

Introduction

This book is about how the technological advances in automation and artificial intelligence (AI) that have fundamentally changed the nature of the US markets for futures contracts and other derivatives are necessitating, in some areas, changes to the legal and regulatory framework for these markets. To arrive at policy solutions to address the ways that AI systems are altering the markets, this book examines how algorithmic robots – algo bots, for short – have largely taken over trading in the futures markets, analyzes how regulators have responded to these changes thus far, and explores what steps policy makers should take in the future. But before diving into any of those topics, allow me to put the societal impact of these advances in computer science technologies in a broader context, beyond finance and derivatives.

Technology has changed our world so much in recent decades that it even has altered the types of things that we take for granted. For example, I went to high school at a time when students would say, “I wrote my term paper *on a computer*.” The last part of that sentence has become assumed. If a student boasted of writing a paper *on a computer* today the reaction would be, “No kidding! How do you send your friends messages? With carrier pigeons instead of texts?” The same is true for spelling and grammar. In the days before widespread use of word-processing programs, only humans could review and correct text for spelling and grammatical errors. Nowadays, practically everyone uses word-processing software that comes with spellcheck and grammar review. As a result, the first reaction of a university professor who receives a student paper riddled with spelling and grammatical errors is likely to be, “How lazy! This student handed in a paper without even running spellcheck.” Indeed, most university professors today probably would not accept hand-written research papers from students, and even the use of typewriters is largely a thing of the past.¹ In short, references to “writing” academic papers, news articles, and, frankly, just about anything, has

¹ See, e.g., Nicholas Jackson, *Last Typewriter Factory in the World Shuts Its Doors*, ATLANTIC, April 25, 2011, <https://www.theatlantic.com/technology/archive/2011/04/last-typewriter-factory-in-the-world-shuts-its-doors/237838/>; Don Woutat, *Smith Corona Bankruptcy Spells End of an Age*, L.A. TIMES,

generally become synonymous with using a computer to do so. When someone tells you that they are working on writing something, in most cases, the use of a computer is implied or assumed.

Of course, when you stop to think about it, technology has long brought about major changes in baseline assumptions. I attended graduate school at a university located in a small town in Upstate New York, and on one of the roads into town there was a run-down hotel with a sign out front informing passers-by, “Color TV in every room.” Needless to say, in 2018, if that is your biggest selling point as a hotel, then you might have trouble competing in the market for overnight lodging. Even the history of the word “computer” is telling.² Oxford University futurist and scholar Luciano Floridi tells us that the word’s meaning was similar to that of words such as accountant, bookkeeper, or auditor – the term “computer” used to refer to a job description category for human beings.³ In particular, Floridi states that

Between the seventeenth and the nineteenth centur[ies], it was synonymous with “a person who performs calculations” simply because there was nothing else in the universe that could compute autonomously. In 1890, for example, a competitive examination for the position of “computer” by the U.S. Civil Service had sections on “orthography, penmanship, copying, letter-writing, algebra, geometry, logarithms, and trigonometry.” . . . Yet by the time [pioneering computer scientist Alan] Turing published his classic paper entitled, “Computing machinery and intelligence,” he had to specify that, in some cases, he was talking about a “human computer,” because by 1950 he knew that “computer” no longer referred only to a person who computes.⁴

Today you would be hard pressed to find a job posting for “human computers.” That is, when someone mentions that work was done *by a computer*, people assume that the computer in question is a machine, not a human being.⁵

Similar changes to our common understandings have only accelerated in recent years. In 2011, renowned technologist and venture capitalist Marc Andreessen stated that “software is eating the world” to highlight the fact “that the boundary between technology companies and the rest of industry was becoming blurred, and that the ‘information economy’ would supplant the physical economy in ways that were not

July 6, 1995, http://articles.latimes.com/1995-07-06/news/mn-20683_1_smith-corona; Marc Fisher, *The Typewriter Reaches the End of the Line*, WASH. POST, July 6, 1995, https://www.washingtonpost.com/archive/lifestyle/1995/07/06/the-typewriter-reaches-the-end-of-the-line/a10dbfb1-e90d-470f-8f77-57ccdec2e400/?utm_term=.e0c933bcf06b; Laurence Zuckerman, *Smith Corona, a Computer Victim, Files for Bankruptcy*, N.Y. TIMES, July 6, 1995, <https://www.nytimes.com/1995/07/06/business/smith-corona-a-computer-victim-files-for-bankruptcy.html>.

² LUCIANO FLORIDI, *THE FOURTH REVOLUTION* 93 (2014).

³ *Id.*

⁴ *Id.*

⁵ Likewise, “[p]rior to World War II, a ‘calculator’ was a skilled professional[.]” JERRY KAPLAN, *ARTIFICIAL INTELLIGENCE: WHAT EVERYONE NEEDS TO KNOW* 2 (2016).

entirely obvious.”⁶ In short, Andreessen’s point was that just about every firm was a technology company – even those that had not realized it yet.

In 2019, eight years after Andreessen’s observation that software was eating the world, it is clear that software’s metaphorical appetite has been so strong that software and related technologies have “consumed,” so to speak, all manner of businesses, both in the financial sector and elsewhere. For example, not only do investment banks like Goldman Sachs⁷ and financial exchanges like Nasdaq⁸ view themselves as technology firms, but so do agricultural firms,⁹ supply-chain management and shipping companies,¹⁰ automakers,¹¹ and even health-care providers.¹² For example, former Goldman Sachs chief executive officer Lloyd Blankfein regularly stated that his investment bank was actually a technology

⁶ Andrew Burt, *The Law Is Adapting to a Software-Driven World*, *Fin. Times*, March 26, 2017; Marc Andreessen, *Why Software Is Eating the World*, *WALL ST. J.*, Aug. 20, 2011, <https://www.wsj.com/articles/SB1000142405311903480904576512250915629460>.

⁷ Jim Marous, *Marcus by Goldman Sachs: The Future of CX + Fintech in Banking?*, *FIN. BRAND*, April 9, 2018, <https://thefinancialbrand.com/71955/marcus-goldman-sachs-fintech-platform-banking-lending-strategy/> (noting that Goldman had “the stated goal of being considered a technology company instead of a bank”); *Goldman Sachs Gambles Big in AI*, *MEDIUM.COM*, April 11, 2018, <https://medium.com/@MarketMadhouse/goldman-sachs-gambles-big-in-ai-d94fed5bca40> (“Goldman Sachs has several AI initiatives in place including Marcus, an AI lending and banking platform that makes loans to individuals.”).

⁸ Reed Tucker, *Could a Robot Steal Your Job?*, *N.Y. POST*, March 5, 2017, 2017 WLNR 7040861 (“A recent experiment found that a computer algorithm correctly diagnosed 90 percent of lung cancer cases presented to it, outperforming a human physician by 40 percent.”); Nicole Bullock & Philip Stafford, *Nasdaq’s Future Lies in Tech, Data and Analytics, Says Chief*, *FIN. TIMES*, Oct. 12, 2017, <https://www.ft.com/content/6d72548a-af30-11e7-beba-5521c713abf4?myftTopics=1f37dfef-fc54-3be6-a475-dbf2bdb76fd9#myft.my-news:grid>; see also John Gapper, *Technology Outsmarts the Human Investor*, *FIN. TIMES*, March 8, 2017 (investors are fleeing hedge funds because “investors are less willing to pay for human interference”).

⁹ Emiko Terazono, *The Billion-dollar Agritech Startups Transforming Farming*, *FIN. TIMES*, Dec. 10, 2018; Emiko Terazono, *Future of Food: Inside Agritech’s Silicon Valley*, *FIN. TIMES*, Oct. 15, 2018; Kathrin Hille, *Taiwan’s Rice Farmers Use Big Data to Cope with Climate Change*, *FIN. TIMES*, Dec. 9, 2018; Chloe Cornish, *John Deere Ploughs a New Furrow with Algorithmic Acquisition*, *FIN. TIMES*, Sept. 11, 2017 (“The agricultural machinery company, with a \$38bn market valuation, announced last week it would pay \$305m for Silicon Valley start-up Blue River Technology, which uses machine learning to make agricultural spraying equipment more precise and cost-effective.”).

¹⁰ Jamie Condliffe, *Shipping Giants Are Looking to Self-Piloting Boats to Shift Cargo*, *FIN. TIMES*, June 9, 2017; *7 Startups Using AI, Satellites, And Data Science to Transform the Maritime Logistics Industry*, Nov. 8, 2017, <https://www.cbinsights.com/research/maritime-shipping-logistics-startups-to-watch/>; Adam Rogers, *Innovation Case Studies: How Companies Use Technology to Solidify a Competitive Advantage*, *FORBES*, April 13, 2018.

¹¹ Dec-Ann Durbin, *Delivery without Drivers: Domino’s, Ford Team up for Test*, *CHI. TRIBUNE*, Aug. 24, 2017; Sven Beiker, *How the Convergence of Automotive and Tech Will Create a New Ecosystem*, *MCKINSEY.COM*, Nov. 2016.

¹² Monique Brouillette, *Deep Learning Is a Black Box, but Healthcare Won’t Mind*, *MIT TECH. REV.*, April 27, 2017 (describing “a ‘deep learning’ algorithm that was capable of diagnosing potentially cancerous skin lesions as accurately as a board-certified dermatologist”); Michael K. Spencer, *Amazon Is Showing Healthcare Is the Next Big Thing for Machine Learning*, *MEDIUM*, Nov. 17, 2018, <https://medium.com/futuresin/amazon-is-showing-healthcare-is-the-next-big-thing-for-machine-learning-202446e4a7a3>.

company.¹³ And Blankfein wasn't joking. In recent years, Goldman Sachs has employed more software programmers and computer engineers than firms such as Facebook, Twitter, and LinkedIn.¹⁴

But the societal changes brought on by technology do not stop there. Recent years have seen the spread of artificial intelligence (AI) – loosely defined by some as computers that can engage in activities that would require intelligence if performed by a human – to more and more aspects of society. In 2017, Jensen Huang, the chief executive officer of chip-maker Nvidia, put an interesting twist on Andreessen's metaphor by stating that while software had eaten the world, AI would soon "eat software."¹⁵ By making this statement, Huang was echoing the sentiments of other technology experts who predict that, in the near future, AI will be ever-present in society, "[l]ike electricity, AI will prove to be an underlying, foundational technology that 'powers' everything else."¹⁶ To be clear, these technologists are not simply stating that AI systems will be a nice optional feature on particular services and

¹³ Kareem Chouli, *Every Financial Services Company Needs to Be a Technology Company*, FRAEDOM, Aug. 30, 2018, <https://www.fraedom.com/2620/every-financial-services-company-needs-to-be-a-technology-company/> (quoting Blankfein as saying, "Goldman Sachs is a technology firm"); Brittany W., *Goldman Sachs – A Technology Company?*, HARV. BUS. SCH. DIGITAL INITIATIVE, April 26, 2018, <https://digit.hbs.org/submission/goldman-sachs-a-technology-company/> ("In early 2017, Lloyd Blankfein (Goldman Sachs CEO) stated 'We are a technology firm. We are a platform.'"); Matt Levine, *It's Getting Harder to Tell Banks from Tech Companies*, BLOOMBERG, Feb. 15, 2018, <https://www.bloomberg.com/opinion/articles/2018-02-15/lloyd-blankfein-wants-goldman-sachs-to-push-technology> (referring to a presentation by Blankfein in which he emphasized that "Engineering underpins our growth initiatives," and "Engineering enhances client engagement through apps, machine learning and big data analytics"); Patrick Fisher, *All Companies Are Technology Companies Now*, THOMSON REUTERS, March 21, 2018, <https://blogs.thomsonreuters.com/answerson/all-companies-are-technology-companies-now/> ("Today, the distinction between technology and non-technology companies is becoming less relevant. . . . [Goldman Sachs] Chairman and CEO Lloyd Blankfein once said 'Goldman Sachs is a technology firm' and pointed to the fact that, at the time, the company employed more engineers than companies such as Facebook, Twitter, or LinkedIn.").

¹⁴ Jonathan Marino, *Goldman Sachs Is a Tech Company*, BUS. INSIDER, April 12, 2015, <http://www.businessinsider.com/goldman-sachs-has-more-engineers-than-facebook-2015-4>. "[O]f about 33,000 full-time employees at the bank, 9,000 of them are engineers and programmers. Facebook's total payroll, which includes non-tech personnel, consisted of 9,199 workers as of the last day of 2014, it said in its annual filing with the SEC. That number includes the many non-tech employees who are there to support and sell the product. Goldman's 9,000 also eclipse the entire payrolls of Twitter, which has 3,638 employees, and LinkedIn, which has 6,897 employees." *Id.*

¹⁵ Tom Simonite, *Nvidia CEO: Software Is Eating the World, but AI Is Going to Eat Software*, MIT TECH. REV., May 12, 2017; Peter Voss, *AI and Natural Language*, MEDIUM, Sept. 26, 2017 ("In the last 6 years we've gone from 'Software is eating the world' to 'AI is eating software.'").

¹⁶ Mike Elgan, *The Latest iPhones Show Why A.I. Is the New Electricity*, COMPUTERWORLD, Sept. 23, 2017, <https://www.computerworld.com/article/3227826/mobile-wireless/the-latest-iphones-show-why-ai-is-the-new-electricity.amp.html>; Daniel Eckert, *AI Is the New Electricity*, PRICEWATERHOUSECOOPERS, July 11, 2016, <http://usblogs.pwc.com/emerging-technology/ai-is-the-new-electricity/> (stating that "it's only a matter of time before 'AI powered' will be the new 'Electric' motor, 'Digital' widget, or 'Internet' enabled offering"); Kathleen J. Davis, *Machine Learning Could Be as Important to Future of Work as Electricity Once Was, Expert Says*, WESA, Jan. 8, 2018, <http://wesa.fm/post/machine-learning-could-be-important-future-work-electricity-once-was-expert-says#stream/0>.

operations, but instead they are predicting that “[l]ike electricity, [AI] will increasingly become easy to access and *necessary* to build into *everything*.”¹⁷

Based on recent technological advances, it does indeed appear that AI systems are spreading into just about every corner of business and life. AI systems “mow our lawns, vacuum our floors, and even milk our cows.”¹⁸ Speaking of cows, dairy farmers now talk about “connected cows” and “smart cows” to refer to cows that have had sensors placed on them so that the farmers, with the help of machine-learning algorithms, can continuously monitor the health of their herds to reduce cow mortality and increase fertility and milk production.¹⁹ Self-driving cars are serving as taxis,²⁰ AI-powered robots are delivering pizzas,²¹ and digital assistants like Amazon’s Alexa are checking people into hotels.²² In fact, not only are AI systems taking over warehouses and manufacturing factories,²³ but such systems

¹⁷ Elgan, *The Latest iPhones Show Why A.I. Is the New Electricity*, (emphasis added). AI is, and will continue to be pervasive, a fact that makes it more disruptive than “all of [the previous] human tech revolutions added together, including electricity, [the] industrial revolution, internet, [and] mobile internet[.]” said Kai-Fu Lee, founder of venture capital firm Sinovation Ventures and former head of Google China. Sophia Yan, *Artificial Intelligence Will Replace Half of All Jobs in Next Decade, Says Widely Followed Technologist*, CNBC.COM, April 27, 2017. “‘I think future generations are going to look back on the AI revolution and compare its impact to the steam engine or electricity,’ said Erik Brynjolfsson, director of the Initiative on the Digital Economy at Massachusetts Institute of Technology.” Steve Lohr, *The Promise of Artificial Intelligence Unfolds in Small Steps*, N.Y. TIMES, Feb. 28, 2016.

¹⁸ Daniela Rus, *Rise of the Robots: Are You Ready?*, FIN. TIMES, March 7, 2018.

¹⁹ Nic Fildes, *Meet the “Connected Cow,”* FIN. TIMES, Nov. 24, 2017, <https://www.ft.com/content/2db7e742-7204-11e7-93ff-99f383b09ff9>; Kathy Pretz, *Connected Cattle: Wearables Are Changing the Dairy Industry*, May 6, 2016, <http://theinstitute.ieee.org/technology-topics/life-sciences/connected-cattle-wearables-are-changing-the-dairy-industry>. For example, pedometers can determine if a particular cow “is walking too little or too much – a key sign of its health and whether it is in oestrus (in a peak fertility phase).” Fildes, “*Connected Cow*.” “Being able to predict accurately when a heifer should be inseminated, and which genetic lines are producing the biggest milk yield, can dramatically improve efficiency and productivity.” *Id.*; Steve Lohr, *Robotic Milkers and an Automated Greenhouse: Inside a High-Tech Small Farm*, N.Y. TIMES, Jan. 13, 2019.

²⁰ Peter Campbell, *Trucks Headed for a Driverless Future*, FIN. TIMES, Jan. 31, 2018; Sven Beiker, *How the Convergence of Automotive and Tech Will Create a New Ecosystem*, MCKINSEY.COM, Nov. 2016.

²¹ When the delivery robot arrives at its destination, customers use an app to unlock the storage compartment and take their items. Javier Espinoza, *Delivery Robots Hit the Streets, but Some Cities Opt Out*, FIN. TIMES, Jan. 31, 2018.

²² Eduardo Porter, *Hotel Workers Fret over a New Rival: Alexa at the Front Desk*, N.Y. TIMES, Sept. 24, 2018, https://www.nytimes.com/2018/09/24/business/economy/hotel-workers-ai-technology-alexa.html?rref=collection%2Fsectioncollection%2Ftechnology&action=click&contentCollection=technology®ion=stream&module=stream_unit&version=latest&contentPlacement=2&pgtype=sectionfront.

²³ Elizabeth Kolbert, *Our Automated Future*, NEW YORKER, Dec. 19 & 26, 2017; Michael Pooler, *Robot Army Is Transforming Global Workplace*, FIN. TIMES, Nov. 20, 2017; see also Declan Butler, *A World Where Everyone Has a Robot: Why 2040 Could Blow Your Mind*, NATURE, Feb. 24, 2016 (“Researchers told *Nature* that they foresee a future just 20 years from now – or even sooner – in which robots with AI are as common as cars or phones and are integrated into families, offices and factories.”).

also are diagnosing patients' illnesses,²⁴ analyzing draft contracts for potential legal issues,²⁵ and writing news stories on topics ranging from sports games to the announcements of company financial results.²⁶ Even toilets are becoming "smart" thanks to AI technology, as recent years have seen the introduction of AI toilets, some of which come equipped with Amazon's Alexa digital assistant and are able to analyze urine and stool samples for illnesses, thereby enabling early diagnosis of potential medical problems.²⁷

The substantial impacts that advances in AI and robotics are having on society have led some to suggest the need for oversight of these technologies. Ryan Calo is

²⁴ Nina Avramova, *AI Technology Can Identify Genetic Diseases by Looking at Your Face, Study Says*, CNN, Jan. 8, 2019, <https://www.cnn.com/2019/01/08/health/ai-technology-to-identify-genetic-disorder-from-facial-image-intl/index.html> ("A new artificial intelligence technology can accurately identify some rare genetic disorders using a photograph of a patient's face, according to a new study. . . . Peter McOwan, professor of computer science at Queen Mary University of London, said in an email to CNN: "This is yet another fantastic potentially life changing application of AI tech. When we see so many negative stories round AI technology it's good to be reminded of the real benefits it can provide to humanity."); Melissa Locker, *Artificial Intelligence Can Detect Alzheimer's in Brain Scans Six Years before a Diagnosis*, Fast Co., Jan. 3, 2019, <https://www.fastcompany.com/90287723/artificial-intelligence-can-detect-alzheimers-in-brain-scans-six-years-before-a-diagnosis>; Brouillette, *Deep Learning Is a Black Box, but Healthcare Won't Mind*, MIT TECH. REV., April 27, 2017.

²⁵ Dan Mangan, *Lawyers Could Be the Next Profession To Be Replaced by Computers*, CNBC, Feb. 17, 2017, <http://www.cnbc.com/2017/02/17/lawyers-could-be-replaced-by-artificial-intelligence.html>; Jane Croft, *Law Firms Programmed for More Technological Disruption*, FIN. TIMES, June 1, 2017, <https://www.ft.com/content/8a4d4634-29a0-11e7-bc4b-5528796fe35c?myftTopics=NTI3YmY4YjctMjMxYy00NjkxLTljMDMtOTQ0MWEzZDBmMjMz-VG9waWNz#myft:my-news:grid>; Reena SenGupta, *Top Legal Practices Face Up to "Do or Die" Tech Challenge*, FIN. TIMES, Dec. 10, 2018, <https://www.ft.com/content/dca58c84-f307-11e8-ae55-df4bf40f9d0d>.

²⁶ Penny Crosman, *Startup Outfit Applies AI to Tell Stories, Prevent Fraud*, AM. BANKER, Nov. 13, 2013, at 7; see also Bonnie Henry, *Robots Will Never Write This Column, Bonnie Said*, ARIZ. DAILY STAR, Aug. 24, 2014, at E2.

²⁷ Chris Mahon, *Tech CEO: Artificial Intelligence Toilets Will Soon Scan Your Poop to Diagnose Illness*, OUTER PLACES, Nov. 14, 2018, <https://www.outerplaces.com/science/item/19069-toilet-poop-artificial-intelligence>; Curtis Silver, *Kohler Unveils Intelligent, Alexa-Enabled Smart Toilet for Your Dumb Butt*, KNOW TECHIE, Jan. 7, 2019, <https://knowtechie.com/kohler-alexa-toilet-numi/> (describing the "Numi 2.0 Intelligent Toilet," which "has personalized cleansing and dryer functions, a heated seat and built-in speakers" as well as "lighting features and voice control"); Dan Patterson & Thom Craver, *CES 2019 Day 1 Features Impossible Burger 2.0, Smart Toilet and Smarter Cars*, CBS NEWS, Jan. 8, 2019, <https://www.cbsnews.com/live-news/ces-2019-day-1-today-impossible-burger-smart-toilet-ford-smarter-cars-technology-2019-01-08/> ("Kohler announced a new smart toilet. The company's intelligent toilet is a part of the company's smart bathroom collection and will be a 'fully immersive experience' with a heated seat, personalized cleansing, ambient lighting, voice control and Amazon Alexa support").

Kohler says a cleansing feature utilizes warm water that alternates between soft and strong pressure is an alternative to toilet tissue. The toilet rinses itself before and after use."); Anthony Cuthbertson, *CES 2019: Bread Robots, Bendy Phones, Talking Toilets, and Everything Else from Day 1: "Alexa, Flush the Toilet,"* INDEPENDENT [UK], Jan. 7, 2019, <https://www.independent.co.uk/life-style/gadgets-and-tech/news/ces-2019-first-day-roundup-bread-robot-talking-toilet-alexa-smart-home-a8716011.html>; Geoffrey A. Fowler & Hayley Tsukayama, *Snuggle Robots and Talking Toilets: CES 2018's Wildest Gadgets*, WASH. POST, Jan. 9, 2018, https://www.washingtonpost.com/news/the-switch/wp/2018/01/09/snuggle-robots-and-talking-toilets-ces-2018s-wildest-gadgets/?utm_term=.60659bed6211.

an associate law professor at the University of Washington and a co-director of the school's Tech Policy Lab who has advocated for the creation of a federal robotics commission. In 2018, Professor Calo reiterated his belief that Congress would need to address the issue of oversight for autonomous AI systems, telling the *Wall Street Journal* that

One of the ironies of artificial intelligence is that proponents often make two contradictory claims. They say artificial intelligence is going to change everything, but there should be no changes to law or legal institutions in response. That doesn't make sense to me. The question is not whether there should be regulation but how can regulation best channel AI toward its ultimate goal of promoting human flourishing.²⁸

Calo emphasized that governments could not count on the tech industry, by itself, to engage in sufficient oversight and governance of AI systems, adding that “[t]he idea that by being hands-off we’ll achieve an optimal result strikes me as optimistic to the point of being goofy.”²⁹ Indeed, the majority sentiment does *not* appear to be that AI systems, such as self-driving cars and self-flying delivery drones, should be completely free from government oversight and regulation, but that the government has a legitimate role in policing these technologies.

Given that AI systems are now operating in – or on – everything from cows to toilets, it should not be surprising to learn that the financial markets – including the financial markets for futures, commodity options, swaps, and other derivatives – have been transformed by advances in automation and AI in recent years. As with many other industries, AI systems, such as automated trading systems (ATSs) that enable investment funds to engage in algorithmic trading and computerized trade matching engines for exchanges, have proliferated inside financial institutions, stock and derivatives exchanges, and commodity brokers and collective investment funds. Indeed, in 2013, the then-Chairman of the CFTC, Gary Gensler, stated:

We have witnessed a fundamental shift in markets from human-based trading to highly automated electronic trading. Automated trading systems, including high frequency traders, enter the market and execute trades in a matter of milliseconds without human involvement. Electronic trading makes up over 91 percent of the futures market.³⁰

²⁸ Heidi Vogt, *What Kind of Regulation Does AI Need? Three Experts Debate What the Government Should Do – and When*, WALL ST. J., April 30, 2018, at R8. “AI lets people dictate text messages instead of typing them, or call up music from a smart speaker on the kitchen counter. That does not mean that policymakers can ignore AI, however. As it is applied in a growing number of areas, there are legitimate concerns about possible unintended consequences.” *There Are No Killer Robots Yet – But Regulators Must Respond to AI in 2019*, ECONOMIST, Jan. 2, 2019.

²⁹ Vogt, *What Kind of Regulation Does AI Need?*, at R8.

³⁰ Concept Release on Risk Controls and System Safeguards for Automated Trading Environments, 78 Fed. Reg. 56,542, 56,573 app. 2 (Sept. 12, 2013).

Gensler’s statements reflected the reality that electronic computer systems and software algorithms had, by that time, largely replaced the human floor brokers and floor traders who once shouted out bids and offers in the physical trading pits of futures exchanges.³¹ More recently, in November of 2018, CFTC Chair J. Christopher Giancarlo spoke at a conference on financial technology hosted by Georgetown University Law Center in Washington, DC, stating

It is certainly no surprise to this audience that, just as our lives are being transformed, so the world’s trading markets are going through the same digital revolution from analog to digital, from human to algorithmic trading and from stand-alone centers to interconnected trading webs. Emerging digital technologies are impacting trading markets and the entire financial landscape with far ranging implications for capital formation and risk transfer. They include algorithm-based trading, “smart” contracts, Distributed Ledger Technology (DLT), and . . . big data, automated data analysis, and artificial intelligence (AI).³²

This is a book about how the changes brought about by automation and AI to the markets for derivatives have affected legal and regulatory issues related to the oversight of those markets. So why do I mention somewhat obvious facts by noting that practically everyone writes academic papers on computers and that a wide swath of traditional businesses employ AI in their core operations? Because just as the use of computers has become more or less essential to writing academic papers, so to will the use of automation and AI become essential to buying or selling derivatives and other financial instruments.

Today people refer to the “digital economy” to mean “economic processes, transactions, interactions and activities that are based on digital technologies.”³³

³¹ See Hearing on High Frequency and Automated Trading in Futures Markets Before the S. Comm. of Agric., Nutrition & Forestry, 113th Cong. (2014), available at <http://www.ag.senate.gov/hearings/high-frequency-and-automated-trading-in-futures-markets> (providing the written testimony of Andrei Kirilenko, professor of the practice of finance at the Sloan School of Management, Massachusetts Institute of Technology, and former chief economist for the CFTC); *id.* (“Today, trading floors have been replaced by server farms, prescribed gestures have been replaced by message protocols, and automated trading is not visible to the human eye. The traders themselves have been replaced by anonymous algorithms that often operate with little or no oversight.”); SCOTT PATTERSON, DARK POOLS: HIGH-SPEED TRADERS, AI BANDITS, AND THE THREAT TO THE GLOBAL FINANCIAL SYSTEM 273 (2012) (quoting US Senator Ted Kaufman, who said, “We basically went from a market that was a floor-based market to a market that was digitalized and decimalized. . . . People came into the market and began to develop these high-speed computers. Human beings were no longer doing the trading, computers were. They developed these algorithms. It ran automatically.”). See generally Jerry W. Markham & Daniel J. Harty, For Whom the Bell Tolls: The Demise of Exchange Trading Floors and the Growth of ECNs, 33 J. CORP. L. 865 (2008) (concluding that technological advances are making trading floors obsolete).

³² J. Christopher Giancarlo, *Keynote Address of Chairman J. Christopher Giancarlo at FinTech Week, Georgetown University Law School*, CFTC.GOV, Nov. 7, 2018, <https://www.cftc.gov/PressRoom/SpeechesTestimony/opagiancarlo59>.

³³ *Digital Economy*, TECHOPEDIA, <https://www.techopedia.com/definition/32989/digital-economy> (“The digital economy is different from the internet economy in that the internet economy is based on

“E-commerce” is short for electronic commerce, and it “refers to business over the Internet.”³⁴ Likewise, “algorithmic trading,” refers to trading derivatives, stocks, bonds, and currencies via computer algorithm and not a through a human trader.³⁵ “FinTech” is short for “financial technology,” and generally refers to the “new financial industry that applies technology to improve financial activities.”³⁶ Just as Oxford University’s Floridi has stated that the distinction between being online and offline is rapidly disappearing and thereby destined for irrelevance,³⁷ I believe that in the very near future, using phrases like “algorithmic trading” and “e-commerce” will be anachronisms – the equivalent of telling someone that you wrote your research paper *on a computer* or that you stayed at a hotel *that has a color TV in every guest room*. Algorithmic trading will simply be *trading*. E-commerce will simply be *commerce*. And all of finance will be FinTech, making the use of that term redundant. In the near future (if not already), one would be just as likely to send their spouse a friendly message by carrier pigeon (as opposed to a text) as they would be to fulfill an order for a futures trade through a human broker standing on the floor of a physical exchange (as opposed to having an algo bot send an electronic order message to an exchange’s computerized trade matching engine). Technological innovations have shaped, and will continue to shape, the nature of the world around us, transforming how the financial markets function.

This fact has enormous implications for the law and for lawyers because if technology and AI “eat the world” and are an integral part of practically every aspect of society, then all lawyers will need to understand tech and AI legal issues. When AI and robots are everywhere, then all lawyers will need to be AI and robot law practitioners. The spread of automation and AI have fundamentally changed many aspects of the markets for futures and other derivatives, such that the crowded

internet connectivity, whereas the digital economy is more broadly based on any of the many digital tools used in today’s economic world.”).

³⁴ *E-commerce*, TECH TERMS, <https://techterms.com/definition/ecommerce>.

³⁵ *Algorithmic Trading*, INVESTOPEDIA, <https://www.investopedia.com/terms/a/algorithmictrading.asp>.

³⁶ Patrick Schueffel, *Taming the Beast: A Scientific Definition of FinTech*, 4 J. OF INNOV. MGMT 32 (2016).

³⁷ “In the near future, the distinction between online and offline will become ever more blurred and then disappear.” LUCIANO FLORIDI, *THE FOURTH REVOLUTION* 43 (2014). “For example, it already makes little sense to ask whether one is online or offline when driving a car following the instructions of a navigation system that is updating its database in real time.” *Id.* Floridi is not the only person who believes that the distinction between being “online” and “offline” will disappear. AI expert Kai-Fu Lee uses the acronym, “OMO,” which stands for online-merge-of-offline), to refer to “the combining of our digital and physical worlds such that every object in our surrounding environment will become an interaction point for the internet – as well as a sensor that collects data about our lives.” Karen Hao, *The Age of Voice*, *THE ALGORITHM* from MIT TECH. REV., Jan. 11, 2019; see Alex Williams, *Do You Take This Robot . . .*, N.Y. TIMES, Jan. 19, 2019, https://www.nytimes.com/2019/01/19/style/sex-robots.html?utm_campaign=the_algo_rithm.unpaid.engagement&utm_source=hs_email&utm_medium=email&utm_content=69200375&_hsenc=p2ANqtz-qx3S3f816hUVLAf9PtCPbrZDDqY5UzWCYUfIhHWvjvPmzIIKwZpoyoV_VqITwo2fD8JhEJFXQUTNFgX5KonQwUyPolQ&_hsmi=69200375 (quoting a technology company entrepreneur as saying, “Subsequent generations will have never known a distinction between their online and offline lives.”).

physical trading floors that were once filled with human brokers and traders shouting out bids and offers largely have been replaced with electronic, computerized servers and networks. For that reason, one cannot understand the challenges facing the law and regulations of the markets for derivatives without understanding the primary issues related to the increasing prevalence of automation and AI in these markets.

This is no small task. The fact that automated trading systems (ATSs) powered by software algorithms – i.e., the algo bots referenced in this book’s title – and not humans make the majority of trades presents legal and regulatory challenges for the US derivatives market regulator, the Commodity Futures Trading Commission (CFTC), which administers the Commodity Exchange Act (CEA). For example, in the United States, the majority of causes of action for market manipulation and disruptive trading practices require proof that the wrongdoer acted with a culpable mental state. Even in cases where firms are accused of engaging in market abuse, the requisite culpable mental state must be found in the mind (or minds) of the firms’ human officers, employees, or agents. In situations where an ATS or AI system initiates the improper trading activities without being directed to do so by a human, it would probably be difficult for a regulator to prove that the requisite culpable mental state existed, even though disruptive trading practices have the same negative effects on the markets regardless of whether they are performed by humans or software algorithms. This problem is not unique to causes of action for misconduct in the financial markets – it appears in many situations where AI systems or autonomous artificial agents take actions that would be illegal if performed by a human – and has been referred to by legal scholars as the “accountability gap.”³⁸

As mentioned above, Professor Calo aptly stated that the fact that AI systems are dramatically reshaping how large swaths of business, finance, and commerce operate is inconsistent with the proposition that the laws and regulations governing these areas should remain the same. But Calo is not the only person who has had this view – indeed, his cogent reasoning has an indirect, but old, pedigree. Francis Bacon, the English statesman and philosopher, is known for saying, “He that will not apply new remedies must expect new evils, for time is the greatest innovator.”³⁹ Although Bacon passed away long ago – in 1626 – his wisdom is applicable to the challenges that society faces today. The changes that automation and AI are causing in the markets for derivatives will undoubtedly necessitate changes to the laws and regulations governing these markets, whether it is to find legal mechanisms to address the accountability gap when AI-powered trading systems manipulate the prices of derivatives or to remedy other problematic issues that are either created or exacerbated by automation and AI systems operating in the financial markets.

Because this book analyzes the primary legal and regulatory issues associated with the activities of automated and AI systems in the financial markets for derivatives, the

³⁸ See, e.g., Lynn LoPucki, *Algorithmic Entities*, 95 WASH. U. L. REV. 887, 901 & n.76 (2018).

³⁹ Francis Bacon Quotes. (n.d.). BrainyQuote.com. Retrieved January 8, 2019, from BrainyQuote.com Web site: https://www.brainyquote.com/quotes/francis_bacon_130602.