prohibitions against fraud as are mutual funds and other market participants and their advisers have the same fiduciary and other duties as other investment advisers."[70]

Hedge funds that trade securities generally fall under exemptions in the Investment Company Act of 1940 and are not required to register with the SEC.[71] However, hedge funds with SEC-registered investment advisors must file a disclosure form, called a Form PF, with the SEC if they manage one or more private funds with at least $150 million in AUM.[72] Smaller hedge funds must also file a Form PF, annually, and qualifying hedge funds (which have at least $500 million in AUM) must file a Form PF "quarterly and with more detail on assets and liabilities."[73]

The Form PF requires hedge funds to provide SEC and the Financial Stability Oversight Council (FSOC) with "information about the basic operations and strategies of private funds."[74] According to the SEC, this provides a baseline to understand "the private fund industry for … assessing systemic risk."[75] Hedge fund managers may also be subject to regulatory requirements with the SEC as Investment Advisors, which have similar disclosure requirements. A hedge

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[67] Congressional Research Service, *Hedge Funds: Background and Policy Issues* (IF12511) (Oct. 17, 2023).
[68] Investment Company Act of 1940, Pub. L. 117-263, Sec. 3(c)(7); Securities and Exchanges Commission, *Accredited Investor Definition*, 85 Fed. Reg. 64234 (Dec. 8, 2020) (final rule).
[69] Kat Tretina, *How to Invest in Hedge Funds*, Forbes (Jan. 11, 2023) (https://www.forbes.com/advisor/investing/how-to-invest-in-hedge-funds/#:~:text=Hedge%20Fund%20Fees%20and%20Minimums,set%20times%20of%20the%20year) (stating "Minimum initial investment amounts for hedge funds range from $100,000 to upwards of $2 million").
[70] Thomas P. Lemke, et al., *Hedge Funds and Other Private Funds: Regulation and Compliance* (Dec. 2022). Part of these duties also includes disclosing obligations to investors and responsibility for addressing any potential conflicts of interest among the fund, its investment manager, and other service providers. *Id*. The SEC's Investor Advisory Committee has also noted that under existing authorities like the Investment Advisers Act, investment advisors, including hedge funds, have an obligation to their clients to provide investment advice in the investor's best interest and "use of technology by advisers does not change the fiduciary" obligations. Investment Advisers Act of 1940, as amended (18 U.S.C. § 80b-1); Letter from Securities and Exchange Commission Investor Advisory Committee to Chair Gary Gensler, Securities and Exchange Commission (Apr. 6, 2023) (https://www.sec.gov/files/20230406-iac-letter-ethical-ai.pdf).
[71] Investment Company Act of 1940, Pub. L. 117-263, Sec. 3(c)(7).
[72] 17 CFR § 275.204(b).
[73] Board of Governors of the Federal Reserve System, *Enhanced Financial Accounts: Hedge Funds* (Mar. 22, 2024) (https://www.federalreserve.gov/releases/efa/efa-hedge-funds.htm).
[74] Securities and Exchanges Commission, *Form PF: Reporting Form for Investment Advisers to Private Funds and Certain Commodity Pool Operators and Commodity Trading Advisors* (https://www.sec.gov/files/formpf.pdf).
[75] Securities and Exchanges Commission, *Fact Sheet Amendments to Form PF* (https://www.sec.gov/files/ia-6297-fact-sheet.pdf).

fund manager "who, for compensation, engages in the business of advising others, … [on the] value of securities or as to the advisability of investing in, purchasing, or selling securities…" among other qualifying activities, must register with SEC.[76]

If a hedge fund trades commodity futures, the fund and hedge fund managers must register with the CFTC, which has similar requirements as the SEC. Hedge funds that operate as commodity pools, meaning "operate for the purpose of trading in commodity interests, including any…commodity for future delivery, security futures product, or swap," must register with the CFTC and become members of the National Futures Association (NFA).[77] Hedge funds must report basic business information, including their holdings as well as any disciplinary actions, such as criminal matters, adverse regulatory actions, and bankruptcy actions.[78] If hedge fund managers provide advising on the value of or the advisability of trading in commodities, futures, or swaps, they must register as a Commodity Trading Advisor (CTO).[79] CTOs must also become NFA members and regularly file Form 7-R.

B. Recent Regulatory Actions

National Institute of Standards and Technology (NIST)

In January 2023, the National Institute of Standards and Technology (NIST) released its *AI Risk Management Framework* (*RMF*) as a resource for development and use of AI systems "to help manage the many risks of AI and promote trustworthy and responsible development and use of AI systems." The *RMF* "is intended to be *voluntary*, rights-preserving, non-sector-specific, and use-case agnostic." It acknowledges that there are multiple best practices to mitigate risks while also emphasizing the unique risks posed by AI that require that additional consideration. The *RMF* provides only high level analysis and does not address risks posed in specific use cases and sectors. For example, the *RMF* discusses specific risks related to AI use providing some examples of what to address in AI risk management reviews; however, this information is not binding, nor does it address sector specific use cases and concerns.[81]

Executive Order 14110

On October 30, 2023, President Biden released Executive Order 14110 (EO 14110), *Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence*.[82] EO 14110 aims to "establish[] new standards for AI safety and security, protects

[76] 15 U.S.C. § 80b–2(a)(11); 15 U.S.C. § 80b–3.
[77] 7 U.S.C. § 1a(10)(A); National Futures Association, *Commodity Pool Operator (CPO) Registration* (https://www.nfa.futures.org/registration-membership/who-has-to-register/cpo.html).
[78] National Futures Association, *Form 7-R Firm Application Instructions* (https://www.nfa.futures.org/registration-membership/templates-and-forms/Form7-R-entire.pdf).
[79] 7 U.S.C. § 1a(12)(a)(i).
[80] National Futures Association, *Commodity Trading Advisor (CTA) Registration* (https://www.nfa.futures.org/registration-membership/who-has-to-register/cta.html).
[81] Department of Commerce National Institute of Standards and Technology, *Artificial Intelligence Risk Management Framework (AI RMF 1.0)* (Jan. 2023) (https://nvlpubs.nist.gov/nistpubs/ai/nist.ai.100-1.pdf).
[82] Exec. Order No. 14110, 88 Fed. Reg. 75191 (Nov. 1, 2023).

Americas' privacy, advances equity and civil rights, stands up for consumers and workers, promotes innovation and competition, advances American leadership around the world, and more."[83] Along with the release of this EO, the Office of Management and Budget (OMB) issued final guidance on how federal agencies should develop standards for AI safety and security; protections for privacy, equity, and civil rights; protections for consumers, patients, students, and workers; promoting innovation; and ensuring responsible government use of AI.[84]

While EO 14110, and OMB's guidance, provide detailed instructions for federal agencies, it is only an initial step in developing a comprehensive framework to address concerns and risks associated with the use of AI. This narrow focus leaves a large amount of impactful AI systems uncovered by the EO's requirements.[85] The EO also exempt independent regulatory agencies, such as SEC and CFTC, from their definition of "agencies", thereby exempting them from most requirements.[86] The EO encourages, rather than requires, independent regulatory agencies, "as they deem appropriate, to consider using their full range of authorities to protect American consumers from fraud, discrimination, and threats to privacy and to address other risks that may arise from the use of AI, including risks to financial stability."[87] The EO goes on to encourage independent regulatory agencies "to consider rulemaking, as well as emphasizing or clarifying where existing regulations and guidance apply to AI, including clarifying the responsibility of regulated entities to conduct due diligence on and monitory any third-part AI services they use, and emphasizing or clarifying requirements and expectations related to the transparency of AI models and regulated entities' ability to explain their use of AI models."[88]

OMB's final guidance extends the definition of 'agencies' to include "independent regulatory agencies as defined in 44 U.S.C. Sec. 3502(5), which were not included in the definition of 'agency' in Executive Order 13960 and Executive Order 14110, *are* covered by this memorandum."[89] However, this guidance only covers agency use of AI, not agency oversight of private sector use of AI.[90]

The EO also fails to adequately address high risk use cases, either by the government or in the private sector, rather it requires agencies to evaluate their positions and propose next steps for developing and using AI. Alone, the EO is insufficient to address risks related to the use of AI and, in relation to the financial services sector, only "encourages" independent regulatory agencies to act "as they deem appropriate," rather than requiring action be taken.[91] Significant

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[83] *Id*.
[84] Office of Management and Budget, *Advancing Governance, Innovation, and Risk Management for Agency Use of Artificial Intelligence* (Oct. 30, 2023) (final implementation guidance).
[85] Exec. Order No. 14110, 88 Fed. Reg. 75191 (Nov. 1, 2023).
[86] Exec. Order No. 14110, 88 Fed. Reg. 75191 (Nov. 1, 2023); Office of Management and Budget, *Advancing Governance, Innovation, and Risk Management for Agency Use of Artificial Intelligence* (Oct. 30, 2023) (draft implementation guidance).
[87] Exec. Order No. 14110, 88 Fed. Reg. 75191 (Nov. 1, 2023).
[88] Exec. Order No. 14110, 88 Fed. Reg. 75191 (Nov. 1, 2023).
[89] Office of Management and Budget, *Advancing Governance, Innovation, and Risk Management for Agency Use of Artificial Intelligence* (Mar. 28, 2024) (final implementation guidance) (emphasis original).
[90] Office of Management and Budget, *Advancing Governance, Innovation, and Risk Management for Agency Use of Artificial Intelligence* (Mar. 28, 2024) (final implementation guidance).
[91] Exec. Order No. 14110 § 8, 88 Fed. Reg. 75191 (Nov. 1, 2023).

subsequent actions by regulators and Congress are necessary to ensure responsible development and use of AI in the private sector.

SEC

As the SEC's Investor Advisory Committee noted in April of 2023, under existing authorities like the Investment Advisers Act, investment advisors, including hedge funds, have an obligation to their clients to provide investment advice in the investor's best interest and "use of technology by advisers does not change the fiduciary" obligations.[92] In addition to its efforts to address the reach of existing authorities, in August 2023, the SEC issued a Proposed Rule, *Conflicts of Interest Associated With the Use of Predictive Data Analytics by Broker-Dealers and Investment Advisers*.[93] The SEC states that the proposed rule aims to "eliminate, or neutralize the effect of, certain conflicts of interest associated with broker-dealers' or investment advisers' interactions with investors through these firms' use of technologies that optimize for, predict, guide, forecast, or direct investment-related behaviors or outcomes."[94]

The proposed rule defines covered technology to include "analytical, technological, or computational function, algorithm, model, correlation matrix, or similar method or process that optimizes for, predicts, guides, forecasts, or directs investment-related behaviors or outcomes."[95] According to the SEC, this definition is designed to include "technologies, such as AI, machine learning, or deep learning algorithms, neural networks, [natural language processors], or large language models."[96] While the comment period on this proposed rule closed in October 2023, in briefings with Majority Committee staff, SEC staff said is still reviewing and assessing comments to determine next steps.[97] If finalized, the rule would require investment advisers to identify and address conflicts of interest within their AI systems.[98] SEC staff stated that the proposed rule focused on conflicts associated with the use of certain technologies, and therefore, was designed to be "technology-neutral."[99] The staff indicated that the use of AI-related technology complicates firms' ability to address conflicts with investors due in part to AI's

[92] Investment Advisers Act of 1940, as amended (18 U.S.C. § 80b-1); Letter from Securities and Exchange Commission Investor Advisory Committee to Chair Gary Gensler, Securities and Exchange Commission (Apr. 6, 2023) (https://www.sec.gov/files/20230406-iac-letter-ethical-ai.pdf).
[93] SEC Proposed Rule on Conflicts of Interest Associated with the Use of Predictive Data Analytics; Securities and Exchange Commission, *Draft Recommendation of the SEC Investor Advisory Committee's Disclosure Subcommittee Regarding Digital Engagement Practices* (https://www.sec.gov/files/20231117-recommendation-use-dep.pdf); 86 Fed. Reg. 49067 (Sept. 1, 2021); SEC Proposed Rule on Conflicts of Interest Associated with the Use of Predictive Data Analytics (stating that "In August 2021, the Commission issued a request for information and public comment on the use of DEPs by broker-dealers and investment advisers, as well as the analytical and technological tolls and methods used in connection with these DEPs").
[94] SEC Proposed Rule on Conflicts of Interest Associated with the Use of Predictive Data Analytics.
[95] *Id*.
[96] *Id*.
[97] SEC Briefing.
[98] *See* SEC Proposed Rule on Conflicts of Interest Associated with the Use of Predictive Data Analytics.
[99] Written Response from Securities and Exchanges Commission to Senate Committee on Homeland Security and Governmental Affairs Chairman Gary Peters (June 4, 2024).

ability to rapidly transmit and scale (i.e. exacerbate the magnitude and potential effect of) a conflict in a more pronounced fashion than previously possible.[100]

Although this rule is primarily directed at retail investors, the rule provides an example of how regulatory authorities within the financial space are tackling the expanded use of AI and investor protection. While this rule does take a step in addressing concerns raised by the use of AI, it fails to provide specific guidance and/or requirements for how investors and broker dealers must address conflicts of interest, leaving remediation to the discretion of the investment adviser. Further, the limited scope of the rule leaves a range of concerns raised by the use of AI to inform trading decisions in the investment industry unaddressed.

CFTC

In January 2024, CFTC issued a Request for Comment "on the use of [AI] in markets regulated by the Commission, as well as the implications of such use or adoption."[101] CFTC Commissioner Kristin N. Johnson explained that the Request for Comment is an "effort[] to advance inquiries regarding the integration of AI in our markets and to explore the need to introduce guardrails to mitigate the risks that AI technologies may present."[102] CFTC staff told Majority Committee staff that the rule aims to "prioritize[] promoting responsible innovation and ensuring the CFTC staff understand current and potential AI use cases and the associated potential risks to the CFTC's jurisdictional markets and the larger financial system."[103] CFTC accepted comments until April 24, 2024.[104] While input from market participants is critical for the agency's rulemaking process, this request merely intends to gather more information on the use of AI in the industry and fails to recognize the rapid pace at which hedge funds are researching and deploying more sophisticated AI systems. Further, it delays action on addressing the potential concerns outlined here.

FSOC and FINRA

FSOC and FINRA play an important role in interagency cooperation and industry compliance. In December 2023, the Federal Stability Oversight Council (FSOC), a key interagency group created under the Dodd Frank Act "to respond to emerging threats to the stability of the United States financial system," cited the use of AI in financial services as a

[100] SEC Briefing; Written Response from Securities and Exchanges Commission to Senate Committee on Homeland Security and Governmental Affairs Committee Chairman Gary Peters (June 4, 2024).
[101] Commodity Futures Trading Commission, *Request for Comment on the Use of Artificial Intelligence in CFTC-Regulated Markets* (Jan. 25, 2024).
[102] *Id*.
[103] Written Response from Commodity Futures Trading Commission to Senate Committee on Homeland Security and Governmental Affairs Chairman Gary Peters (May 30, 2024).
[104] Commodity Futures Trading Commission, *CFTC Staff Releases Request for Comment on the Use of Artificial Intelligence in CFTC-Regulated Markets* (Jan. 25, 2024) (https://www.cftc.gov/PressRoom/PressReleases/8853-24); Commodity Futures Trading Commission, *Customer Advisory: AI Won't Turn Trading Bots into Money Machines* (Jan. 2024) (https://www.cftc.gov/LearnAndProtect/AdvisoriesAndArticles/AITradingBots.html) (stating "[f]raudsters are exploiting public interest in [AI] to tout automated trading algorithms, trade signal strategies, and crypto-asset trading schemes that promise unreasonably high or guaranteed returns").

potential risk in its annual report.[105] Among other risks, FSOC notes that AI may present risks related to safety-and-soundness of AI models. The report also noted that AI poses a risk to consumers, such as through the inability to explain how the models function, biases, and inaccurate outputs. The report highlighted the importance of data in training AI models.[106] In its January 2024 annual report, FINRA also identified AI as an emerging risk.[107]

Additionally, some states are also taking steps to identify needed areas for regulating development and use of AI.[108] However, both at the federal and state level, the primary result of the actions described above has been the identification of risks in the industry, rather than establishment of any comprehensive baseline requirements or prerequisites for development and use of AI in trading decisions within the financial services sector.

V. Risks of Hedge Funds' Use of AI

While hedge funds have long used technology-based trading strategies, as detailed in Section III.B-C above, in recent years, a number of these management firms have increasingly used complex approaches to AI/ML to inform trading decisions. In January 2023, a Market Makers survey found that nine of out of ten traders at the top 50 hedge funds planned to use AI when making investment decisions.[109]

In interviews with Majority Committee staff, regulators stated that the growing use of AI in the financial services sector, and by investment vehicles like hedge funds, could present new and unique risks and amplify existing risks.[110] When present, these risks tend to interact with each other and intensify their impact. In interviews with Majority Committee staff, FINRA representatives stated that, "available models are trained with little disclosure on how they are being trained, and [broker dealer] firms may use these trained models and then point them against their own data."[111]

FINRA representatives further stated that "this creates a host of risks including explainability and transparency; as well as potential concentration risks – in other words, these

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[105] Department of Treasury Financial Stability Oversight Council, *Financial Stability Oversight Council Annual Report* (2023) (https://home.treasury.gov/system/files/261/FSOC2023AnnualReport.pdf).
[106] *Id*.
[107] Financial Industry Regulatory Authority, *2024 FINRA Annual Regulatory Oversight Report* (Jan. 9, 2024) (https://www.finra.org/rules-guidance/guidance/reports/2024-finra-annual-regulatory-oversight-report).
[108] Council of State Governments, *Artificial Intelligence in the States: Emerging Legislation* (Dec. 6, 2023) (https://www.csg.org/2023/12/06/artificial-intelligence-in-the-states-emerging-legislation/#:~:text=Four%20states%20%E2%80%94%20California%20(AB%20302,unsafe%20or%20ineffective%20AI%20systems) (stating "17 states have enacted 29 bills that focus on AI regulation," with policies focused on interdisciplinary collaboration, protection from ineffective systems, data privacy, transparency, protection from discrimination, accountability." These seventeen states California, Colorado, Connecticut, Delaware, Illinois, Iowa, Louisiana, Maryland, Montana, New York, Oregon, Tennessee, Vermont, Virginia, and Washington).
[109] Market Makers, *9 Out Of 10 Hedge Fund Stars Will Use Ai In 2023. (New Market Makers Survey Revealed)*, Cision PR News (Jan. 17, 2023) (https://www.prnewswire.com/news-releases/9-out-of-10-hedge-fund-stars-will-use-ai-in-2023-new-market-makers-survey-revealed-301722699.html).
[110] SEC Briefing; CFTC Briefing; Federal Reserve Briefing; FINRA Briefing.
[111] FINRA Briefing.

models are so expensive that the average firm is unlikely to be able to build their own models; and as a result of using available models, you may get a herding effect, based on similar model decisions."[112] However, certain regulators Majority Committee staff spoke with, including SEC staff, also noted that any regulatory recommendation takes into account the fact that AI, or similar technologies, have been around for decades.[113] CFTC staff told Majority Committee staff that they were still trying to figure out "how AI is different from automated trading," and they are seeking information as to how regulated entities and registrants may treat AI different from related and previous iterations of the technology.[114]

While hedge funds fall under a different regulatory scheme than other investment vehicles and financial services entities, risks identified below are not exclusive to hedge funds and apply to the wider financial services sector, including for example, private funds, mutual funds, and other investment advisors.

A. Unique Risks Posed by AI

1. Explainability

AI use in the financial services sector presents unique concerns, including with respect to explainability, bias, and accountability. Explainability can be broken down into two specific concerns: (1) explainability, and (2) interpretability.[115] Simply put, "explainability can answer the question of 'how' a decision was made in the system," and "[i]nterpretability can answer the question of 'why' a decision was made by the system and its meaning or context to the user."[116]

In a briefing with Majority Committee staff, FRB staff emphasized that explainability can be a challenge with more complex and opaque AI models as in certain cases, system developers may not know how the system works.[117] According to FRB, it is the company's responsibility to evaluate the system's conceptual soundness—the logic and intuition of the model. FRB staff told Majority Committee staff that explainability should be interpreted as having different degrees and levels and that, "it is helpful not to look at [explainability] as a binary issue."[118] For instance, ML techniques that involve decision trees are explainable even when more complex. However, even in the academic community, the trustworthiness of large language models is still being analyzed.[119]

2. Disparate Outcomes

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[112] FINRA Briefing.
[113] SEC Briefing.
[114] CFTC Briefing; Written Response from Commodity Futures Trading Commission to Senate Committee on Homeland Security and Governmental Affairs Chairman Gary Peters (May 30, 2024).
[115] Department of Commerce National Institute of Standards and Technology, *Artificial Intelligence Risk Management Framework (AI RMF 1.0)* (Jan. 2023) (https://nvlpubs.nist.gov/nistpubs/ai/NIST.AI.100-1.pdf).
[116] *Id.*
[117] Federal Reserve Briefing.
[118] Federal Reserve Briefing.
[119] Sun et al., *TrustLLM: Trustworthiness in Large Language Models*, Cornell University (Mar. 18, 2024).

According to NIST, bias as a concern in AI systems "is broader than demographic balance and data representativeness" and its presence can negate much of the benefits AI promises, corrupting the reliability of any product.[120] These risks can have serious implications when used by hedge funds to inform trading decisions. Investment advisors have a duty to act in their client's best interests and must be able to explain to their clients how they make investment decisions.[121] Using AI to inform these trading decisions complicates this duty if investment advisors are not able to fully explain how a decision was made or if the decision was made in such a way that contributes to increased bias. Additionally, as FSOC has warned, with respect to use of AI in the financial services sector, "without proper design, testing, and controls, AI can lead to disparate outcomes, which may cause direct consumer harm and/or raise consumer compliance risks."[122] The FSOC has also warned that "[e]rrors and biases can become even more difficult to identify and correct as AI approaches increase in complexity, underscoring the need for vigilance by developers to the technology, the financial sector firms using it, and the regulators overseeing such firms."[123]

3. Accountability, AI-Washing and AI Audit-Washing

Increasingly more independent AI systems raise concerns with respect to accountability both internally within a firm and externally with respect to investors, regulators, and participants in the market.[124] As AI trading systems become more widely used, the AI systems will need to be able to account for any involvement in executing decisions, including in instances that could result in taking actions against the interests of investors, particularly in cases where the systems operate as "black boxes."[125] If humans become less involved in the operations of AI systems for trading, the ability of investment managers to ensure "a continuous chain of human responsibility across the entire AI project lifecycle" including "conceptualization, design, development, deployment, and retirement" and to demonstrate that through audits will be critical.[126]

Government regulators including the SEC have identified an increase in "AI washing" whereby investment advisers overstate or fabricate statements regarding the use of AI in their investment processes.[127] For instance, on March 18, 2024, the SEC imposed a $400,000 fine on two investments advisers, Delphia USA and Global Predictions, for making false and misleading statements to clients and potential clients regarding their purported use of AI and ML.[128]

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[120] Department of Commerce National Institute of Standards and Technology, *Artificial Intelligence Risk Management Framework (AI RMF 1.0)* (Jan. 2023) (https://nvlpubs.nist.gov/nistpubs/ai/NIST.AI.100-1.pdf)
[121] *See* Section IV.
[122] Department of Treasury Financial Stability Oversight Council, *Financial Stability Oversight Council Annual Report* (2023) (https://home.treasury.gov/system/files/261/FSOC2023AnnualReport.pdf).
[123] *Id.*
[124] *See* Florian Ostmann and Cosmina Dorobantu, *AI in Financial Services,* Alan Turing Institute (2021).
[125] *See* Ellen Goodman and Julia Trehu, *AI Audit-Washing and Accountability*, German Marshall Fund (Nov. 15, 2022) (https://www.gmfus.org/news/ai-audit-washing-and-accountability).
[126] Florian Ostmann and Cosmina Dorobantu, *AI in Financial Services,* Alan Turing Institute (2021).
[127] Securities and Exchange Commission, *SEC Enforcement Director Gurbir Grewal Discusses AI Washing Enforcement Cases* (Mar. 18, 2024) (https://www.sec.gov/news/sec-videos/sec-enforcement-director-gurbir-grewal-discusses-ai-washing-enforcement-cases).
[128] Delphia (USA) Inc., No. 3-21894 (Mar. 18, 2024); Global Predictions, Inc., No. 3-21895 (Mar. 18, 2024). *See also* Securities and Exchange Commission, *SEC Charges Two Investment Advisers with Making False and*

Another deceptive practice in this space involves the practice of conducting meaningless audits of algorithms to assert compliance with norms and laws—"AI audit-washing."[129] The lack of existing guidelines regarding end-to-end oversight of AI systems that help inform trading increases the risk of inaccurate statements by companies in regulatory filings and in company disclosures regarding the use of AI systems and enhances the risks associated with the opacity of AI/ML models.[130]

B. Amplification of Traditional Risks

1. Disclosure to Clients and Conflicts of Interest

Company information required by the SEC and CFTC helps clients make informed decisions when investing.[131] These disclosures must be "full and fair," meaning they "should be sufficiently specific so that a client is able to understand the material fact or conflict of interest and make an informed decision whether to provide consent."[132] Fed staff emphasized in a briefing with Committee staff, that "details matter" and that a disclosure stating that AI is generally being used would be ineffective without details on the use and materiality.[133] AI's risk of lack of explainability enhances the traditional risk of inadequate disclosures to clients. If an investment advisor is unable to fully explain the AI systems it uses, it calls into question whether clients can understand the systems' decision sufficiently to assess whether they consent to the investment advisor's work.

Another example of this concern is the disclosure of potential conflicts of interest by investment advisors. Conflicts of interest can be present where clients pay a fee for services and where "an investment adviser that is paid a percentage fee based on assets under management has an incentive to encourage a client to move assets into his or her advisory account, which could conflict with investors' interest, for example, to retain assets in a 401(k) plan or other retirement account."[134] To address this traditional risk, regulators developed a framework that requires the appropriate parties "to, as applicable, disclose, mitigate, or eliminate conflicts."[135]

If an investment advisor utilizes AI to inform or make trading decisions, it could amplify the traditional risk of conflicts of interest. AI systems may make decisions that benefit the advisor but are hidden within the AI systems such that investment advisors are not able to

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Misleading Statements About Their Use of Artificial Intelligence (Mar. 18, 2024) (https://www.sec.gov/news/press-release/2024-36).

[129] Ellen P. Goodman and Julia Trehu, *AI Audit-Washing and Accountability*, Germany Marshall Fund (Nov. 15, 2022) (https://www.gmfus.org/news/ai-audit-washing-and-accountability).

[130] Florian Ostmann and Cosmina Dorobantu, *AI in Financial Services,* Alan Turing Institute (2021); Ellen Goodman and Julia Trehu, *AI Audit-Washing and Accountability*, German Marshall Fund (Nov. 15, 2022) (https://www.gmfus.org/news/ai-audit-washing-and-accountability).

[131] Securities and Exchanges Commission, *Fact Sheet Amendments to Form PF* (https://www.sec.gov/files/ia-6297-fact-sheet.pdf).

[132] Securities and Exchange Commission, *Commission Interpretation Regarding Standard of Conduct for Investment Advisers*, 84 Fed. Reg. 33669 (July 12, 2019) (interpretation).

[133] Federal Reserve Briefing.

[134] SEC Proposed Rule on Conflicts of Interest Associated with the Use of Predictive Data Analytics.

[135] *Id.*

identify and thereby disclose them to clients. Additionally, the rate at which AI operates also poses a concern, since it "could rapidly and exponentially scale the transmission of any conflicts of interest associated with such technologies to investors."[136] In communications with Majority Committee staff, the SEC stressed that the potential for rapid scaling of conflicts with respect to technologies like AI is a notable difference and that certain uses in the financial sector call into question whether disclosure would be sufficient to adequately address conflicts or elicit informed consent to a conflict in the context of an investment adviser.[137]

While regulators have an existing regulatory framework around conflicts of interest, as discussed above, SEC recently proposed a new rule to address conflicts presented by the use of predictive data analytics (which includes AI technologies), which would require investment advisors to identify and address potential conflicts within their systems.[138] This rule only covers the narrow concern of conflicts of interest, leaving other areas requiring disclosure, such as disclosure of policies and procedures around trading practices and portfolio management, unaddressed.[139]

2. Herding Behavior

Herding behavior is a long-standing risk in financial markets and occurs when a large number of investors act in a similar manner.[140] Some experts believe that this behavior "exacerbates volatility, destabilizes markets, and increases the fragility of the financial system."[141] To address this risk, exchanges, with the approval of SEC, have in place market-wide circuit breakers such as "Limit Up-Limit Down circuit breaker[s] ("LULD")…to prevent large, sudden price moves in a stock" and temporarily halt trading when certain conditions are triggered.[142]

AI inherently amplifies herding risks. As experts on AI in the financial sector have argued, when "actors make use of similar models to interpret signals from the market," it can lead to herding behavior.[143] For example, in some cases "individual actors may make similar decisions as they get a similar signal from a base model or rely on a data aggregator," which, according to SEC Chair Gary Gensler, could then lead to systemic risk.[144] Chairman Gensler has also warned that "[w]hile current model risk management guidance – generally written prior to

[136] *Id.*
[137] SEC Briefing.
[138] SEC Proposed Rule on Conflicts of Interest Associated with the Use of Predictive Data Analytics.
[139] Securities and Exchange Commission, *Information for Newly-Registered Investment Advisers* (Nov. 23, 2010) (https://www.sec.gov/divisions/investment/advoverview.htm).
[140] International Monetary Fund, *Herd behavior in Financial Markets* (2001) (https://www.imf.org/external/pubs/ft/staffp/2001/01/pdf/bikhchan.pdf).
[141] *Id*.
[142] Securities and Exchange Commission, *Stock Market Circuit Breakers* (accessed June 10, 2024) (https://www.investor.gov/introduction-investing/investing-basics/glossary/stock-market-circuit-breakers#:~:text=Market%2Dwide%20circuit%20breakers%20provide,20%25%20(Level%203).
[143] Dirk A. Zetzsche et al., *Artificial Intelligence in Finance: Putting the Human in the Loop*, CFTE Academic Paper Series (Feb. 2020).
[144] Securities and Exchange Commission, *"AI, Finance, Movies, and the Law" Prepared Remarks before the Yale Law School* (Feb. 13, 2024) (https://www.sec.gov/news/speech/gensler-ai-021324).

this new wave of data analytics – will need to be updated, it won't be sufficient. The challenges to financial stability that AI may pose in the future will require new thinking on system-wide or macro-prudential policy interventions."[145] SEC Chair Gensler has warned that the increased threat of herding behavior caused by the use of AI is a risk he believes could lead to a future financial crisis.[146]

This concern is compounded in cases where AI is combined with increased speeds of trade, such as high-frequency trading. In the past, herding behavior coupled with algorithmic trading and high frequency trading has led to market volatility.[147] AI can amplify this risk though the speed at which it can function and the lack of visibility into its decision making, which can then "result[] in extreme volatility events, referred to as flash crashes."[148]

3. Manipulation and Influence

Another traditional risk, market manipulation, exists when a firm or an actor "artificially affects the supply or demand for a security…."[149] SEC explains market manipulation to include techniques, such as "[s]preading false or misleading information about a company; [e]ngaging in a series of transactions to make a security appear more actively traded; and [r]igging quotes, prices, or trades to make it look like there is more or less demand for a security than is the case."[150] AI amplifies this risk by its speed and ability "to unfairly distort information and prices relating to financial instruments or transactions."[151] Once implemented, "these distortive actions and effects tamper with the humans and computerized information and communication systems of the marketplace… [corrupting] how humans and machines communicate between and amongst each other in the financial markets."[152] In a briefing with Majority Committee staff, CFTC staff indicated that from a market integrity perspective, there is always a concern of "bad actors using AI for fraud or manipulation in markets similar to the types of bad conduct executed via other technologies."[153] The agency is assessing needed steps to identify and address data anomalies and curb market manipulation.[154]

Bad actors can intentionally target the AI systems used by hedge funds, and other investment vehicles, and create market instability. In 2016, Director of National Intelligence James Clapper, in an intelligence community statement for the record on worldwide threat

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[145] Chair Gary Gensler, Securities and Exchange Commission, Remarks as Prepared for Delivery at Yale Law School (Feb. 13, 2024).
[146] Stefania Palma and Patrick Jenkins, *Gary Gensler Urges Regulators to Tame AI Risks to Financial Stability*, Financial Times (Oct. 15, 2023) (https://www.ft.com/content/8227636f-e819-443a-aeba-c8237f0ec1ac).
[147] Katie Kolchin, *The 10th Anniversary of the Flash Crash*, SIFMA Insights (May 19, 2020) (https://www.sifma.org/resources/research/10th-flash-crash-anniversary/).
[148] Dirk A. Zetzsche et al., *Artificial Intelligence in Finance: Putting the Human in the Loop*, CFTE Academic Paper Series (Feb. 2020).
[149] Securities and Exchange Commission, *Glossary: Market manipulation* (accessed June 10, 2024) (https://www.investor.gov/introduction-investing/investing-basics/glossary/market-manipulation).
[150] *Id*.
[151] Tom C. Lin, *The New Market Manipulation*, Emory law Journal (2017).
[152] *Id*.
[153] CFTC Briefing.
[154] CFTC Briefing.

assessments told the Senate Committee on Armed Services that "we have already seen, false data and unanticipated algorithm behaviors have caused significant fluctuations in the stock market because of the reliance on automated trading of financial instruments."[155]

4. Market Stability

Certain AI use cases by investment management firms and others in the financial services sector increase opportunities for market instability and resulting risks to the larger economy. Moreover, through lack of explainability, increased speed of operations, and increased scale of impact, AI use, in particular, in aiding trading decisions, can limit the ability to timely detect market risks.

One well-known instance of financial instability related to technology-based strategies involves the failure of Long-Term Capital Management (LTCM). LTCM, founded in 1993, was a hedge fund focused on bond trading.[156] A distinct feature of the firm's business model included its approach of using "complex mathematical models to find connections between yields of a variety of different bonds."[157] LTCM focused on convergence trading, whereby the firm "analyzed price relationships between different types of securities and took positions when those relationships diverged from their historical patterns."[158] Following the 1997 Asian Financial Crisis, LTCM's reliance on this model led to catastrophic failure for the firm in 1998 as "LTCM's strategy became extremely unprofitable."[159] LTCM's failure was viewed as "a threat to the financial system at large" due to its position as a highly-leveraged institution.[160] A $3.65 billion bailout of LTCM was ultimately engineered by the New York Federal Reserve Bank to prevent concerns of a larger market fallout.[161] This included a "14-member group" of financial institutions "who would collectively receive a 90 percent equity stake" in LTCM, with LTCM partners only receiving the remaining 10 percent.[162]

One of the largest failures related to the use of automated technology in trading involved the May 2010 flash crash of U.S. based equities in the futures and securities markets, largely triggered by failures associated with high-frequency trading. On May 6, 2010, the Dow Jones Industrial Average (DJIA) experienced a 1,000-point drop and lost nine percent of its value

[155] Senate Armed Services Committee, Statement for the Record to Director of National Intelligence James R. Clapper, Defense Intelligence Agency*, Worldwide Threat Assessment of the US Intelligence Community*, 114th Cong. (Feb. 9, 2016).
[156] Congressional Research Service, *Systematic Risk and The Long-term Capital Management Rescue* (RL30232) (June 10, 1999).
[157] Federal Reserve Bank of Richmond, *Economic History: Too Interconnected to Fail* (2009) (https://www.richmondfed.org/-/media/richmondfedorg/publications/research/econ_focus/2009/summer/pdf/economic_history.pdf).
[158] Congressional Research Service, *Systematic Risk and The Long-term Capital Management Rescue* (RL30232) (June 10, 1999).
[159] *Id.*
[160] *Id.*
[161] Federal Reserve Bank of Richmond, *Economic History: Too Interconnected to Fail* (2009) (https://www.richmondfed.org/-/media/richmondfedorg/publications/research/econ_focus/2009/summer/pdf/economic_history.pdf).
[162] *Id.*

within ten minutes before recovering and closing down three percent.[164] In a post-mortem analysis of the causes of the crash, the SEC and CFTC determined that the failures occurred when "a large fundamental trader … initiated a sell program to sell a total of 75,000 E-mini contracts" through an automated execution algorithm and mutual trading.[165] The SEC/CFTC findings noted that the automated trading program executed the sale of these high-volume E-mini contracts in 20 minutes, which was then absorbed by HFTs and intermediaries.[166] *See* Figure 3. More recently, a similar incident occurred in October 2016 when the British pound fell six percent overnight as a result of, what many experts believe, were also technology-based failures related to algorithmic trading.[167]

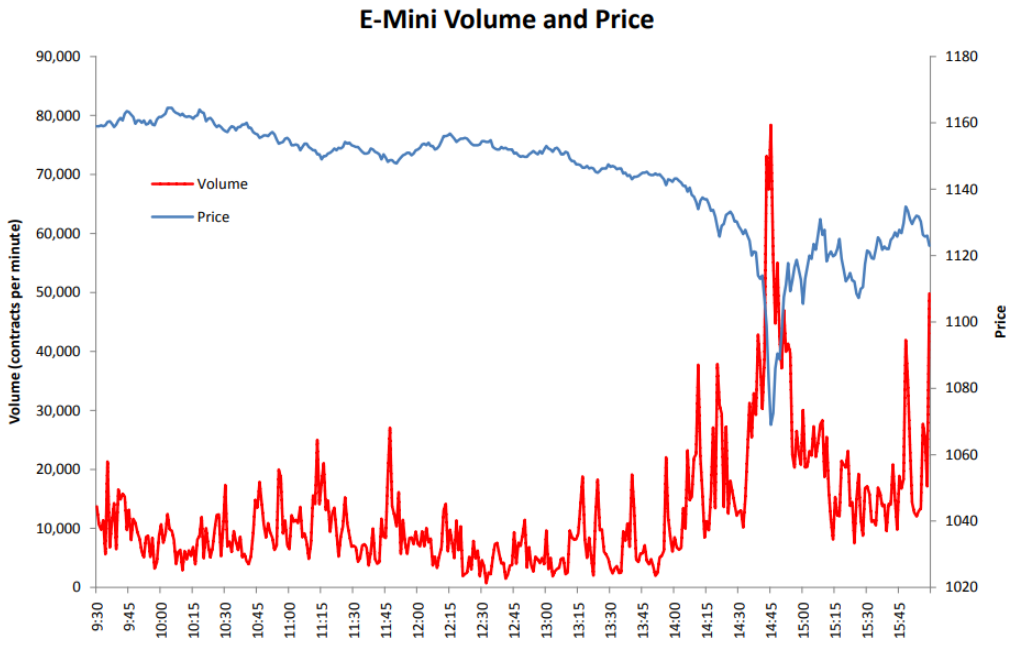

Figure 3. E-Mini Volume and Price on May 6, 2010[168]

VI. Case Studies

Hedge funds make up a discrete segment of the financial services sector. Despite this, hedge funds can substantially influence markets, including by posing a threat to financial

[164] Commodity Futures Trading Commission and Securities and Exchange Commission, *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* (Sept. 30, 2010).
[165] *Id*.
[166] *Id*.
[167] *Sterling Takes a Pounding*, Economist (Oct. 7, 2016) (https://www.economist.com/buttonwoods-notebook/2016/10/07/sterling-takes-a-pounding); Markets Committee, *The sterling 'flash event' of 7 October 2016*, Bank for International Settlements (Jan. 13, 2017).
[168] Commodity Futures Trading Commission and Securities and Exchange Commission, *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* (Sept. 30, 2010).

stability through their interconnected position.[169] According to a recent Mordor Intelligence report, as of 2023, "the US has 3,405 of the 5,523 institutional investors who are active in hedge funds, and 3,319 of the 5,383 hedge fund managers who are active."[170] According to a Statista review, as of 2023, hedge funds in the U.S. are responsible for over $5 trillion AUM.[171] This review also found that hedge funds have experienced near continuous growth since the 1990s and have increased their AUM in the last ten years by over $3 trillion.[172]

A. Hedge Funds

As part of its review, Majority Committee staff received information from six different hedge funds with varying degrees of exposure and with different designs and focus within the financial sector. Three hedge funds, Renaissance Technologies, Bridgewater Associates, and Citadel LLC, represent larger hedge funds that have historically used technology and automated trading-based strategies. Three other hedge funds, AI Capital Management, WorldQuant, and Numerai, represent newer and smaller firms that employ more recently developed technology-based strategies, including ones that rely on AI/ML systems. All firms, except for AI Capital Management, WorldQuant, and Numerai, are registered with both the SEC and CFTC (through the National Futures Association).[173] In interviews with Majority Committee staff, each of the firms discussed the details of their development processes and use of ML.[174]

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[169] Congressional Research Service, *Hedge Funds: Background and Policy Issues* (IF12511) (Oct. 17, 2023).
[170] Modor Intelligence, *US Hedge Fund Market Fintech Market Size & Share Analysis - Growth Trends & Forecasts* (2024) (https://www.mordorintelligence.com/industry-reports/us-hedge-fund-market).
[171] Statista Research Department, *Assets under management of hedge funds worldwide 1997-2023*, Statista (Jan. 18, 2024) (https://www.statista.com/statistics/271771/assets-of-the-hedge-funds-worldwide/#:~:text=In%202023%2C%20the%20value%20of,and%20efficient%20risk%20management%20tactics).
[172] *Id*.
[173] SEC, *Renaissance Technologies LLC SEC Filing* (accessed Jan. 26, 2024) (https://reports.adviserinfo.sec.gov/reports/ADV/106661/PDF/106661.pdf); Securities and Exchange Commission, *Bridgewater Associates Filing* (accessed Jan. 24, 2024) (https://reports.adviserinfo.sec.gov/reports/ADV/105129/PDF/105129.pdf); Securities and Exchange Commission, *Citadel Advisors LLC, Brochure* (Mar. 31, 2023) (https://files.adviserinfo.sec.gov/IAPD/Content/Common/crd_iapd_Brochure.aspx?BRCHR_VRSN_ID=842328); Securities and Exchange Commission, *Form 13F* (Dec. 31, 2023) (https://www.sec.gov/Archives/edgar/data/1745981/000127308724000047/xslForm13F_X02/primary_doc.xml); Written Response from WorldQuant to Senate Committee on Homeland Security and Governmental Affairs Chairman Gary Peters (June 3, 2024). Numerai is an exempt Commodity Pool Operator under rule 4.13(a)(3), a pool with minimal commodity interest trading. National Futures Association, Numerai (accessed Mar. 20, 2024) (https://www.nfa.futures.org/BasicNet/basic-pools-exemptions-current.aspx?nfaid=CRSU4FwI5O0%3D). *See also* National Futures Association, CFTC Part 4 Exemption Easy Reference Guide (accessed Mar. 20, 2024) (https://www.nfa.futures.org/members/member-resources/files/exemptions-reference-guide.html).
[174] Letter from Renaissance Technologies LLC to Chairman Gary Peters (Nov. 29, 2023) (hereinafter "Letter from Renaissance Technologies"); Renaissance Technologies LLC, Briefing with Senate Committee on Homeland Security and Governmental Affairs Majority Staff (Jul. 26, 2023) (hereinafter "Renaissance Technologies Briefing"); Letter from Bridgewater Associates LP to Chairman Gary Peters (Dec. 1, 2023) (hereinafter "Letter from Bridgewater Associates"); Bridgewater Associates, LP, Briefing with Senate Committee on Homeland Security and Governmental Affairs Majority Committee (Sept. 7, 2023) (hereinafter "Bridgewater Associates Briefing"); Letter from Citadel Advisors LLC/Citadel Securities LLC to Chairman Gary Peters (Sept. 20, 2023) (hereinafter "Letter from Citadel"); Citadel Advisors LLC/Citadel Securities LLC, Briefing with Senate Committee on Homeland Security and Governmental Affairs Majority Staff (Nov. 30, 2023) (hereinafter "Citadel Briefing"); Letter from AI Capital Management to Chairman Gary Peters (Nov. 14, 2023) (hereinafter "Letter from AI Capital Management");

Renaissance Technologies LLC. Renaissance Technologies LLC (RenTec) specializes in investment management strategies that employ mathematics and statistics in their trading systems.[175] As of 2024, RenTec manages two outside funds, the Renaissance Institutional Equities Funds (RIEF) and the Renaissance Institutional Diversified Alpha Funds (RIDA). A third fund is exclusive to employees within their company, the Medallion Fund. From 1988 through 2020 the firm has generated over $100 billion in profits.[176] The company recently reported that it manages $69 billion in securities and has over $106 billion in AUM.[177]

Bridgewater Associates, LP. Bridgewater Associates, LP (Bridgewater), manages three main strategies: (1) Pure Alpha Strategies, (2) All Weather Strategy, and (3) Tailored Strategies, such as the Optimal Portfolio Strategy. In 2015, Bridgewater created a team of software engineers, entitled the Systematized Intelligence Lab, to specialize in analytics and AI.[178] More recently, the firm established an Artificial Investment Associate (AIA) Lab made up of 20 investors and machine-learning experts to explore the application of ML techniques to the firm's investment methodology.[179] Bridgewater Associates has 133 accounts and approximately $171 billion in Regulatory AUM.[180]

Citadel Advisors LLC. Citadel Advisors LLC (Citadel) is a member of a group of affiliated entities that together comprise a leading global financial institution with a diverse business platform (collectively, "Citadel Group"), which includes two separate and distinct units: (i) global investment firm ("Citadel") and (ii) a global market maker ("Citadel Securities").[181] Citadel manages private investment funds for sophisticated investors and engages in investment strategies that include, among other focuses, equities, fixed income and macro commodities,

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AI Capital Management LLC, Briefing with Senate Committee on Homeland Security and Governmental Affairs Majority Staff (Nov. 29, 2023) (hereinafter "AI Capital Management Briefing"); Letter from WorldQuant LLC to Chairman Gary Peters (Dec. 1, 2023) (hereinafter "Letter from WorldQuant"); WorldQuant LLC, Briefing with Senate Committee on Homeland Security and Governmental Affairs Majority Staff (Jan. 17, 2024) (hereinafter "WorldQuant Briefing"); Letter from Numerai to Chairman Gary Peters (Dec. 6, 2023) (hereinafter "Letter from Numerai"); Numerai, Briefing with Senate Committee on Homeland Security and Governmental Affairs Majority Staff (Jan. 17, 2024) (hereinafter "Numerai Briefing").

[175] Renaissance Technologies, *Homepage* (https://www.rentec.com/Home.action?index=true) (accessed Jan. 25, 2024).

[176] Yahoo Finance, *Renaissance Technologies Returns, AUM, CEO and Top Energy Stock Picks* (Oct. 26, 2023) (https://finance.yahoo.com/news/renaissance-technologies-returns-aum-ceo-145524029.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAADPJ58dkgSMUUtLpAj8fMGkRw__afLBOk8nfoLc4soygpVCGn_KHp5OvmPZKhxWMnyAkVKPCR7baHPcDdui5jbBNeSb4GG4jO7YygCjACce95Vb1WyQFX8QIdFyOpzsxuAAqQ-iLO_qSF_CgUccOrfbYQ0DlPl8ZqThyQjykNlHU).

[177] Securities and Exchange Commission, *Renaissance Technologies LLC SEC Filing* (accessed Jan. 26, 2024) (https://reports.adviserinfo.sec.gov/reports/ADV/106661/PDF/106661.pdf) (showing that RenTec's regulatory assets under management and total number of accounts total over $106 billion and 15 accounts respectively).

[178] Bridgewater Associates Briefing.

[179] Wealth Advisor, *Bridgewater Assc. Looks to Future with New Automated AI Fund* (Nov. 24, 2023) (https://www.thewealthadvisor.com/article/bridgewater-assc-looks-future-new-automated-ai-fund).

[180] Securities and Exchange Commission, *Bridgewater Associates Filing* (accessed Jan. 24, 2024) (https://reports.adviserinfo.sec.gov/reports/ADV/105129/PDF/105129.pdf).

[181] Written Response from Citadel Advisors LLC/Citadel Securities to Senate Committee on Homeland Security and Governmental Affairs Chairman Gary Peters (June 4, 2024).

credit, and quantitative strategies as an alternative investment firm/hedge fund.[182] Citadel reports that as of January 1, 2024, the firm holds $63 billion in investment capital.[183] The firm recently reported over $397 billion in regulatory AUM under the category of pooled investment vehicles with 26 clients.[184]

AI Capital Management LLC. AI Capital Management LLC (AICM) is a start-up that focuses on the combination of financial trading and computer science as a quantitative trading firm.[185] Since its inception, AICM has been examining the potential for applying AI models in the financial market.[186] AICM has several AI approaches including (1) End-to-End Deep Reinforcement Learning, (2) Machine Vision and Technical Analysis, (3) Systematic Approach Deprived of Human Emotion, (4) GPU Powered Trading Execution, and (5) Scalability and Flexibility in Model Design.[187] AICM currently only engages in proprietary trading and does not take on external clients, but plans to expand to operate as a fund in the future.[188] AICM told Majority Committee staff that it "currently operates as a proprietary trading firm, managing its own capital that is below $10 million."[189] Since it does not have external clients, AICM is not registered with SEC or CFTC.

WorldQuant LLC. WorldQuant is a global quantitative asset management firm that incorporates AI in its investment process.[190] WorldQuant develops and implements trading and investment strategies (including in liquid global asset markets) that may utilize AI, such as in connection with the development of trading signals derived from mathematical models in conjunction with historical data, seeking to predict future movements of various financial instruments.[191] As of January 2024, WorldQuant employs over 1,000 individuals across 26 global offices.[192] WorldQuant has over $7 billion in AUM.[193]

Numerai. Numerai is a quantitative hedge fund "in which an artificially intelligent system chooses all the trades."[194] Numerai operates a Numerai Tournament process in which

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[182] Securities and Exchange Commission, *Citadel Advisors LLC, Brochure* (Mar. 31, 2023) (https://files.adviserinfo.sec.gov/IAPD/Content/Common/crd_iapd_Brochure.aspx?BRCHR_VRSN_ID=842328); Written Response from Citadel Advisors LLC/Citadel Securities to Senate Committee on Homeland Security and Governmental Affairs Chairman Gary Peters (June 4, 2024).
[183] Citadel, Home Page (accessed Jan. 29, 2024) (https://www.citadel.com/).
[184] Securities and Exchange Commission, *Citadel LLC and Citadel Investment Advisors Group Joint Filing* (accessed Jan. 29, 2024) (https://adviserinfo.sec.gov/firm/summary/148826).
[185] AI Capital Management Briefing.
[186] *Id.*
[187] AI Capital Management, Our Team (accessed Jan. 29, 2024) (https://www.aicm.world/about).
[188] AI Capital Management Briefing.
[189] Written Response from AI Capital Management to Senate Committee on Homeland Security and Governmental Affairs Chairman Gary Peters (May 24, 2024).
[190] WorldQuant Briefing.
[191] *Id.*
[192] WorldQuant, Home Page (accessed Jan. 29, 2024) (https://www.worldquant.com/).
[193] Email from Wilmer Cutler Pickering Hale and Dorr LLP, Counsel for WorldQuant, to Senate Committee on Homeland Security and Governmental Affairs Chairman Peters (June 10, 2024).
[194] Cade Metz, *An AI Hedge fund Created a New Currency to Make Wall Street Work Like Open Source*, Wired (Feb. 21, 2017) (https://www.wired.com/2017/02/ai-hedge-fund-created-new-currency-make-wall-street-work-like-open-source/).

individuals obtain raw market data to create crowdsourced ML data sets used to generate a suggested list of stocks to trade.[195] Numerai's dataset includes 5,000 global equities and traditional financial market data.[196] Numerai manages two funds, Numerai One and Numerai Supreme – both require a minimum investment of $5 million.[197] The firm has $320 million in AUM, as of July 2023.[198]

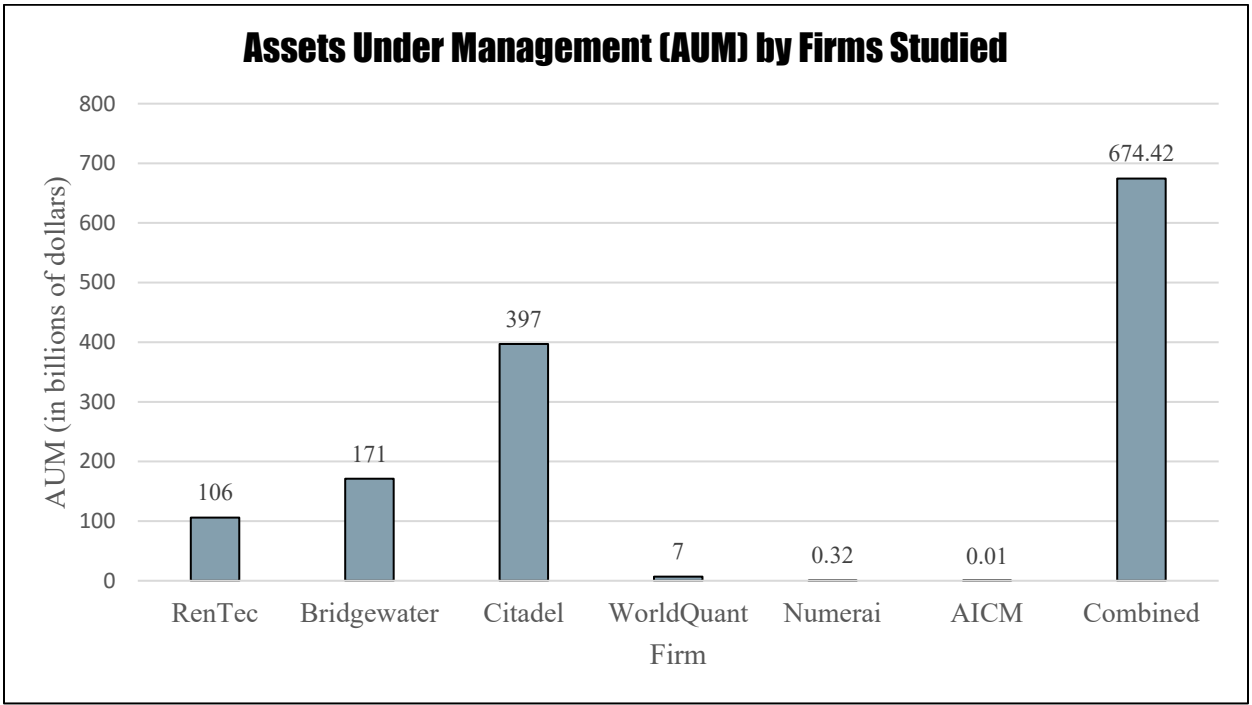

Figure 4. Assets Under Management (AUM) by Firms Studied[199]

B. Systems Definitions

[195] Numerai Briefing.
[196] Numerai, Home Page (accessed Jan. 29, 2024) (https://web.archive.org/web/20230918160238/https:/numer.ai/fund).
[197] *Id.*
[198] *Id.*
[199] Securities and Exchange Commission, *Renaissance Technologies LLC SEC Filing* (accessed Jan. 26, 2024) (https://reports.adviserinfo.sec.gov/reports/ADV/106661/PDF/106661.pdf); Securities and Exchange Commission, *Bridgewater Associates Filing* (accessed Jan. 24, 2024) (https://reports.adviserinfo.sec.gov/reports/ADV/105129/PDF/105129.pdf); Securities and Exchange Commission, *Citadel LLC and Citadel Investment Advisors Group Joint Filing* (accessed Jan. 29, 2024) (https://adviserinfo.sec.gov/firm/summary/148826); Written Response from AI Capital Management to Senate Committee on Homeland Security and Governmental Affairs Chairman Gary Peters (May 24, 2024); Numerai, Home Page (accessed Jan. 29, 2024) (https://web.archive.org/web/20230918160238/https:/numer.ai/fund); Email from Wilmer Cutler Pickering Hale and Dorr LLP, Counsel for WorldQuant, to Senate Committee on Homeland Security and Governmental Affairs Chairman Peters (June 10, 2024).

The hedge funds analyzed by Majority Committee staff provided different definitions for AI related technology and utilized a variety of terms when naming and defining their systems.[200] In particular, they provided a wide range of responses when defining "AI trading," despite similarly describing their systems and uses for their systems.[201] In interviews and responses to Majority Committee staff, certain firms provided definitions for "AI trading" while the majority did not use the term "AI" to define their systems rather subsuming AI into existing definitions related to automated trading.[202] The lack of consistency – and the lack of uniformly applicable definitions in rule or statute – causes a concerning lack of clarity over what technology is being used in the industry and how. Specifically, the lack of clarity around the definitions for AI and AI related technology used by hedge funds makes it difficult to understand what type of systems are in use, the associated risks with these systems, and what details should be provided in disclosures to clients.

AICM defined AI trading as a combination of strategies, such as quant and algo trading, that "centers on, but is not limited to, using complex models and functions to create a set of rules for trading."[203] According to AICM, a difference between AI trading and other strategies "is that AI trading can learn and update its rules to better adapt to the markets."[204] Numerai told the Committee it does not use AI trading, which it defined as "the use of fully autonomous systems to place trades into the market in the expectation of an investment return."[205]

In Citadel's response to Committee requests, it stated that "AI trading" "is not a term that is used by either Citadel or Citadel Securities." It further asserted that the company does not "understand [AI trading] to be generally used in the industry."[206] Citadel said it believes that the term "AI trading" "inaccurately represents quant and algo trading," strategies that have been around for decades and that can sometimes incorporate ML for pattern recognition.[207]

Like Citadel, WorldQuant told Majority Committee staff that it views AI as an umbrella term. WorldQuant defined AI as encompassing "various technologies such as [ML], deep learning, and generative AI."[208] WorldQuant defined ML as "an application of AI that uses algorithms to help computers learn from, and make decisions based upon, data without direct instruction by humans."[209]

RenTec does not label its systems as "AI trading" systems and sought to redefine the interpretation underpinning common use of the term "AI" stating that, "[w]hen most people say

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[200] Bridgewater, RenTec, Citadel, WorldQuant, AICM, and Numerai responses to Committee requests for information, on file with Committee.
[201] Nasdaq, Inc., *AI Trading – What is AI Trading & How It's Used in Stock Trading* (Dec. 4, 2023) (https://www.nasdaq.com/articles/ai-trading-what-is-ai-trading-how-its-used-in-stock-trading).
[202] Renaissance Technologies Briefing; Bridgewater Associates Briefing; Citadel Briefing; AI Capital Management Briefing; WorldQuant Briefing; Numerai Briefing.
[203] Letter from AI Capital Management.
[204] AI Capital Management Briefing.
[205] Letter from Numerai.
[206] Letter from Citadel.
[207] Citadel Briefing.
[208] Letter from WorldQuant.
[209] *Id*.

AI, we would like to translate that into machine learning. ML systems are the algorithms and statistical models that are used to draw conclusions from data."[210] RenTec told the Committee that it "has been using ML as a means for trading for at least 30 years."[211] RenTec acknowledged a distinction with the rise of more complex AI, stating "AI is commonly discussed today in the context of GPT [Generative Pre-Trained Transformer], DNN [Deep Neural Networks]." However, the company appeared to subsume this distinction under a broad ML umbrella, stating that "from our perspective we like to keep the definition [of AI] to just ML."[212] "AI trading," according to RenTec, is a form of quant trading, "[m]achine learning pushes quant trading to an extreme. AI trading comes under the rubric of quant trading."[213]

Bridgewater referred to its investment systems as "expert systems," a term it has historically used to refer to the building of an automated model that reflects a particular person's expertise.[214] In its briefing with the Committee, the firm stated that expert systems "could be considered under the broad AI model."[215] The company further indicated that these systems could be called "algo-trading or AI trading."[216] Generally, Bridgewater viewed AI as being "very broad," including both ML and GAI.[217] Bridgewater described ML as "the process of mathematical techniques to take data and produce an outcome based on a target."[218]

The way a company characterizes its AI/ML systems and uses impacts how investors are notified of the risks attributed to novel AI technologies. As such, the hedge funds' responses to the Committee have implications for both investors and regulators. For instance, RenTec, which appears to view AI and ML as merely another phase in the evolution of existing ML techniques, told Committee staff that disclosures regarding use of AI are provided upon investors' request. The company typically tells these investors, "we have been using the tools and techniques of machine learning for over 30 years."[219] In comparison, Bridgewater includes disclosures in offering materials that detail certain associated actual or perceived risks with the use of AI tools including general risk, implementation risk, and regulatory risk.[220]

C. Use of AI

As discussed in Section III above, hedge funds have long employed technology-based trading systems as part of their business models.[221] In recent years, funds have begun to create their own, or utilize commercially available, ML and AI systems.[222] As certain companies

[210] Renaissance Technologies Briefing.
[211] Letter from Renaissance Technologies.
[212] Renaissance Technologies Briefing.
[213] *Id*.
[214] Bridgewater Associates Briefing.
[215] Bridgewater Associates Briefing.
[216] *Id*.
[217] *Id*.
[218] *Id*.
[219] Renaissance Technologies Briefing.
[220] Letter from Bridgewater Associates.
[221] *See* Section III.
[222] *See* Section III.

indicated, versions of ML have been used for decades.[223] However, it is only in recent history that ML using more intricate neural networks has been used to recognize patterns among variables with complex and non-linear relationships.

Each of the firms told Majority Committee staff that, generally, the hedge funds do not use ML for conducting actual trades in the market independently of human involvement. Bridgewater told the Committee that it "is not currently utilizing machine learning systems in its investment process, with the exception of a narrow use case involving Trade Analytics personnel, to assist them in estimating transaction costs to help identify potential improvements to more traditional analytical, non-ML based models."[224] Citadel also stated that it does not use ML for automated trading because, in part, Citadel does not think the current tools are sufficient.[225] AICM stated that, while "people are always trying to find an edge in trading to increase profits … at the end of the day these are just tools, it does not make the decisions for investment management or the traders."[226] RenTec, which views AI as one of the latest developments in the evolution of ML, told the Committee that it "employs [such] advances when they prove useful to [RenTec's] business" without providing further detail.[227]

While each of the hedge funds explained that they do not use AI to fully and independently conduct trades, all told Majority Staff that AI/ML helps inform aspects of their trading decisions, including for data analysis and research.[228] Some hedge funds were open about their interests. For example, RenTech told Majority Committee staff that it intentionally brought in leadership and employees with ML background and that it uses ML "to extract information from large data sets and then use that information to trade in markets."[229] Additionally, WorldQuant stated that it has been using AI, defined broadly, for several years. WorldQuant allows employees to use certain AI tools for research, code editing, and in some instances, allows its portfolio managers to use ML systems to identify the best combination of trading signals to support their portfolio strategy.[230] Both AICM and Numerai were founded with the intention of relying on AI/ML systems. AICM specifically relies on AI/ML systems, while Numerai combines its AI/ML system with a crowdsource tournament.[231] AICM, which does not currently have external clients, told Majority staff that it uses AI to analyze data and inform investment decisions.[232]

Other hedge funds were less clear about their interests and intended uses for AI/ML. Citadel stated in responses to Majority Committee staff, that the company does not use ML for

[223] Citadel Briefing.
[224] Letter from Bridgewater Associates.
[225] Citadel Briefing.
[226] AI Capital Management Briefing.
[227] Renaissance Technologies Briefing.
[228] Letter from Renaissance Technologies; Renaissance Technologies Briefing; Letter from Bridgewater Associates; Bridgewater Associates Briefing; Letter from Citadel; Citadel Briefing; Letter from AI Capital Management; AI Capital Management Briefing; Letter from WorldQuant; WorldQuant Briefing; Letter from Numerai; Numerai Briefing.
[229] Renaissance Technologies Briefing.
[230] WorldQuant Briefing.
[231] Numerai Briefing; AI Capital Management Briefing.
[232] AI Capital Management Briefing.

fully automated trading, but does leverage ML to create some signals that are incorporated into quantitative or discretionary strategies.[233] Bridgewater told Majority Committee staff it has been exploring ML techniques for more than five years. According to the company, it is "not currently utilizing ML systems in its investment process, with the exception of a narrow use case…."[234] However, public reports indicate that it has plans for launching a fund that relies solely on various AI models to "execute investment strategies for a select group of clients" which, according to a 2023 report, will be used for every step in the fund's process of conducting trades.[235]

D. Development and Training of AI/ML Systems

Data Collection

More sophisticated forms of AI are trained on vast amounts of data and as a result can process and analyze significant volumes of information. However, this results in much more complex models for which accurate, diverse, and reliable data collection is even more important.

With respect to volume, hedge funds shared that their systems require vast amounts of inputs to perform. RenTec told the Committee it brings in around "ten terabytes per day, that is then added to [their] repository," and used for future simulations.[236] Data can come from a variety of sources, including third party data aggregators and vendors.[238] Standard categories of data used in hedge funds' AI/ML systems include price data, information from regulatory filings as well as from corporate filings, and specific data on areas of interest, such as data on equities and bonds.[239] Some hedge funds use data curated by its internal processes. For example, Numerai uses tournament data, a process where "Numerai's users submit stock predictions to [the company] daily."[240]

With respect to data reliability, hedge funds provided varying responses. Several hedge funds referenced the adage 'garbage in, garbage out' asserting that a top priority in developing more complex AI/ML systems was the assurance that reliable data, training, and organization was being utilized.[241] Curating data to ensure the data is not "garbage"

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[233] Citadel Briefing; Email from Akin Gump Strauss Hauer & Feld LLP, Counsel for Citadel, to Senate Committee on Homeland Security and Governmental Affairs Chairman Peters (June 10, 2024).
[234] Letter from Bridgewater Associates.
[235] *Bridgewater Assc. Looks to Future With New Automated AI Fund*, Wealth Advisor (Nov. 24, 2023) (https://www.thewealthadvisor.com/article/bridgewater-assc-looks-future-new-automated-ai-fund).
[236] Renaissance Technologies Briefing.
[238] Letter from Numerai; Renaissance Technologies Briefing.
[239] *See* Renaissance Technologies Briefing; Bridgewater Associates Briefing; Letter from AI Capital Management; Email from Akin Gump Strauss Hauer & Feld LLP, Counsel for Citadel, to Senate Committee on Homeland Security and Governmental Affairs Chairman Peters (Feb. 16, 2024); Letter from Numerai.
[240] Letter from Numerai.
[241] Renaissance Technologies Briefing; Citadel Briefing; AI Capital Management Briefing. *See also* Simon Jelley, *Garbage In, Garbage Out: The Role of Data Management in Effective AI*, Forbes (Nov. 16, 2023) (https://www.forbes.com/sites/forbesbusinesscouncil/2023/11/16/garbage-in-garbage-out-the-role-of-data-management-in-effective-ai/?sh=5b1a8745dbb0).

is key for accurate and effective AI/ML systems.[242] Citadel highlighted limitations with data collection regardless of accuracy. The company emphasized for Majority Committee staff that, even if all of the data is accurate and was reported correctly, some functions may still be inaccurately depicted.[243] AICM also highlighted concerns with "overfitting" which occurs when "the model learns every detail of the training data but is unable to generalize any useful knowledge when facing unseen data."[244] At present, AICM indicated that best method to address this concern is to use increasingly bigger datasets, however this is not possible in financial markets. According to AICM,

> Unlike image, voice, and words, financial data cannot be indefinitely generated as the market is path-dependent and we only have one path which is historical data. Overfitting the historical data is almost unavoidable and detrimental in the task, since trading decisions are continuous and every decision can be mission critical to the overall goal, either to achieve absolute return or beating certain benchmarks.[245]

Multiple hedge funds told Majority Committee staff that newly developed models are commonly tested by evaluating how they would have performed in the past using historical data.[246] However, back testing of an AI model would likely fail to adequately test the model's ability to search for patterns and accurately predict future trends during a period of unprecedented economic conditions.

Development

Each of the firms told Majority Committee staff they follow general scientific research processes when developing their AI/ML systems.[247] Hedge funds claim they develop systems through extensive research periods, followed by peer review and testing, prior to launching of the systems.[248] However, there is little government oversight over how these systems are developed to verify adequate development process. To ensure that hedge funds have used adequate data and developed their systems correctly, they must perform tests and reviews on their systems to ensure safety and accuracy.

Most hedge funds explained that they use base systems that employees then can make additions or changes to.[249] For example, RenTec told the Committee that it has three different trading systems, and researchers can contribute to the systems through proposing new models

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[242] Simon Jelley, *Garbage In, Garbage Out: The Role of Data Management in Effective AI*, Forbes (Nov. 16, 2023) (https://www.forbes.com/sites/forbesbusinesscouncil/2023/11/16/garbage-in-garbage-out-the-role-of-data-management-in-effective-ai/?sh=5b1a8745dbb0).
[243] Citadel Briefing.
[244] AI Capital Management Briefing.
[245] Letter from AI Capital Management.
[246] Letter from WorldQuant.
[247] Letter from Renaissance Technologies; Renaissance Technologies Briefing; Letter from Bridgewater Associates; Bridgewater Associates Briefing; Letter from Citadel; Citadel Briefing; Letter from AI Capital Management; AI Capital Management Briefing; Letter from WorldQuant; WorldQuant Briefing; Letter from Numerai; Numerai Briefing.
[248] *Id*.
[249] Renaissance Technologies Briefing; Bridgewater Associates Briefing; Numerai Briefing.

that make changes or additions to the systems.[250] Bridgewater has existing rules that produce outputs and a basis of understanding that researchers then build off of.[251] Researchers can explore and propose new additions or changes to the baseline models.[252]

By contrast, other hedge funds have created multiple models that employees may use in trading. For example, WorldQuant employees develop mathematical models, called alphas.[253] If the alpha successfully passes review and quality checks, it is stored WorldQuant's alpha library and portfolio managers may use the alpha as a component, in combination with other components, to create a strategy for trading.[254] AICM stated that it "elects to use smaller models that are understandable and manageable."[255] AICM uses these smaller models because it "prefer[s] to see how a model is deciding outcomes and [AICM] wants to optimize those strategies," rather than have an overarching complex model.[256]

Human Interaction and Quality Control

In interviews with Majority Committee staff, hedge funds said that humans are involved throughout the various stages of their AI systems' development and deployment. Regardless of whether an AI trading system is defined as an "expert system" or an AI/ML system, the systems are conceptualized, designed, researched, trained, tested, deployed, moderated, and reviewed by humans, at least as of the writing of this report.

All six hedge funds told Majority Committee staff that their systems are reviewed and moderated by humans.[257] All six hedge funds provided Majority Committee staff with explanations of systems review and testing processes during the development of their systems.[258] After deployment, all six hedge funds told Majority staff that they continue to run tests and reviews on models to evaluate their performance.[259]

Certain hedge funds have established procedures to approve an employee's use of AI. For instance, Bridgewater told Majority Committee staff, that the company had formed a working group to approve employee use for, and determine the governance of, "any employee use of AI for trading decisions or client communications before it is rolled out."[260] RenTec and

[250] Renaissance Technologies Briefing.
[251] Bridgewater Associates Briefing.
[252] *Id*.
[253] Letter from WorldQuant.
[254] *Id*.
[255] Letter from AI Capital Management.
[256] AI Capital Management Briefing.
[257] Letter from Renaissance Technologies; Renaissance Technologies Briefing; Letter from Bridgewater Associates; Bridgewater Associates Briefing; Letter from Citadel; Citadel Briefing; Letter from AI Capital Management; AI Capital Management Briefing; Letter from WorldQuant; WorldQuant Briefing; Letter from Numerai; Numerai Briefing.
[258] *Id*.
[259] *Id*.
[260] Bridgewater Associates Briefing.

Numerai told Majority Committee staff their firms require a review process with several steps and layers of approval by humans prior to deployment.[261]

Bridgewater and Numerai told Majority staff that they create an audit trail, allowing them to review the steps that led to trades being placed.[262] All six hedge funds explained the role of human moderation and review in their models' development processes. RenTec told Majority staff that it has humans monitoring the trades and results "around the clock."[263] Bridgewater also explained that its "employees, including its investment professionals, remain responsible for overseeing all aspects of the systematic process, including human oversight of inputs into and outputs from any ML system."[264] Smaller, start-up hedge funds also emphasized the role of human moderation in their funds, explaining that humans still play a large role in their systems.[265] For example, WorldQuant told the Committee that while portfolio managers (PMs) may use AI, "PMs still review investment strategies after deep learning processes are completed, and the resulting investment strategies are still subject to the customary testing and approval process before implementation in live trading."[266]

There are currently no regulations or requirements on how and when hedge funds must review and test their AI systems or when and whether a human must be involved in decision making, including related to trading decisions.[267] However, reviews and human moderation of systems are important because they help hedge funds to ensure their models are making accurate and reliable decisions. They also help to identify potential concerns and issues with models prior to their deployment, such as models that have conflicts of interest or make decisions that may not be in the best interest of the clients. While all hedge funds had review processes in place, Majority Committee staff found that this lack of consistency makes it difficult for clients and regulators to understand what steps hedge funds take to ensure safe and effective systems. It can also lead to hedge funds using AI systems with a wide range of efficacy, potentially causing harm to clients and market instability. Given that certain hedge funds are on the precipice of introducing fully automated AI trading systems despite emphasizing the much-needed human involvement in the development and deployment of these models, regulators should consider guidelines regarding the role of human moderation in the development and deployment of AI trading systems.

Statutory and Regulatory Compliance

To ensure compliance with statutory and regulatory requirements, hedge funds incorporate reviews into different stages of their development and deployment processes. RenTec documents all orders it places, and it tracks orders placed by ML systems the same as it

[261] Renaissance Technologies Briefing; Numerai Briefing; Letter from Numerai.
[262] Bridgewater Associates Briefing; Letter from Numerai.
[263] Renaissance Technologies Briefing.
[264] Letter from Bridgewater Associates.
[265] AI Capital Management Briefing; Letter from AI Capital Management; Numerai Briefing; Letter from Numerai; WorldQuant Briefing; Letter from WorldQuant.
[266] Letter from WorldQuant.
[267] *See* Section IV.

does for human traders.[268] Bridgewater claims to use ML in limited circumstances, and performs risk assessments when employees submit new requests for ML use.[269] Bridgewater told the Committee that it reviews for compliance issues at multiple points, including in the testing of systems during development and during implementation.[270] The company noted that existing compliance measures can address risks related to AI related technology stating, "we view [AI models and potential applications] as no different [from existing fiduciary responsibilities and security policies], it is just another type of tool that our investment folks might want to use, it has to satisfy the rules we already implement."[271] The company further told staff,

> We are already required to have policies that are reasonably designed to prevent misconduct. In communicating with clients or in providing investment advice – you need to have processes that facilitate understanding the inputs and the outputs and being able to explain them. You cannot just rely on outputs without having a reasonable process in place to address different regulatory considerations whether that's market manipulations, improper disclosure, risks with insider trading (in breach of confidentially), and data security issues, until we are comfortable with meeting the standards we have to meet, we cannot allow [the use of any technology].[272]

Hedge funds also incorporate compliance restrictions into their systems. For example, RenTec says it builds compliance into its systems by "hard cod[ing] limitations into [its] system," to help account for these restrictions.[273] Numerai also told the Committee that it builds compliance into its system, called an optimizer, along with other factors.[274] AICM explained that it currently does not take on external clients, but that "[i]n the event of taking on clients through a hedge fund structure, the methodology, investment goal and risk parameter of the fund will be disclosed to qualified investors."[275]

Under SEC rules, investment advisers must disclose to clients "methods of analysis, investment strategies and risk of loss."[276] While advisers are required to disclose "material risks," and in cases of "significant or unusual risks," advisers must "discuss these risks in detail."[277] Disclosures must be clear and informative enough that clients can consent to engaging with the hedge fund. The use of AI by hedge funds raises questions as to what is effective disclosure on the use of AI. All six hedge funds provide different levels of disclosures to clients with respect to information on their use of ML and AI.[278]

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[268] Renaissance Technologies Briefing.
[269] Letter from Bridgewater Associates.
[270] Bridgewater Associates Briefing.
[271] *Id*.
[272] *Id*.
[273] Renaissance Technologies Briefing.
[274] Numerai Briefing.
[275] Letter from AI Capital Management.
[276] Securities and Exchanges Commission, *General Instructions for Part 2 of Form ADV* (https://www.sec.gov/about/forms/formadv-part2.pdf).
[277] *Id*.
[278] Letter from Renaissance Technologies; Renaissance Technologies Briefing; Letter from Bridgewater Associates; Bridgewater Associates Briefing; Letter from Citadel; Citadel Briefing; Email from Akin Gump Strauss Hauer &

However, these disclosures tend to be high level and vague. For example, companies told majority committee staff that they inform clients of the potential use of AI and risks associated with the use.[279] But the information disclosed did not include details on the systems or AI development and use review processes. Not providing clear information on how systems are reviewed and tested for safety and accuracy calls into question whether clients have sufficient information to consent to the use of the technology.

VII. Increasing Use of AI in Financial Services Sector

The development and varying uses of AI/ML continues to expand, and a number of hedge funds are researching new ways to incorporate the technology into their systems and processes. For example, Bridgewater is currently limiting its ML use, but told Majority Committee staff that it "is actively exploring other potential ML applications and has been developing proprietary methods for years [and] expects that it will soon launch a small size allocation to one of its broader investment strategies that is based on ML."[280]

Another area of future growth is generative AI (GAI). GAI identifies patterns from bodies of information including language, similar to traditional AI systems.[281] However, unlike traditional AI systems, once a GAI system identifies the pattern, it then "generate[s] new content that may be similar, but not identical, to the underlying training data."[282] GAI is not currently being widely used by hedge funds for trading purposes. Some hedge funds told Majority Committee staff that, as of the date of their briefing, they have begun exploring the use of GAI but emphasized that they were not currently using the technology.[283]

Bridgewater and Citadel told Majority Committee staff that they have begun to research the use and benefits of GAI, but only in approved and closely monitored circumstances.[284] Public sources also indicate that Bridgewater has been experimenting with ChatGPT for trading, claiming that the OpenAI's GPT—3.5 and GPT—4 passed the company's investment associate test.[285] GAI enhances concerns related to the use of AI by hedge funds, discussed above, and also introduces new concerns. For example, the Government Accountability Office (GAO) has explained that GAI systems can produce 'hallucinations' which occurs when a system is unable

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Feld LLP, Counsel for Citadel, to Senate Committee on Homeland Security and Governmental Affairs Chairman Peters (Feb. 16, 2024); Letter from AI Capital Management; AI Capital Management Briefing; Letter from WorldQuant; WorldQuant Briefing; Letter from Numerai; Numerai Briefing.

[279] Letter from Renaissance Technologies; Letter from Bridgewater Associates; Citadel Briefing; Numerai Briefing; WorldQuant Briefing.

[280] Letter from Bridgewater Associates.

[281] Government Accountability Organization, *Science & Tech Spotlight: Generative AI* (GAO-23-106782) (June 2023).

[282] *Id*.

[283] Bridgewater Associates Briefing; Citadel Briefing.

[284] Bridgewater Associates Briefing; Citadel Briefing; Letter from Citadel.

[285] Mike Sak, *GPT-4 Passes Bridgewater's Investment Associate Test*, MLQ (2023) (https://www.mlq.ai/gpt-4-passes-bridgewaters-investment-associate-test/).

to provide a response to an information request or query and instead of disclosing that status, produces a false, inaccurate, or erroneous responses that appears credible.[286]

The use of AI outside of hedge funds and other investment vehicles can also pose risks to financial stability. For example, bad actors can use 'deep fake' content, or "AI-generated media that depict made-up events, sometimes quite realistically," to commit a range of financial crimes, including identity theft, scams, fraud, and market manipulation.[287] Deep fake technology also has the ability to amplify stock manipulation concerns "by generating seemingly credible false narratives," such as "fabricating the private remarks of a corporate leader."[288]

Precursor technology to AI, such as automated trading algorithms, reacting to false events can also have drastic impacts on the markets.[289] For example, on April 23, 2013, a foreign hacking group "hijacked the Twitter account for the Associated Press and then tweeted, 'Breaking: Two Explosions in the White House and Barack Obama is injured.'"[290] This incident led to a 'flash crash' where '[a]utomated trading algorithms drove much of the volume."[291] The introduction of deep fake content to these types of events only amplifies the potential risks. In May 2023, an AI generated photo of an explosion at the Pentagon had an impact on the stock market.[292] Public reports suggest that "the image was likely generated by artificial intelligence," and caused a brief drop in stock market indices.[293] While the markets quickly recovered, and tweets containing the image were deleted, the incident showed the impact that external uses of AI can have on financial stability.

VIII. Conclusion

AI development and use by hedge funds has become increasingly prevalent. While hedge funds have long used technology-based trading strategies, the hedge funds Majority Committee staff spoke with all acknowledged their increasing interest in expanded uses for AI and AI related technology. However, these hedge funds minimized risks associated with the use of AI technology, despite multiple federal regulators' recent identification of this technology as an area of concern. While hedge funds assured the committee that they conducted tests and reviews on their systems, under existing authorities, regulators have little insight into these processes and the results of these tests and reviews. Hedge funds' clients have equally limited insight into the systems and their uses, calling into questions whether enough information is disclosed to clients for them to effectively consent to their use in various trading decisions or benefit from perceived safeguards against potential conflicts of interest.

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[286] Government Accountability Organization, *Science & Tech Spotlight: Generative AI* (GAO-23-106782) (June 2023).
[287] Jon Bateman, *Deepfakes and Synthetic Media in the Financial System: Assessing Threat Scenarios*, Carnegie Endowment for International Peace (July 8, 2020) (https://carnegieendowment.org/2020/07/08/deepfakes-and-synthetic-media-in-financial-system-assessing-threat-scenarios-pub-82237).
[288] *Id*.
[289] *Id*.
[290] *Id*.
[291] *Id*.
[292] Shannon Bond, *Fake viral images of an explosion at the Pentagon were probably created by AI*, NPR (May 22, 2023) (https://www.npr.org/2023/05/22/1177590231/fake-viral-images-of-an-explosion-at-the-pentagon-were-probably-created-by-ai).
[293] *Id*.

While the SEC, CFTC, and other regulators that oversee hedge funds have recently begun to explore the impact of AI on the financial services sector, these regulators have not clarified how existing frameworks apply to the use of these technologies nor proposed rules to sufficiently consider potential gaps in existing regulations. Current and planned efforts do not adequately address the risks – both to investors and markets – presented by hedge funds' use of AI to inform trading decisions.

Use of AI by hedge funds poses unique risks and amplifies traditional risks. While this report focuses on hedge funds' evolving uses of AI/ML to inform trading decisions, the risks identified have the potential to negatively impact individuals and investors across the financial services sector, including, for example, private funds, mutual funds, and other investment advisors. As such, the recommendations in this report should be considered across the financial services sector.

Congress and regulators must act to address the amplified risks adoption of AI/ML technologies pose for longstanding concerns related to herding, market manipulation, and broader financial market stability identified in this report. External AI use, such as the use of AI generated content to manipulate markets, can also amplify risks for market stability. As GAI becomes a growing consideration by market actors, including in the financial services sector, its evolving uses will also further exacerbate these risks unless Congress and relevant regulatory agencies establish baseline universally applicable rules for use and reporting.