HARVARD LAW SCHOOL | The Case Studies

Algorithmic Trading Strategies

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Memorandum

TO: Special Counsel, CFTC Division of Market Oversight
FROM: Director, CFTC Division of Market Oversight
RE: Algorithmic Trading and Regulation Automated Trading
DATE: January 9, 2020

Welcome to DMO. I'm confident that you'll find the position a challenging one, and I've already got a meaty topic to get you started on.

I recently received an email from the Chairman expressing his concerns regarding the negative effects of algorithmic trading on financial markets. The Chairman is convinced that the CFTC should have direct access to trading systems' source code to prevent potential market abuses with systemic implications. To that end, the Chairman proposes we reconsider Regulation Automated Trading ("Regulation AT") which would require all traders using algorithms to register with the CFTC and would give CFTC direct and unfettered access to their source code. Please find attached the Chairman's email which outlines his priorities and main concerns pertaining to algorithmic trading. In addition, I have sketched out my own reactions to reconsidering Regulation AT in an informal memo, attached as Appendix I. In addition, you may find it useful to refer to a legal intern's memoranda, attached as Appendix II, which offers a brief overview of Regulation AT, its history, and a short discussion of other regulators' efforts to address algorithmic trading.

After considering these materials, please come and brief me on the following questions:

- What, precisely, are the public policy challenges posed by the emergence of algorithmic trading, and does this practice pose any serious problems to U.S. capital markets?

- To what extent are there legal or policy problems with implementing a regime of the sort contemplated in the revised version of Regulation AT?

- If the Commission chooses to take up the issue of direct access to source code as the Chairman seems to want, are there other approaches to the issue that might be preferable to the approach that the revised Regulation AT contemplated?

In answering the above questions, please focus your presentation on potential reform proposals. Specifically, the presentation should indicate how a proposal (or aspects of a proposal) address or solve (at least some of) the issues raised in the materials below.

In preparing for the briefing, please make sure that you examine the supplemental materials that my other DMO staff members have gathered on the topic, attached as Appendices III – XII, which should provide both useful background as well as more tendentious perspectives from a variety of interested parties. Appendix II contains some information pertaining to the ways in which other actors have sought to address the problems raised by HFT and algorithmic trading. Appendix VI also addresses these alternative proposals in sections IV(B) and IV(C). When answering the questions framed above, please bear in mind that there may be overlapping or different concerns raised by the Chairman, the legal intern, and me. Please address the concerns raised by the incoming Chairman in the detailed email below. I think that you will find that all three of these documents may raise important implications for your analysis.

CFTC CHAIRMAN SMITH EMAIL

TO: Director, CFTC Division of Market Oversight
FROM: CFTC Chairman
SUBJECT: Algorithmic Trading – Reviving Regulation Automated Trading
DATE: April 12, 2019

Dear DMO Director:

I am writing to request your advice on the possibility of reviving plans to regulate algorithmic trading. In 2015, the CFTC proposed Regulation Automated Trading ("Regulation AT") largely as a regulatory response to the events of May 6, 2010, better known as the *Flash Crash*.[1] As you know, during this event, the use of an automated trading algorithm caused major U.S. equity indices to plummet 5 to 6% and rebound almost instantly.[2] Due to a lack of visibility in the market, it took the CFTC and SEC four months to identify potential causes of this market failure that took a mere 20 minutes to unfold.[3] Both the reasons for this incident and the identity of those responsible remain highly contested.[4] This investigation formed part of the basis for Regulation AT. A key component of the proposed rule would require automated trading firms to allow the CFTC to inspect the source code of these trading algorithms. However, due to

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[1] *CFTC Unanimously Approves Proposed Rule on Automated Trading*, U.S. COMMODITY FUTURES TRADING COMMISSION (Nov. 24, 2015), https://www.cftc.gov/PressRoom/PressReleases/pr7283-15 [https://perma.cc/R5R5-LCRV].
[2] Jill Treanor, *The 2010 "flash crash": how it unfolded,* THE GUARDIAN (April 22, 2015), https://www.theguardian.com/business/2015/apr/22/2010-flash-crash-new-york-stock-exchange-unfolded; Report of the Staffs of the CFTC and SEC to the Joint Advisory Committee on Emerging Regulatory Issues, *Findings Regarding the Market Events of May 6, 2010*, 104 (2010).
[3] Dave Michaels et al., *Flash Crash Arrest Shows Lack Of Market Regulation*, AUSTRALIAN FINANCIAL REVIEW (Apr. 23, 2015), https://www.afr.com/markets/equity-markets/flash-crash-arrest-shows-lack-of-market-regulation-20150423-1mrayk [https://perma.cc/42R4-T3SB].
[4] Matt Levine, *Guy Trading at Home Caused the Flash Crash*, BLOOMBERG (Apr. 21, 2015), https://www.bloomberg.com/opinion/articles/2015-04-21/guy-trading-at-home-caused-the-flash-crash.

its controversial nature and industry pushback, the CFTC subsequently abandoned Regulation AT. Then Commissioner Brian Quintenz famously pronounced Regulation AT "D-E-A-D."[5]

To me, the most critical component of Regulation AT pertains to gaining access to the relevant source code. However, regardless, I believe that the subsequent failure of the CFTC to regulate automated trading in any capacity was a mistake. I still have grave concerns over the nature and use of automated trading, which I have briefly sketched out below:

Main Concerns Regarding Algorithmic Trading

1.   Market Stability

A chief concern is the effect of algorithmic trading on market stability. The 2010 Flash Crash showcased how rapid algorithmic trading can quickly lead to a widespread destabilization of the market. It turns out that the Flash Crash was not an isolated incident. Since then there have been thousands of flash crashes, some of which have considerably disrupted the market.[6] These flash crashes have mostly been attributed to or said to have been exacerbated by algorithmic trading.[7] Furthermore, many highly reputable market analysts and financial regulators (including the Bank of England)[8] have warned that further market crashes are likely.[9] More troubling, these reports warn that if a flash crash were to occur during a recession (heretofore all flash crashes have taken place during favorable economic conditions), the negative impact would be greatly multiplied and could lead to a serious liquidity crisis.

I believe that there are two issues at the root of the threat to market stability. The first issue is the near-instantaneous nature of algorithmic trades. Algorithms are programmed to perform thousands of trades in mere seconds, and the smallest error in the programming language of an algorithm can cause major market disruptions. These disruptions can cause catastrophic damage to the financial system and investors may suffer huge losses before intervention is possible. Temple Law School Professor Tom Lin has described the resulting systemic risk as "too fast to save."[10]

The second issue stems from the linked or connected nature of modern markets. Some argue that electronic trading has greatly exacerbated the interconnectedness of markets. Given the new forms of market interconnectedness,[11] these disruptions are liable to have ripple effects and cause market distress.[12] For example, one false tweet regarding explosions in the White House caused algorithms linked

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[5] *CFTC commissioner: plans to seize algo trading source code are "D-E-A-D",* Finextra Research (Oct. 5, 2017), https://www.finextra.com/newsarticle/31157/cftc-commissioner-plans-to-seize-algo-trading-source-code-are-d-e-a-d [https://perma.cc/UV8D-6H89].

[6] Jean-Philippe Serbera, *Flash crashes: if reforms aren't ramped up, the next one could spell global disaster*, The Conversation (Jan. 7, 2019) ://theconversation.com/flash-crahttpsshes-if-reforms-arent-ramped-up-the-next-one-could-spell-global-disaster-109362 [https://perma.cc/6TF8-ETTK] (giving an overview of flash crashes which have occurred since 2010).

[7] Michelle Fox, *SEC "has" to investigate Christmas Eve sell-off, says ex-SEC attorney*, CNBC (Jan. 24, 2019), https://www.cnbc.com/2019/01/24/sec-has-to-investigate-christmas-eve-sell-off-says-ex-sec-attorney.html [https://perma.cc/Z2KM-LETV] (blaming HFT for 2018 Christmas Eve crash); Wayne Cole & Swati Pandey, *Japanese Yen Soars As "Flash Crash" Sweeps Currency Market*, Reuters (Jan. 2, 2019), https://www.reuters.com/article/us-markets-forex/japanese-yen-soars-as-flash-crash-sweeps-currency-market-idUSKCN1OW1UH [https://perma.cc/M53V-WPS2](Algorithms said to have exacerbated the flash crash of the yen); Giovanni Cespa & Xavier Vives, High Frequency Trading and Fragility, ECB Working paper (2017), https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp2020.en.pdf?f0853c8630ef920d9429e31ff85b2682; Netty Ismail & Lukanyo Mnyanda, *Pound's Flash Crash Has Traders Blaming Algos for Selling Frenzy,* Bloomberg Briefs (Oct. 07, 2016), https://www.bloomberg.com/professional/blog/pounds-flash-crash/ (algorithms blamed for British Pound Crash).

[8] Patrick Graham, *UPDATE 1-Bank Of England's Salmon Says Brace For Further Flash Crashes*, Reuters (Jan. 24, 2017) https://www.reuters.com/article/britain-boe-flashcrash/update-1-bank-of-englands-salmon-says-brace-for-further-flash-crashes-idUSL5N1FE6IF [https://perma.cc/KQ2T-97GA].

[9] Thomas Heath, *The Warning From JPMorgan About Flash Crashes Ahead*, The Washington Post (Sept. 5, 2018), https://www.washingtonpost.com/business/economy/the-warning-from-jpmorgan-about-flash-crashes-ahead/2018/09/05/25b1f90a-b148-11e8-a20b-5f4f84429666_story.html?utm_term=.21f78c4f8358 [https://perma.cc/ER85-3GQY].

[10] Tom C.W. Lin, *The New Investor*, 60 UCLA L. Rev. 678, 711-14 (2013) https://www.uclalawreview.org/the-new-investor-2/ [https://perma.cc/M4H6-7NUC].

[11] *Id.* at 714.

[12] Dave Michaels, *Machine Trading Needs More Oversight, Departing SEC Official Says*, Wall Street Journal (December 21, 2018),

to social media to begin executing certain trades. This one incident caused the S&P 500 Index to lose more than $135 billion of value in mere seconds following the post.[13] Both the speed of algorithmic trading and the linked nature of financial markets demonstrate how algorithmic trading can have negative effects on overall market stability.

The potential for information monoculture only enhances these systemic risks. For example, if trading algorithms used by multiple market participants all rely on the same sources of information or contain the same coding or design error (such as the above-mentioned tweet), this could trigger a cascade of erroneous trades. Because artificial intelligence may become embedded in these algorithms, there is also a risk that independently developed algorithms may "learn" to perform the same trading strategy. A number of algorithms engaged in similar or connected trading would significantly heighten systemic risk.[14]

2. Market Manipulation and Investor Confidence

Another concern prompting me to reconsider Regulation AT is how algorithmic trading has led to new techniques to manipulate the market and the resulting erosion of investor trust in financial markets. These new forms of manipulative conduct have prompted investors and academics to speculate whether the "market is rigged."[15] A prime example of market manipulation is how high-frequency traders place servers within dark-pool data centers to get information regarding stock orders before other market participants. Once the traders receive information regarding the upcoming purchase, they leverage their superior trading speed to buy the assets in question. Thus, the original purchaser has no other option but to acquire the assets from the high-frequency trader at a premium.[16] This technique is most commonly referred to as "front-running." A further problem is that exchanges actively participate in these practices by charging higher prices for placing servers closer to the exchange system.[17] Other malicious practices include taking advantage of the fragmented nature of the market to perform spoofing,[18] and pinging,[19] which are currently happening on an unprecedented scale.

3. Market Opacity and Insufficient Information

My third concern is that neither the CFTC nor other U.S. financial regulators have enough visibility into the market.[20] The fallout from the Flash Crash clearly demonstrated how difficult it is for regulators to determine the reasons for a crash or ascribe responsibility to individuated manipulative practices.[21] Part of the difficulty is proving the requisite intent in cases where there might not even be a paper trail to follow (such as a silent change of source code).[22] Indeed, a source of academic debate is whether the

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https://www.wsj.com/articles/machine-trading-needs-more-oversight-departing-sec-official-says-11545404400.

[13] Mark Prigg, *The tweet that cost $139 BILLION: Researchers analyse impact of hacked message claiming President Obama had been injured by White House explosion*, DAILY MAIL ONLINE (MAY 20, 2015), https://www.dailymail.co.uk/sciencetech/article-3090221/The-tweet-cost-139-BILLION-Researchers-analyse-impact-hacked-message-claiming-President-Obama-injured-White-House-explosion.html [https://perma.cc/2FW6-X2SD].

[14] Lin, *supra* note 10, at 25.

[15] Kamal Ahmed, *'The market is rigged' - Michael Lewis*, BBC NEWS (April 10, 2015), https://www.bbc.com/news/business-32246655 [https://perma.cc/EY64-CVFL].

[16] Jacob Adrian, *Informational Inequality: How High Frequency Traders Use Premier Access to Information to Prey on Institutional Investors*, 14 TECHNOLOGY REVIEW 24 (2016).

[17] *Id.*

[18] Matthew Leising, *Spoofing*, BLOOMBERG (Jan. 19, 2017), https://www.bloomberg.com/quicktake/spoofing (Citigroup recently fined $25M for spoofing. Spoofing is the practice of asking or bidding then canceling before the order is executed. This creates the illusion that the market is moving. Traders thus benefit from the actual increase in value resulting from market optimism).

[19] Gregory Scopino, *The (Questionable) Legality of High-Speed "Pinging" and "Front Running" in the Futures Market,* 47 CONN. L. REV. 607, 611-2 (2015) (involves placing small orders in the market at different price levels to detect large trading orders and accordingly trade ahead).

[20] Luis A. Aguilar, Commissioner, SEC, Keynote Address at the Georgia Law Review Annual Symposium: Preparing for the Regulatory Challenges of the 21st Century (Mar. 20, 2015) (transcript available at https://www.sec.gov/news/speech/preparing-for-regulatory-challenges-of-21st-century.html [https://perma.cc/EH3Q-6WBC].

[21] Levine, *supra* note 4.

[22] Gregory Scopino, Special Counsel, CFTC, Remarks at the 23rd Annual Financial Markets Conference: Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies, and Strategies (May 2018) (transcript available at https://www.frbatlanta.org/news/conferences-and-events/conferences/2018/0506-financial-markets-conference/transcripts/research-papers/scherer-regulating-artificial-intelligence-systems-

current regulatory regime is adequate to combat these malicious practices.[23] As markets become increasingly more complex and fragmented, the lack of access to critical data becomes more acute.[24]

The Solution: Reviving Regulation AT

The CFTC is mandated to guard against financial crises and to foster open, transparent, competitive and financially sound markets.[25] The CFTC cannot fulfill its mandate without regulating algorithmic trading and banning manipulative practices. I am committed to providing overdue guidance and regulation on this issue. In addition, I believe that worries over this Regulation's impact on algorithmic trading are overblown. For example, columnist Matt Levine opined that "[t]he thing is, high-frequency trading just isn't that important" and ought not lead to such intense emotional debate.[26]

Furthermore, I fervently believe that this issue cannot be effectively regulated without reserving source code access to the CFTC, and that the source code provisions are the most crucial component of the overall Regulation AT framework. The CFTC needs access to source code in order to accurately and quickly identify algorithmic trading practices that may lead to systemic risk.[27] Access to source code would essentially provide the CFTC with the ability to preempt and possibly even *prevent* flash crashes, as well as more easily reconstruct market events and determine their causes post hoc. I therefore propose that the CFTC reconsider Regulation AT.

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risks-challenges-competencies-strategies.aspx [https://perma.cc/EH3Q-6WBC] (describing the difficulty of proving intent given the new possibility of misconduct without a paper trail, save source code).

[23] *See* Gregory Scopino, *Do Automated Trading Systems Dream of Manipulating the Price of Futures Contracts? Policing Markets for Improper Trading Practices by Algorithmic Robots*, 67 FLA. L. REV. 221 (2016). *See also generally,* Tom C.W. Lin, *The New Market Manipulation*, 66 Emory L.J. 1253 at 1288-90 (2017).

[24] Aguilar, *supra* note 20.

[25] *Mission & Responsibilities*, U.S. COMMODITY FUTURES TRADING COMMISSION, https://www.cftc.gov/About/MissionResponsibilities/index.htm [https://perma.cc/56V8-3LXW] (last visited May 15, 2019).

[26] *See* Matt Levine, *Source Code and Chicken Indexes*, Bloomberg (November 7, 2016), https://www.bloomberg.com/opinion/articles/2016-11-07/source-code-and-chicken-indexes (last visited January 23, 2019).

[27] *See* Michael Morelli, *Regulating Secondary Markets in the High Frequency Age: A Principled and Coordinated Approach*, 6 Mich. Bus. & Entrepreneurial L. Rev. 79 (2016).

Appendix I: DMO Director Memorandum

TO: CFTC DMO Staff
FROM: Director, CFTC Division of Market Oversight
RE: Regulation AT Considerations
DATE: July 22, 2019

Memorandum

Background:

This memo highlights my concerns with the requirement in Regulation AT that would grant the CFTC direct access to source code. The most important issues that ought to be considered are market manipulation, governmental use of algorithms, governmental oversight issues, constitutionality concerns, beneficial aspects of HFT and cybersecurity.

I.   Market Manipulation

The Chairman mentioned before that investors and academics have highlighted that algorithmic trading has created the potential for new forms of market manipulation. However, I think that this issue is so crucial that I write separately to emphasize that the market impact of manipulative practices must not be underestimated. First, manipulative practices contribute to a shift in asset prices that is unrelated to a change in expectations regarding the future cash flows of the assets. This results in "artificial prices" and inhibits market efficiency.[1] It can also harm market "fairness" as investors find out the true value of the asset when its price is eventually corrected.[2] Second, wary of falling prey to manipulators who are better informed of future price changes, liquidity providers widen their bid-ask spread, heightening transaction costs.[3] This, in turn, deters market participants from trading, which results in decreased market liquidity. Thus, market manipulation negatively affects "both of the market's core social functions – facilitating liquidity and enhancing price accuracy."[4]

Despite near universal agreement that "market manipulation" ought to be outlawed (its codification came in the form of the 1934 Securities Exchange Act)[5], there is no consensus over which practices are "manipulative" based on two main reasons. First, the legal definition of market manipulation is overbroad. Second, it is very difficult in practice to distinguish illegitimate practices from legitimate trading.[6] Because trading in securities, even when it results in an impact on price, is otherwise legitimate, the element that differentiates market manipulation from market trading is a showing of *manipulative intent*.[7] However,

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[1] *See* Merritt B. Fox, Lawrence R. Glosten, & Gabriel V. Rauterberg, *Stock Market Manipulation and Its Regulation*, 35 YALE JOURNAL ON REGULATION 61, 73 (2018).
[2] *Id.*
[3] *Id.* at *102.*
[4] *Id.* at 73.
[5] *See* Jerry W. Markham, *Law Enforcement and the History of Financial Market Manipulation* 53-6 (2015).
[6] *See* Ignacio Orellana Garcia, Market Manipulation In The Age Of Machines: An Analysis Of Two Trading Strategies (May, 2019) (unpublished LL.M Paper, Harvard Law School) (on file with Harvard University Library system).
[7] *Id.* at 69; *see also* Orellana, *supra* note 6 (citing *Ernst & Ernst v. Hochfelder*, 425 U.S. 185, 198, (1976), where the Court described market manipulation as "*intentional or willful* conduct designed to deceive or defraud investors by controlling or artificially affecting the price of securities." (emphasis added)).

when trades are facially legitimate, proof of manipulative intent requires nothing less than a "smoking gun,"[8] such as discussion of the strategy in written correspondence. As CFTC Special Counsel Gregory A. Scopino notes, in the age of algorithms where a manipulative strategy is simply programmed into a trading platform, a sufficient paper trail may not exist.[9] Therefore, in many cases, source code itself can become the "smoking gun" regulators need to prove scienter.

Algorithmic trading has introduced a new dimension to this debate. As commenters have noted, high-frequency traders are increasingly using their superior trading speeds to submit orders and cancel them in fractions of a second. These practices can harbor an intent to move the stock price in their desired direction (spoofing) or find out the price point at which market participants are willing to trade (pinging). High frequency traders also harness their speed to trade ahead of known future price changes (front-running). These new practices are accurately described and helpfully put in parallel with traditional forms of manipulation in an article by Professor Tom Lin, which has been provided for your reference as Appendix VII.[10] Some argue that high frequency traders use these practices to prey on unsuspecting market participants and make considerable profits at the expense of investors and the marketplace.

II.   Government Usage of Algorithms

Governmental entities are also increasingly using algorithms to make decisions affecting the lives of millions of Americans. Algorithms have played a role in decisions on Medicare eligibility, school placement, and even criminal sentencing. Although these decisions may have a tremendous impact on individuals, governmental algorithms generally remain completely outside of the scope of public scrutiny. These automated decision systems are sometimes deployed without public knowledge, and the government does not explain how these decisions were made. As a result, people have less power to question or appeal them.[11] Just as regulators have been trying to access private (*e.g.*, company) algorithmic source code, academics, NGOs, and civil rights advocates have been pressuring government agencies to publicize information regarding governmental algorithms.[12] Some even argue that keeping these algorithms secret goes against the idea of a democratic government and threatens the rule of law.[13] Despite calls for reform, governmental agencies have repeatedly refused to make public the source code they utilize and argue that algorithms are not "agency records" or "records" subject to disclosure. In addition, they argue that these algorithms fall under the trade secret exemption of the Freedom of Information Act ("FOIA") allowing records to be withheld if releasing them would harm a company's competitive advantage.[14]

One recent high-profile incident captures this potential hypocrisy.[15] In 2017, New York City Council Member James Vacca drafted a bill mandating that city agencies make publicly available any source code

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[8] Yesha Yadav, *The Failure of Liability in Modern Markets*, 102 VIR. L. REV. 1031, 1053 (2016).
[9] Gregory Scopino, Special Counsel, CFTC, Remarks at the 23rd Annual Financial Markets Conference: Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies, and Strategies (May 2018) (transcript available at https://www.frbatlanta.org/news/conferences-and-events/conferences/2018/0506-financial-markets-conference/transcripts/research-papers/scherer-regulating-artificial-intelligence-systems-risks-challenges-competencies-strategies.aspx [https://perma.cc/EH3Q-6WBC] (describing the difficulty of proving intent given the new possibility of misconduct without a paper trail, save source code).
[10] Tom C.W. Lin, *The New Market Manipulation*, 66 EMORY L.J. 1253, 1280-92 (2017).
[11] Dillon Reisman, Jason Schultz, Kate Crawford & Meredith Whittaker, *Algorithmic Impact Assessments: A Practical Framework for Public Agency Accountability*, AI NOW, April, 2018, https://ainowinstitute.org/aiareport2018.pdf [https://perma.cc/2WGG-DARB].
[12] *See*, Sonia K. Katyal, *Private Accountability in the Age of Artificial Intelligence*, 66 UCLA L. Rev. 54, 2019; Tom Simonite, *AI Experts Want To End 'Black Box' Algorithms In Government*, WIRED, Oct. 18, 2017, https://www.wired.com/story/ai-experts-want-to-end-black-box-algorithms-in-government/ [https://perma.cc/389X-T239]; Julia Angwin, *Make Algorithms Accountable*, THE NEW YORK TIMES, Aug. 1, 2016), https://www.nytimes.com/2016/08/01/opinion/make-algorithms-accountable.html [https://perma.cc/7YLX-D4V6]; Saranya Vijayakumar, *Algorithmic Decision-Making*, HARVARD POLITICAL REV. ,June 28, 2017, http://harvardpolitics.com/covers/algorithmic-decision-making-to-what-extent-should-computers-make-decisions-for-society/.
[13] David S. Levine, *Secrecy and Unaccountability: Trade Secrets in Our Public Infrastructure*, 59 Fla. L. Rev. 135, 138 (2017).
[14] Freedom of Information Act 5 U.S.C § 552(b) (4) (2000). *See* Katherine Fink, *Opening the government's black boxes: freedom of information and algorithmic accountability*, 21 Information, Communication & Society (discussion of Exemption 4 in the context of algorithms).
[15] Julia Powles, , THE NEW YORKER (Dec. 20, 2017), https://www.newyorker.com/tech/annals-of-technology/new-york-citys-bold-flawed-attempt-

used in an automated-decision system.[16] New York City Mayor Bill de Blasio opposed the idea.[17] He voiced concerns that this proposal would threaten government cybersecurity and the intellectual property rights of certain companies, and would violate procurement agreements with vendors—dissuading them from further contracting with the city.[18] Thereafter, the bill was significantly altered and forfeited the disclosure requirements.[19]

Similarly, in the context of stress tests, some theorists argue that increasing demands by regulators for more information from regulated entities weakens the ability of the regulator to, in turn, deny requests for disclosing their own internal documents or algorithms. For example, Professor Hal Scott believes that the Federal Reserve ought to follow a normal notice-and-comment regulatory process which could involve the Fed disclosing more of its internal examination documents.[20] It could similarly be argued that it would be difficult for the CFTC to continue to refuse to disclose its own algorithms used to detect manipulative practices while demanding access to the source code of high frequency traders. Industry groups could point to a concrete example of information withheld by the CFTC and, perhaps, legitimize their resistance to source code access.

III. Regulatory Secrecy

A culture of supervisory confidentiality has historically existed in the banking sector.[21] Since the 1800s, bank examinations have been conducted under a cloak of secrecy and kept in place by the criminalization of "spreading false rumors about a bank."[22] The traditional view is that confidential bank examination is necessary to prevent a "run on the banks" if the examination yields negative results. A further justification has been the need for a direct line of communication between the regulator and the financial institution uninhibited by any fear of disclosure to the general public.[23]

Ironically, federal financial regulators used the passage of FOIA to expand the scope of the confidentiality requirement.[24] FOIA exempts information "contained in or related to examination . . . by an agency responsible for the regulation or supervision of financial institutions."[25] This has given regulators leeway to promulgate rules asserting that examinations are the property of the regulator and imposing further constraints on their disclosure. As a result, financial institutions are not allowed to disclose "confidential supervisory information,"[26] such as CAMELS ratings which evaluate a bank's overall health. Moreover, while sharing confidential supervisory information ("CSI") *within* the banking organization is generally permitted, the OCC has limited sharing to situations where it is "necessary or appropriate for business purposes."[27]

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to-make-algorithms-accountable.
[16] *Id.*
[17] Lauren Kirchner, *Federal Judge Unseals New York Crime Lab's Software for Analyzing DNA Evidence*, ProPublica (Oct. 20, 2017, 08:00 AM), https://www.propublica.org/article/federal-judge-unseals-new-york-crime-labs-software-for-analyzing-dna-evidence.
[18] *Id.*
[19] Powles, *supra* note 15.
[20] *See* Hal Scott, Stress Tests: Restore Compliance with the APA, THE CLEARING HOUSE, (2017), https://www.theclearinghouse.org/banking-perspectives/2017/2017-q3-banking-perspectives/articles/stress-tests-apa-compliance.
[21] Margaret E. Tahyar, *Are Bank Regulators Special?*, TCH BANKING PERSPECTIVES, https://www.theclearinghouse.org/banking-perspectives/2018/2018-q1-banking-perspectives/articles/are-bank-regulators-special [https://perma.cc/42XS-5T8U] (last visited May 5, 2019).
[22] *See Guidance, Supervisory Expectations, and the Rule of Law: How do the Banking Agencies Regulate and Supervise Institutions*: *Hearing before the S. Comm. On Banking, Housing, and Urban Affairs*, 116th Cong. (2019). (Statement of Margaret E. Tahyar, Partner, Davis Polk & Wardwell LLP), https://www.banking.senate.gov/imo/media/doc/Tahyar%20Testimony%204-30-19.pdf.
[23] *Id.*
[24] *Id.*
[25] 5 U.S.C. § 552(b)(8) (2016).
[26] 12 CFR § 4.32(b) (1995); *see also* Clifford S. Stanford, *Towards A Coherent and Consistent Framework for Treatment of Confidential Supervisory Information*, 22 N.C. BANKING INST. 41, 46 (2018) (Confidential Supervisory information is defined as any information related to an examination, inspection or other visitation of a financial institution prepared by on behalf of or for the use of financial regulatory agencies).
[27] 12 C.F.R. § 4.37(b)(2).

This legal framework, founded in the 1960s, does not account for the volume of information currently generated by financial institutions on a daily basis. The broad definition of CSI could theoretically encompass every email, file and megabyte of data shared with the regulator.[28] Because regulators consider CSI to be their property, its theft or misuse implies criminal liability. Thus, financial institutions and their personnel now daily operate with the constant threat of criminal liability for the "property" of financial regulators.[29]

The confidentiality of supervisory information has given regulators unchecked discretionary power and a culture of "secret guidance and secret lore".[30] The theory and logic behind banking supervision is shrouded in secrecy and inaccessible even to financial entities subject to supervision. In some instances, rules of behavior and conduct were not even disclosed to the supervised entities. Indeed, they were not even written down anywhere. Rather, they are passed down orally from experienced federal employees to new hires like "gnostic secrets…transmitted…from shaman to novice."[31] Supervised entities operate in an environment where they are not even allowed to know the rules for how they ought to behave, which, in turn, increases the risk that regulators will arbitrarily punish supervised entities for unrelated reasons.

While CSI materials are primarily utilized by other regulatory entities, the CFTC has analogous procedures whereby they also receive confidential information of a proprietary nature. The CFTC routinely requests and receives similar sensitive information from its own regulated entities which may give rise to worries that similar problems may plague the relationship between financial institutions and the CFTC regulators. Specifically, there may be similar restrictions on the ability of the regulated entities (expanded under Regulation AT) to disclose or disseminate information that had been shared with CFTC regulators as part of regulatory requirements.

IV. Punitive Regulators

Similarly, this culture of secrecy has also allowed regulators to engage in the practice of "regulation by negotiation" whereby regulators attempt to use the power disparity to achieve unrelated ends or use underhanded methods, such as unlimited delays and silence, to achieve a preferred result. For example, three financial institutions "voluntarily" consented to limit their market share in exchange for having an application expedited to the Federal Reserve.[32] With regulators unwilling to disclose certain supervisory practices, some argue that it seems unfair that banking organizations have been required to disclose infinitely more information following the strong tilt towards transparency and accountability prompted by the New Deal.[33] Some argue that the proposed request for direct access to source code is another, more extreme, example of the trend to impose heavy transparency requirements on banking organizations. However, given the different roles played by financial institutions and financial regulators as well as their different goals, it may be rational to have different transparency schemes for each type of actor.

V. Benefits of High Frequency Trading

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[28] *See* Hearings, *supra* note 22.
[29] *Id.* at 6.
[30] *Id.* at 9.
[31] *Id.* (citing Board of Governors of the Federal Reserve System, Transcript Open Board Meeting on April 23, 2019, at 2–3).
[32] *Id.* at 12-3.
[33] *See* Hearings, *supra* note 22.

Whether algorithmic trading causes market volatility is a question that has given rise to vociferous academic dispute. Many researchers argue that HFT, as currently regulated, provides important benefits to markets. If true, it could be that Regulation AT would impede the positive effects that come from algorithmic trading.

Many researchers argue that HFT reduces transaction costs[34] and improves pricing accuracy in secondary markets.[35] Furthermore, there is evidence that HFT bolsters market liquidity by raising the volume of purchases and sales, and it may reduce volatility levels. Harvard Law School professor Hal Scott testified before the Senate that it was his opinion that "high frequency trading activity in and of itself has not negatively affected our secondary markets."[36] He went on to state that by increasing liquidity and driving issuance prices downward, HFT had improved capital formation and bolstered growth in the real economy.[37] Most critics of HFT cite the May 6, 2010 *Flash Crash* as conclusive evidence of its negative effects. During the Flash Crash, a trader used an automated algorithm which caused U.S. equity indices to take a massive dip (and rebound) during the course of a single day. However, in its joint report with the CFTC on the Flash Crash, the U.S. Treasury conceded that HFT has brought market benefits such as reduced costs and increased market efficiency.[38] Some argue that imposing additional restrictions in the form of Regulation AT would diminish the benefits that HFT has created.

VI. Constitutionality Concerns Over Source Code Access

Many entities and opponents of the initial version of Regulation AT's source code provision believed that it would allow regulators to sidestep constitutional protections against unreasonable searches and seizures by the government.[39] In *New York v. Burger*,[40] the Supreme Court held that the expectation of privacy in commercial property is particularly attenuated in "closely regulated" industries. The Supreme Court recognized that, due to a heightened government interest in regulating particular markets, a warrantless inspection may be reasonable under the meaning of the Fourth Amendment in certain circumstances. The Supreme Court established a three-part test whereby regulators must show that:

(i)   there is "substantial" government interest underlying the regulatory scheme that purports to authorize the inspection at issue;

(ii)   the warrantless inspection is "necessary to further [the] regulatory scheme"; and

(iii)   "the inspection program, in terms of certainty and regularity of its application provides a constitutionally adequate substitute for warrant."

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[34] *Hearing on High Frequency Trading's Impact on The Economy Before the Subcomm. On Securities, Insurance, and Investment of the S. Comm. On Banking, Housing, and Urban Affairs*, 113th Cong. (2014) (Testimony of Hal Scott, Nomura Professor, Harvard Law School), https://www.govinfo.gov/content/pkg/CHRG-113shrg91299/html/CHRG-113shrg91299.htm (stating that transaction costs had fallen 50% since 2006).

[35] *See* Terrence Hendershott et. al., *Does Algorithmic Trading Improve Liquidity?*, 66 THE J. OF FIN. 1, 1-33 (2010) http://faculty.haas.berkeley.edu/hender/Algo.pdf; *see also* Cristina McEachern Gibbs, *Breaking It Down: An Overview of High- Frequency Trading*, WALL STREET & TECHNOLOGY (Sept 29, 2009).

[36] Hearings, *supra* note 34.

[37] *Id.*

[38] Tom Bailey, *US Treasury takes aim at high frequency traders*, WORLD FINANCE (Jul. 14, 2015), https://www.worldfinance.com/strategy/government-policy/us-treasury-takes-aim-at-high-frequency-traders [https://perma.cc/E63P-WQ6J].

[39] John S. Servidio & Bo Harvey, McGuireWoods LLP, *Avocados, the U.S. Constitution and the CFTC's regulation Automated Trading*, LEXOLOGY (Nov.9, 2016), https://www.lexology.com/library/detail.aspx?g=5d746725-6f7b-4d88-9854-7e958a6bc955 [https://perma.cc/3F6N-GX4M].

[40] *See* New York v. Burger, 482 U.S. 691 (1987).

Much of the literature related to this issue comes from industry insiders who may be predisposed to argue that Regulation AT's provisions would fail the *Burger* test. For example, in a comment, the Futures Industry Association hypothetically applied the *Burger* test to conclude that a warrantless inspection of source code would not be "reasonable" and was, therefore, likely unconstitutional.[41]

Given the inconclusive nature of the effects of algorithmic trading (and high frequency trading, specifically), some argue it may be conceivable that the CFTC lacks "substantial" government interest in requesting direct access to source code. However, it would be very difficult to contend that financial regulators do not have a "substantial" government interest in preventing market manipulation, which in many cases has been known to have algorithmic trading at root.[42] Moreover, substantial government interest has been found in industries (cases cited below) which have far more limited impact on the nation. Similarly, it is of government interest to have visibility into the financial market so as to determine and monitor the extent of systemic risk. It is for the above reason that, when providing commentary to the proposed regulation, market participants have generally not disputed the CFTC's interest in requesting source code.

Other opponents have challenged the notion that the lower level of due process afforded in the event of an administrative inspection of source code is "necessary" to further the regulatory scheme of Regulation AT. They cite the use of various programming languages and complex algorithmic strategies to conclude that the CFTC would need to employ expert staff to review source code.[43] Incidentally, members of the CFTC have themselves admitted to a lack of resources.[44] This has pushed market participants to argue that because source code would be "of little practical benefit" to the CFTC, this requirement cannot be "necessary" and, thus, does not satisfy the second prong of the test established in *Burger*.[45] Indeed, even CFTC Commissioner Giancarlo has expressed doubt that access to source code is necessary.[46]

Another argument grounded in the second *Burger* prong is that the Commodity Exchange Act already allows the CFTC to access source code in its course of conducting investigations, that the CFTC has failed to show why these powers are insufficient, and that the compulsory source code preservation and access provision is not "necessary" in the context of the agency's already-broad investigatory powers.

Finally, market participants also contend that the source code section of Regulation AT does not satisfy the third prong of the test. The use of the terms "all code used in the production environment," "related systems," and "software" in §1.81 of the Regulation does not indicate with sufficient clarity or precision the types of information subject to inspection. Furthermore, the Regulation does not specify the regularity with which the source code can be inspected. Thus, market participants contend that the inspection cannot provide a "constitutionally adequate substitute for a warrant," as its scope and regularity under Regulation AT are uncertain.[47] Most importantly, commenters have voiced concerns that the new provision strips market participants of the important procedural safeguards afforded by the subpoena

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[41] Futures Industry Association (FIA), Comment Letter on Notice of Proposed Rulemaking on Regulation Automated Trading (Mar. 16, 2016), https://fia.org/sites/default/files/content_attachments/2016-03-16_Regulation_AT_Comment_Letter.pdf [https://perma.cc/LBU5-YDZE].
[42] Matt Levine, *The Computers Are Sorry About the Flash* Crashes, BLOOMBERG (Jan. 3, 2019, 11:55 AM), https://www.bloomberg.com/opinion/articles/2019-01-03/the-computers-are-sorry-about-the-flash-crashes.
[43] FIA, *supra* note 41.
[44] *Hearing to review the Fiscal Year 2017 budget request and funding justification for the SEC and CFTC Before the Subcomm. on Financial Services and General Gvt. Of the S. Comm. on Appropriations*, 114th Cong. (2016) (Testimony of Timothy Massad, Chairman, CFTC), https://www.appropriations.senate.gov/imo/media/doc/041216%20CFTC%20Chairman%20Massad%20Testimony.pdf ("[T]he agency does not have the resources to adequately oversee these markets.").
[45] FIA, *supra* note 41, at 46.
[46] J. Christopher Giancarlo, Commissioner, CFTC, Statement Regarding Notice of Proposed Rulemaking on Regulation Automated Trading (Nov. 24, 2015) (transcript available at https://www.cftc.gov/PressRoom/SpeechesTestimony/giancarlostatement112415 [https://perma.cc/6ZAT-N43J].
[47] *See* FIA, *supra* note 41, at 47-8.

process, such as limits on the scope of inspection or the ability to apply for a protective order, to ensure the proper maintenance of any disclosed information.[48]

However, despite these arguments from Regulation AT opponents, it would likely be exceedingly difficult to successfully challenge Regulation AT on the grounds that the regulation would authorize unreasonable searches or seizures. While the U.S Supreme Court has rarely spoken on what qualifies as a closely regulated industry, both state and lower federal courts have greatly expanded the definition.[49] For example, there are a whole series of cases indicating that credit unions, banking, and insurance are closely regulated industries.[50] Some have concluded that, considering the breadth of types of industries that qualify, the exception may actually be "the default rule in searches of businesses".[51] Further precedential support for the proposition that the Court would not invalidate Regulation AT on these grounds comes from lower courts. As noted in an Eastern District of New York case that upheld warrantless inspections on cigarette sellers, "the Supreme Court has identified a handful of industries that are subject to pervasive and often longstanding regulation".[52] Courts appear to consider it important whether there has been a longstanding history of government oversight. Also, courts put emphasis on whether it can be said that a given entity has tacitly consented or "voluntarily chosen to subject himself to a full arsenal of governmental regulation."[53] Based on these cases, it could be that fears over legal challenges to the constitutionality of Regulation AT are overblown.

VII. Non-Legal Concerns with Source Code Access

a. Unique Nature of Source Code

Regulation AT proponents such as CFTC Chairman Timothy Massad argue that source code is indistinguishable from other types of confidential information routinely provided to the CFTC.[54] However, others, such as CFTC Commissioner Giancarlo, consider source code different from ordinary records because it shows "what positions the firm intends to buy or sell *in the future*."[55] Giancarlo stated that Regulation AT effectively "lowered the bar for the federal government" to access intellectual property and future business strategies.[56] Commenters largely shared the view of Commissioner Giancarlo,[57] and they emphasized that source code is "not a routine business record and should not be treated as such."[58] The argument is based on the view that source code both reflects historical information but also contains information regarding future business strategies. The intellectual property contained in source code, thereby, contains commercially valuable strategic information which some market participants have even described as the "lifeblood of . . . commercial success."[59]

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[48] Citadel LLC, Comment Letter on Notice of Proposed Rulemaking on Regulation Automated Trading (Mar. 16, 2016), available at https://comments.cftc.gov/PublicComments/ViewComment.aspx?id=60745&SearchText [https://perma.cc/2SJN-J2QC].

[49] *See* Rethinking Closely Regulated Industries, 129 Harv. L. Rev. 797, 805 (2016)

[50] *Id.*

[51] *Id.*

[52] United States v. Mansour, 252 F. Supp. 3d 182, 190 (W.D.N.Y. 2017)

[53] *Id.*

[54] Timothy Massad, Chairman, CFTC, Statement Regarding Approval of Supplemental Proposal to Automated Trading Regulation (Nov. 4, 2016), https://www.cftc.gov/PressRoom/SpeechesTestimony/massadstatement110416 [https://perma.cc/3J2X-V6M7].

[55] Giancarlo, *supra* note 46.

[56] *Id.*

[57] *See* Citadel LLC, *supra* note 48; *see also* FIA, *supra* note 41.

[58] CME Group Inc., Comment Letter on Notice of Proposed Rulemaking on Regulation Automated Trading, 38 (Mar. 16, 2016), https://comments.cftc.gov/PublicComme/ViewComment.aspx?id=60765&SearchText= [https://perma.cc/43JX-Y2F3].

[59] FIA, *supra* note 41 at 8.

In support of the argument that source code differs from ordinary records, opponents point out that proprietary source code is afforded protections under multiple areas of the law (*e.g.*, trade secret law, database rights, copyright law), whereas ordinary records contain mere facts and are generally not entitled to such protections. Commenters emphasized that if a trade secret is accidentally or intentionally exposed, it loses its protected character.[60] In essence, accidental disclosure of algorithmic-trading source code could render as public information the trading strategies of the most successful investment firms.[61]

b. Information Security Concerns

Adding to the weight of the abovementioned arguments is that worries over the confidentiality of source code are not groundless. Hackers have increasingly targeted financial institutions and regulators.[62] CFTC Chairman Massad echoed this point when he stated that "cyber security is the single most important new risk to market integrity and financial stability."[63] On this point, Commissioner Giancarlo agrees that confidentiality of source code is a strong concern and highlights the federal government's "poor track record of keeping sensitive information secure from cyber-attacks."[64]

Indeed, financial regulators have been known to suffer from both internal and external data thefts. In 2015, the Federal Deposit Insurance Corporation (FDIC) suffered one of the largest internal data thefts. A report from the FDIC's Office of Inspector General that investigated a series of eight separate information security incidents from 2015 to 2016 found serious issues with the FDIC responses to these data breaches.[65] In one of those instances, an employee left the agency with a USB containing the "living wills" of several systemically important financial institutions.[66] In another case, a Federal Reserve employee passed confidential information to a former supervisor working at an investment bank.[67] Data security issues have not been limited to just the FDIC. In 2016, the SEC suffered one of the most severe external data breaches to date. This incident involved the theft of corporate announcements from SEC's EDGAR filing system which contained nonpublic earnings results.[68] The hackers responsible for the theft allegedly gained around $4 million in illegal profits by trading on the information.[69] The CFTC and the DOJ have also suffered cyber security breaches resulting in the loss of confidential employee information which included social security numbers.[70] These episodes show that no executive agency is safe from the threat of both internal and external data breaches.

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[60] *Id.* at 50.

[61] Citadel, *supra* note 52.

[62] Bhakti Mirchandani, *Laughing All The Way To The Bank: Cybercriminals Targeting U.S. Financial Institutions*, Forbes (Aug. 28, 2018, 01:57AM), https://www.forbes.com/sites/bhaktimirchandani/2018/08/28/laughing-all-the-way-to-the-bank-cybercriminals-targeting-us-financial-institutions/#798496396e90.

[63] *Hearing Before the H. Comm. on Agriculture*, 114th Cong. (2015) (Testimony of Timothy Massad, Chairman, CFTC), https://www.cftc.gov/PressRoom/SpeechesTestimony/opamassad-11 [https://perma.cc/QVT8-MBED].

[64] Giancarlo, *supra*, note 46.

[65] See Federal Deposit Insurance Corporation, Office of the Inspector General, *Special Inquiry Report*, (April 2018). https://www.fdicoig.gov/sites/default/files/report-release/OIG-18-001.pdf.

[66] *Former Senior Employee at FDIC Convicted of Embezzling Confidential Documents*, DEPARTMENT OF JUSTICE U.S. ATTY'S OFFICE, EASTERN DISTRICT OF N.Y. (Dec. 11, 2018), https://www.justice.gov/usao-edny/pr/former-senior-employee-fdic-convicted-embezzling-confidential-documents [https://perma.cc/2KNH-9YXB].

[67] *Former Employee of Federal Reserve Bank of New York Pleads Guilty in Manhattan Federal Court to Theft of Confidential Information From the Federal Reserve*, DEPARTMENT OF JUSTICE U.S. ATTY'S OFFICE, SOUTHERN DISTRICT OF N.Y. https://oig.federalreserve.gov/releases/news-gross-guilty-theft-confidential-information-nov2015.htm [https://perma.cc/6KSF-RBHQ].

[68] Matt Robinson & Chris Dolmetsch, *SEC Sues Same Group Behind Press Release Hack Over Its Edgar Breach*, BLOOMBERG (Jan. 15, 2019, 9:33AM), https://www.bloomberg.com/news/articles/2019-01-15/sec-files-lawsuit-over-scheme-to-hack-edgar-database.

[69] *SEC Brings Charges in EDGAR Hacking Case*, SEC (Jan. 15, 2019), https://www.sec.gov/news/press-release/2019-1 [https://perma.cc/5QE3-H6Y9].

[70] Spencer Ackerman & Sam Thielman, *US officials downplay impact of Department of Justice hacking*, THE GUARDIAN (Feb. 8, 2016 2:48 PM), https://www.theguardian.com/technology/2016/feb/08/department-of-justice-homeland-security-hacking [https://perma.cc/K795-HKMU]; Silla Brush, *CFTC Data Breach Risks Employees' Social Security Numbers*, BLOOMBERG (June 25, 2012, 12:01 AM), https://www.bloomberg.com/news/articles/2012-06-25/cftc-data-breach-risks-employees-social-security-numbers.

Regulation AT also extended source code testing and retention requirements to algorithms licensed from third-party providers. Commenters strongly oppose this provision, stating that it is not clear how traders who license systems from third parties, and thus do not have access to source code, can comply with the provision. Furthermore, market participants cannot be required to obtain source code from vendors. Even if the latter were to provide their code, the costs associated with maintaining the proprietary information of a third-party would be prohibitive.[71]

In addition to data breaches, market participants made note of the existing controversy regarding the applicability of the FOIA to source code. Although government agencies contend that source code is not a "record," and is thus exempt from FOIA requirements, this question remains a subject of debate. In response to the argument that source code would be protected by FOIA's trade secret exemption even if FOIA did apply, commenters note that the protections provided are not absolute and do not shield companies from requests made by Congress and other regulatory agencies.[72]

A recent Supreme Court case strongly suggests that materials disclosed to the CFTC under Regulation AT would be covered by the trade secret exemption. In *Food Marketing Institute*, the Court widened the breadth of information considered "confidential" for purposes of FOIA's Exemption 4 for trade secrets and commercial or financial information.[73] In this case, the Court categorically rejected the idea that a company must show "substantial competitive harm" in order for the disclosed information to be protected.[74] Instead, provided that (1) the information is customarily treated as private or privately held the by the person providing it and (2) there are assurances by the government that it will not be disclosed, then the disclosed information will fall under this exemption.[75] This likely means that private entities who are providing sensitive financial documents or data to the federal government can likely rest assured the information will not be released under FOIA.[76] This would suggest that this particular worry over data leakage as a result of Regulation AT may be overblown.

VIII.   Conclusion

The above concerns are founded on my experience working in the intersection of law and finance for the past several decades and ought to bear heavily on any future decisions regarding how to regulate HFT and algorithmic trading.

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[71] International Swaps and Derivatives Association (ISDA), Comment Letter on Notice of Proposed Rulemaking on Regulation Automated Trading (Mar. 16, 2016), https://www.isda.org/a/vniDE/regulation-at-comment-03-16-16-002.pdf [https://perma.cc/CC9N-F2J9].
[72] FIA, *supra* note 41.
[73] *See* Food Mktg. Inst. V. Argus Leader Media, 139 S. Ct. 2356 (2019).
[74] *Id.* at 2363.
[75] *Id.*
[76] Davis Polk, *SCOTUS Expands Scope of FOIA Trade Secrets and Commercial Information Exemption*, https://www.davispolk.com/files/2019-06-26_scotus_expands_scope_of_foia_trade_secrets_commercial_information_exemption.pdf (last visited March 28, 2019).

Appendix II: Legal Intern Research Memorandum on Regulation AT

TO: Director, CFTC Division of Market Oversight
FROM: Summer 2018 Legal Intern
RE: Regulation Automated Trading Overview
DATE: July 15, 2018

Memorandum

I.   Background:

On November 15, 2015, the CFTC unanimously approved Regulation Automated Trading ("Regulation AT").[1] This original version of Regulation AT aimed to reduce the risks of algorithmic trading activity by imposing risk control requirements for market participants, futures commission merchants, and designated contract markets ("DCM") executing algorithmic trading orders.[2] However, Regulation AT provoked a backlash from market participants.[3] While commenters strongly supported CFTC's efforts to regulate algorithmic trading, most voiced concerns regarding its scope and reach. The key requirements of Regulation AT were (i) registration of algorithmic traders, (ii) establishment of risk control measures, and (iii) requirements of source code preservation.[4] This memo proceeds by first describing the three main regulatory requirements. Then, it outlines subsequent developments in the timeline of Regulation AT and concludes by spelling out the regulatory efforts being made by other U.S. and foreign regulators. **This last section of the memorandum covers, at a high level, alternative proposals or policy solutions for handling the same types of issues Regulation AT is aimed at solving.**

II. Key Regulatory Requirements of Regulation AT

a.   Registration

Regulation AT introduced rules for determining whether a trader was an "algorithmic trader." This development would force otherwise unregistered trading firms to register with the CFTC so long as they have direct electronic access to the market and operate algorithmic trading systems. The CFTC hoped that this regulation and the SEC's FINRA registration requirement[5] would together mean that all algorithmic traders would be brought within regulators' reach.[6] Now, even the smallest market participant (five total trades per day) would be subject to registration if that trader used algorithms to perform the trades.

The CFTC argued that the regulation was justified because the marketplace is "too linked to fail."[7] They stated that because a single malfunction could have a devastating impact, the breadth of

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[1] *CFTC Unanimously Approves Proposed Rule on Automated Trading,* U.S. Commodity Futures Trading Commission (Nov. 24, 2015), https://www.cftc.gov/PressRoom/PressReleases/pr7283-15 [https://perma.cc/R5R5-LCRV].
[2] *Id.*
[3] CFTC Stirs Outrage Over Algo Trading Source Code Proposals, FINEXTRA (04, Nov., 2016), https://www.finextra.com/newsarticle/29718/cftc-stirs-outrage-over-algo-trading-source-code-proposals [https://perma.cc/4LL2-82XE].
[4] Woodward Megan, *The Need for Speed: Regulatory Approaches to High Frequency Trading in the United States and the European Union*, Vanderbilt Journal of Transnational Law 50, no. 5 1359, 1384 (2017).
[5] *Id.* at 1381.
[6] *Id.*
[7] Tom C.W. Lin, *The New Investor*, 60 UCLA L. REV. 678, 714 (2013) https://www.uclalawreview.org/the-new-investor-2/

the registration requirement was critical to ensuring that *all* firms using trading algorithms were subject to Regulation AT.[8] Commentators, however, strongly opposed the broad reach of the registration requirements. One of the strongest critics of Regulation AT, CFTC Commissioner Christopher Giancarlo, stated that by capturing and unduly burdening small market participants, Regulation AT would be erecting further barriers to entry into this market.[9] Moreover, many commenters believe that the CFTC registration requirement was needless because the CFTC *already* has sufficient legal authority to impose requirements on non-registrants[10] trading on U.S. futures markets if the nature of their trading is "disruptive."[11]

b. Risk Control Measures

In terms of risk control measures, Regulation AT imposed maximum order message and order size parameters, in addition to standards for the development, testing and monitoring of algorithmic trading systems.[12] These are aimed at limiting the volume or quantity of items in any given transaction and throttle or control excessive messages being sent to the electronic order book. To counter the disruptive practice of algorithms being directly tested in the actual market, the regulation required that the developmental environment of algorithms be isolated from the trading environment.[13] The regulation mandated testing of all changes to algorithmic code and tests to identify circumstances that could lead to future flash crashes.[14] A flash crash occurs when there is a rapid withdrawal of orders from a given market that is amplified (or caused) by electronic trading algorithms which lead to dramatic declines in a very short period of time. The proposed risk control measures were mostly criticized for focusing on the type of market participant, rather than the nature of the trade.[15]

c. Source Code Preservation

Section 1.81(a)(1)(vi) of Regulation AT required that companies create and maintain source code repositories which would include copies of all code used in the production of the algorithm as well as both all changes later made to the code and even information on "who, when and why" each specific change occurred.[16] However, existing recordkeeping provisions under broad administrative regulations adopted by the CFTC already require that regulated entities hold all books and records accessible and open to inspection by the CFTC and the DOJ.[17] It is possible that the CFTC and the DOJ would have access to algorithmic source code without use of a subpoena even if the algorithm was developed by a third-party outside the scope of the regulation.

[https://perma.cc/M4H6-7NUC].

[8] Regulation Automated Trading, 80 Fed. Reg. 78845 (proposed Dec. 17, 2015), https://www.federalregister.gov/documents/2015/12/17/2015-30533/regulation-automated-trading.

[9] J. Christopher Giancarlo, Commissioner, CFTC, Statement Regarding Notice of Proposed Rulemaking on Regulation Automated Trading (Nov. 24, 2015) (transcript available at https://www.cftc.gov/PressRoom/SpeechesTestimony/giancarlostatement112415 [https://perma.cc/6ZAT-N43J].

[10] 7 U.S.C 6c(6) ("[T]he Commission may make and promulgate such rules and regulations as, in the judgment of the Commission, are reasonably necessary to prohibit the trading practices described in paragraph (5) and any other trading practice that is disruptive of fair and equitable trading.").

[11] Futures Industry Association (FIA), Comment Letter on Notice of Proposed Rulemaking on Regulation Automated Trading (Mar. 16, 2016), https://fia.org/sites/default/files/content_attachments/2016-03-16_Regulation_AT_Comment_Letter.pdf [https://perma.cc/LBU5-YDZE].

[12] Regulation Automated Trading, *supra* note 8.

[13] *Id* at 78857.

[14] *Id.*

[15] *Id.*

[16] *Id.*

[17] 17 CFR § 1.31 (2017).

Source code preservation provisions garnered the most controversy. Market participants, and even members of the CFTC, were opposed to the CFTC or the DOJ potentially having access to proprietary source code without a subpoena. "It is unconceivable that any firm should be expected to leave its intellectual property on the doorstep of the government," said Bill Harts, Chief Executive of Modern Markets Initiative.[18] As further discussed below, Regulation AT was highly criticized for having sidestepped constitutional privacy concerns, disregarding algorithms' unique nature, and unduly endangering market participants' core intellectual property.

d. Initial Response and Industry Backlash

A number of academics, regulators, and industry participants raised serious concerns after the initial unveiling of Regulation AT. Most of the backlash focused on the source code provisions; however, other concerns were raised related to regulatory oversaturation, duplication of efforts by other agencies, practical concerns with implementing the Regulation, and similar issues. The CFTC's General Counsel intends to incorporate many of these concerns in her analysis of the Regulation.

III. Supplemental Proposal and Abandonment of Regulation AT

In 2016, the CFTC issued a Notice of Supplemental Proposed Rulemaking ("Supplemental Proposal") to address some of the comments received from market participants.[19]

a. Registration

Regarding registration, the CFTC added a volume-based quantitative test for determining whether a trader was an algorithmic trader subject to registration.[20] However, commenters found this amendment unsatisfactory and argued that small market participants would still fall within the registration requirements because of the expanded definition of electronic trading.[21] They further argued that too many small traders would be ensnared because the volume-based test looked at the aggregate of all electronic trading without considering the scale or frequency of activity.[22] On the other side, many regulators *also* found the increased size requirement unsatisfactory. They believed this new definition still left too many small entities unregulated which would still lead to large-scale catastrophic events based on the extremely interconnected nature of the market.[23]

b. Source Code

The CFTC pushed back on the opposition to the source code provisions but also eased some requirements. The CFTC again emphasized that it receives confidential information on a daily basis and handles "sensitive, proprietary and trade secret information" under strict rules.[24] The

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[18] Gregory Meyer & Philip Stafford, *US Regulators Propose Powers To Scrutinize Algo Traders' Source Code*, FINANCIAL TIMES (DEC. 1, 2015) https://www.ft.com/content/137f81bc-944f-11e5-b190-291e94b77c8f [https://perma.cc/8HJQ-CQEC].
[19] Regulation Automated Trading, 81 Fed. Reg. 85334 (proposed Nov. 25, 2016), https://www.cftc.gov/sites/default/files/idc/groups/public/@lrfederalregister/documents/file/2016-27250c.pdf.
[20] *Id.* at 85336.
[21] Futures Industry Association (FIA), Comment Letter on Supplemental Notice of Proposed Rulemaking regarding Regulation Automated Trading (May. 1, 2017), https://fia.org/sites/default/files/content_attachments/2017-05-01_CFTC_RegAT_0.pdf [https://perma.cc/VR7E-N4A3]; ISDA, Comment Letter on Supplemental Notice of Proposed Rulemaking regarding Regulation Automated Trading (May. 1, 2017), https://www.isda.org/a/ZniDE/supplemental-reg-at-comment-letter-isda-05-01.pdf [https://perma.cc/KV4P-UPWT].
[22] *Id.*
[23] *See generally* Tom C.W. Lin, *The New Market Manipulation*, 66 EMORY L.J. 1253, 1280-92 (2017).
[24] Regulation Automated Trading, *supra* at note 19.

Supplemental Proposal continued to require source code preservation, however, under a set of rules separate from those generally applicable to books and records.[25] Specifically, the Commission could only access source code via subpoena or by a special call authorized by the Commission ("Enhanced Special Call"). Furthermore, the CFTC would use specifically tailored means of access to ensure the source code remains secured. The procedure would include on-site inspection of the market participant, the use of computers disconnected from the network, and the provision of records stored on secure storage media.[26]

However, many opponents doubted the sufficiency of these changes. For example, they argued that the Enhanced Special Call still leaves market participants with less protection than a normal subpoena.[27] Faced with a subpoena, the subpoenaed party can move to quash, challenge its scope, or apply for a protective order for additional confidential obligations on the CFTC. In contrast, the Enhanced Special Call provides none of these protections. Commenters re-emphasized that no policy concerns could justify such unfettered access to proprietary information.[28] Commissioner Giancarlo echoed these concerns, stating that this would "[g]ive unchecked power to the CFTC to decide if, when and how property owners must turn over their source code."[29] Commissioner Giancarlo noted "no subpoena means no due process of law," thereby highlighting the importance of the subpoena process in striking a balance between the rights of property owners and the unlimited power of the government.[30] Moreover, he heavily criticized the "Special Call" process, stating that "a few additional" bureaucratic hurdles could not undermine the rights of property owners.[31] Opponents fear that allowing the CFTC to adopt such practices would encourage other regulators, domestic and foreign, to require similar access.

c. **Third-Parties**

The CFTC also responded to criticism of proposing onerous requirements upon third-party developers of trading algorithms to be used by market participants. The Supplemental Notice highlighted that the use of third-party systems should not serve as an excuse for market participants to circumvent compliance and regulatory standards for algorithmic trading. However, recognizing the practical difficulties of the requirement, the Supplemental Notice permitted market participants to satisfy the development and testing requirements by: (i) obtaining a certificate that the third party is complying with Regulation AT requirements and (ii) conducting due diligence regarding the accuracy of the certification. Dissatisfied, the industry labeled this as "untenable" because it would require them to monitor developers. This would only be possible if developers consented to providing their users with access to their proprietary source code. One industry group labeled it "regulatory overkill" to both require market participants to obtain a certificate saying its developers were compliant, while also checking the veracity of the underlying facts.[32] Others were worried that market participants lacked the appropriate expertise to perform such functions. Some found impractical the requirement for recertification following every material change to source code, arguing that third-party software was renewed and changed

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[25] *Id.* at 85337.

[26] *Id.*

[27] ISDA, *supra* note 21, at 6.

[28] *Id.*

[29] J. Christopher Giancarlo, Commissioner, CFTC, Statement of Dissent Regarding Supplemental Notice of Proposed Rulemaking on Regulation Automated Trading (Nov. 4, 2016), https://www.cftc.gov/PressRoom/SpeechesTestimony/giancarlostatement110416 [https://perma.cc/R7P5-FDKR].

[30] *Id.*

[31] *Id.*

[32] *Id.* at 5.

regularly and that it would be difficult to determine what constituted a "material" change under the Regulation.[33]

d. CFTC Internal Debate and Cessation of Regulation AT

After unveiling the Supplemental Proposal, the CFTC then voted to approve the modified version on November 4, 2016. CFTC Commissioner Giancarlo dissented from the majority vote approving the modified regulation.[34] He gave weight to the possible constitutional challenge to such a rule, concluding that the time spent and expenses incurred in fighting that challenge would be a "sad waste of American taxpayer money."[35] The Commissioner went on to note that the laws prohibiting the release of trade secrets, which were cited by the CFTC in the Supplemental Notice, did nothing to assure that source code would be secure. Highlighting that the CFTC had also been known to suffer from data breaches, he posited that the rules must include specific confidentiality assurances such as on-site inspection of source code and its return to the proprietor once reviewed.[36] Given the opposition from both within the CFTC and from market participants, the CFTC subsequently abandoned Regulation AT.[37]

IV.   Other Regulatory Efforts

It is important to catalogue and characterize similar efforts being made by other regulators to address alleged negative effects of algorithmic trading and HFT. These efforts are being pursued both by parallel domestic agencies or regulators as well as foreign counterparts to U.S. financial regulators. Importantly, some academics believe that the current U.S. regulatory framework, considered holistically, has already endowed regulators with sufficient authority and ability to combat the negative effects of HFT.[38] Still others believe that both industry and government have severely overstated the importance of regulation of HFT within financial markets as well.[39]

a. Domestic Regulation

i.   CFTC's Spoofing Prohibition

Section 747 of the Dodd-Frank Act amended the Commodity Exchange Act to prohibit disruptive trading practices in general and spoofing in particular.[40] The CFTC has since successfully enforced the prohibition on multiple occasions, despite doubts regarding its enforceability with regard to the difficulty of proving intent.[41]

ii. U.S. Securities and Exchange Commission

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[33] FIA, *supra* note 21.
[34] *See* Giancarlo, *supra* note 29.
[35] *Id.*
[36] *Id.*
[37] *CFTC commissioner: plans to seize algo trading source code are "D-E-A-D",* FINEXTRA RESEARCH (Oct. 5, 2017), https://www.finextra.com/newsarticle/31157/cftc-commissioner-plans-to-seize-algo-trading-source-code-are-d-e-a-d [https://perma.cc/UV8D-6H89].
[38] *See* Kevin O'Connell, *Has Regulation Affected the High Frequency Trading Market?*, 27 Cath. U. J. L. & Tech. 145 (2019).
[39] *See* Bloomberg, *Source Code and Chicken Indexes*, 1-2, 9-10 (October 5, 2019).
[40] 7 U.S.C. § 6c(a)(5) (2012) (outlawing "spoofing," a strategy similar to HFT strategies).
[41] Megan Woodward, *The Need for Speed: Regulatory Approaches to High Frequency Trading in the United States and the European Union*, Vanderbilt Journal of Transnational Law 50, no. 5 1359, 1381 (2017).

Recognizing that financial regulators are now essentially "overseeing technology companies"[42] and with a view to address high frequency trading, the SEC adopted Regulation Systems Compliance and Integrity ("Reg SCI"),[43] which sought to reduce the number of trading system issues such as failures, disruptions, delays, errors, or other operational problems with automated systems. Reg SCI also paved the way for the SEC to strengthen oversight of the overall technology infrastructure of US securities markets.[44] Under Reg SCI, these "SCI entities" such as self-regulatory organizations (*e.g.,* FINRA), clearing agencies and alternative trading systems, were required to design, implement and maintain IT policies ensuring that their systems operated in the manner intended and complied with federal securities laws and rules. Reg SCI also provided instructions responding to or correcting errors in the event of a system disruption. The regulation received an overall positive response and was praised for fostering collaboration amongst market participants.[45] However, there was also a widespread belief that the regulation did not go far enough given the ever-increasing use of automated technologies.[46]

To address the Flash Crash, the SEC adopted market-wide circuit breakers that either temporarily halt or close markets if trading if the S&P 500 Index falls below certain thresholds calculated daily based on the prior day's closing price.[47] The SEC also amended the trading rules, as contained in the National Market System Plan, for single-stock circuit breakers, using a "limit-up" and "limit-down" mechanism to determine the thresholds for acceptable trading within a given tier of stock.[48] However, during the Flash Crash, it became apparent that the circuit breakers backfired, which prompted the SEC to consider modifying the rules to address current shortcomings.[49]

To address transparency issues, the SEC has also proposed the establishment of a "Consolidated Audit Trail" ("CAT") to improve the ability of the SEC and other industry regulators to oversee trading within the securities markets.[50] Most notably, it would lift the veil on activities in dark pools and other alternative trading platforms. Dark pools are private exchanges or arenas for securities trading that restrict access to their exchange and are known for their lack of transparency. The SEC would require that national securities exchanges, broker-dealers and self-regulated entities report "order lifecycles," the entire progression beginning with ordering a trade and ending when that trade is fully completed and billed, for equities and options to a central repository. These reporting requirements are more exhaustive than any previous requirements and include information regarding order cancellations, the identity of customers, and prices.[51] These new SEC regulations, embodied in Rule 613, also require that each order, broker-dealer, and national securities exchange be assigned a unique code in order to provide regulators with the capacity to not only track the lifecycle of individual orders but also link them to the respective broker-dealer or national

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[42] Dave Michaels, *Machine Trading Needs More Oversight, Departing SEC Official Says*, THE WALL STREET JOURNAL https://www.wsj.com/articles/machine-trading-needs-more-oversight-departing-sec-official-says-11545404400 [https://perma.cc/Q7QA-J54B].

[43] *Spotlight on Regulation Systems Compliance and Integrity,* SEC, https://www.sec.gov/spotlight/regulation-sci.shtml [https://perma.cc/P4VU-Q8CV] (last visited May 16, 2019).

[44] *Id.*

[45] Woodward, *supra* note 41, at 1378-9.

[46] Woodward, *supra* note 41, at 1379.

[47] *Investor Bulletin: Measures to Address Market Volatility,* SEC (July 1, 2012), https://www.sec.gov/oiea/investor-alerts-bulletins/investor-alerts-circuitbreakersbulletinhtm.html [https://perma.cc/Y28L-GQHN].

[48] *Id.*

[49] *See* Investopedia, *Circuit Breaker*, https://www.investopedia.com/terms/c/circuitbreaker.asp [https://perma.cc/4NWH-3Y8T].

[50] *See* Rule 613 (Consolidated Audit Trail), SEC https://www.sec.gov/divisions/marketreg/rule613-info.htm [https://perma.cc/U4VX-F7DF] (last visited May 16th, 2019).

[51] 17 CFR § 242.613 (2012).

exchange.[52] The CAT would greatly enhance the power of the SEC to accurately reconstruct market events and would give private parties a tool to analyze HFT manipulation to establish causation and intent.[53] However, due to technical difficulties, it is years behind schedule. Former SEC Commissioner Kara Stein termed the CAT the "Hubble Telescope" for securities markets".[54]

iii. Financial Industry Regulatory Authority (FINRA)

In 2016, the SEC approved a rule proposed by FINRA which requires all persons associated with a FINRA member, who are also primarily responsible for the design, development, modification or supervision of algorithmic trading strategies, to register as "Security Traders."[55] The rules subject these persons to qualification exams and continuing education requirements. FINRA recognized that developers were largely unaware of the securities rules governing the products they were designing.[56] By educating developers, FINRA hoped to reduce the incidence of inadequate risk management controls or failures to check for order accuracy.[57]

Some commenters on Regulation AT have posited that other regulatory efforts (*e.g.,* Reg SCI, CAT) combined with the CFTC's spoofing provision in the Dodd-Frank bill and the new FINRA registration requirements are sufficient to address algorithmic trading concerns and specifically eliminate the need for direct access to source code.[58]

b. Foreign Regulatory Efforts

i. European Union: Markets in Financial Instruments Directive II (MiFID II)

The European Union began closer regulation of algorithmic trading, and HFT in particular, by supplementing its prior regulation in January 2018. It requires that investment firms notify regulators that they are engaging in algorithmic trading[59] and sets forth standards for determining which activities constitute HFT.[60] Similar to the SEC's CAT, the EU's Markets in Financial Instruments Directive II (MiFID II) requires that an algorithmic trader maintain and make available records of all orders placed including cancellations, executed orders, and quotations on trading venues.[61] Furthermore, analogous to CFTC's Regulation AT, MiFID II provides that a regulator may require an algorithmic trader to provide, *on an ad hoc basis*, information regarding its algorithmic trading strategies. The rule further provides that the regulator may, *at any time*, request further information without describing the scope of

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[52] *See* SEC, *supra* note 50.
[53] *See* Morelli, *supra* note 26, at 53.
[54] *Supra* note 13.
[55] *SEC Approves Rule to Require Registration of Associated Persons Involved in the Design, Development or Significant Modification of Algorithmic Trading Strategies,* FINRA (2016), http://www.finra.org/industry/notices/16-21 [https://perma.cc/5V6L-7XK4].
[56] *SEC approves FINRA rule requiring registration of algorithmic trading developers*, BLOOMBERG (Apr. 20, 2016), https://www.bloomberg.com/professional/blog/sec-approves-finra-rule-requiring-registration-of-algorithmic-trading-developers/.
[57] *Id.*
[58] Holly A. Bell, Mercatus Center, Comment Letter on Notice of Proposed Rulemaking on Regulation Automated Trading (Mar. 16, 2016), https://www.mercatus.org/publication/potential-effects-reg-unintended-risks-and-diminished-cooperation-market-participants [https://perma.cc/5S6N-2PGU].
[59] Directive 2014/65/EU of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Directive 2009/92/EC and Directive 2011/61/EU (MiFID II), Article 17(2), https://ec.europa.eu/info/law/markets-financial-instruments-mifid-ii-directive-2014-65-eu_en.
[60] Article 4(1)(40), MiFID II Directive.
[61] Directive 2014/65/EU of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Directive 2009/92/EC and Directive 2011/61/EU (MiFID II), Article 17(2), https://ec.europa.eu/info/law/markets-financial-instruments-mifid-ii-directive-2014-65-eu_en.

information that can be requested.[62] MiFID II, thereby, potentially allows regulators to request source code without a subpoena, however, that has not yet come to pass.[63] Some believe this suggests the U.S. ought to reconsider Regulation AT. However, one current CFTC Commissioner, Brian Quintenz, rejected "automatically adopt[ing] comparable regulatory requirements," especially warrantless access to source code.[64] He rejected the concept of a "one-size-fits-all" regulatory ideal and stated that different jurisdictions must be free to adopt regulation tailored to their unique history and market structures.[65]

ii. Germany: High Frequency Trading Act ("HFT Act")

In 2013, Germany enacted the HFT Act, which requires HFTs to register with Germany's Financial Supervisory Authority and become licensed as a bank or financial trading institution. The licensing requirement applied not only to companies located in Germany, but also to any company directly or indirectly trading on a market subject to German regulation.[66]

The HFT Act also required that firms "tag" each algorithm with a unique code so that regulators can identify which particular algorithm made any given trading decision. German regulators consider the "algorithm-tagging" rule a better alternative to direct source access. These German authorities pointed to confidentiality concerns, the low efficacy of source code access, and practical difficulties inherent in monitoring frequently amended or updated code as reasons for adopting their alternative approach. Tagging algorithms also dissipates the concern that experts will seek to be hired by the regulator with the express purpose of stealing code. A recent study[67] analyzing Germany's algorithmic tagging approach found that although it may not provide regulators with a full picture of algorithmic trading, it better equips regulators to investigate potential manipulative practices.[68] The study found that while tagging is not perfect for monitoring *all* high frequency algorithms, there has been a net improvement in algorithmic transparency after the measure was implemented.[69]

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[62] 52 Article 17(2), MiFID II. *See also* Hogan Lovells, MiFID II, Algorithmic and High-Frequency Trading for Investment Firms (Dec. 2016), https://www.hoganlovells.com/~/media/hogan-lovells/pdf/mifid/new_mifid_update_31_dec_2016/5466119v1mifid-ii-algorithmic-trading-29122016lwdlib01.pdf.

[63] *See* Danny Busch, *MiFID II: Regulating High Frequency Trading, Other Forms Of Algorithmic Trading And Direct Electronic Market Access*, 10, L. and Fin. Markets Rev. 72, 76 (2016), https://doi.org/10.1080/17521440.2016.1200333.

[64] Brian Quintenz, Commissioner, CFRC, Remarks at the Institute of International Bankers Membership Luncheon: Deference for Different Approaches (June, 2018), https://www.cftc.gov/PressRoom/SpeechesTestimony/opaquintenz14 [https://perma.cc/8W2V-R3GP].

[65] *Id.*

[66] *See* Holly A. Bell & Harrison Searles, *An Analysis of Global HFT Regulation Motivations, Market Failures, and Alternative Outcomes* 8-9 (Mercatus Center, Working Paper No. 14-11, 2014).

[67] *See* Alex Walsh, *Evaluating Germany's Success in Regulating High-Frequency Trading* The Regulatory Review (Oct. 25, 2016), https://www.theregreview.org/2016/10/25/walsh-germany-regulating-high-frequency-trading/ [https://perma.cc/T4E6-D92K].

[68] *Id.*

[69] *See generally,* Nathan Coombs, *What is an algorithm? Financial regulation in the era of high-frequency trading,* 45 ECONOMY AND SOCIETY J. 278, 278-302 (2016), https://doi.org/10.1080/03085147.2016.1213977 [https://perma.cc/96MY-YHRX].

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