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Re: Comments on the Cybersecurity Roundtable; File Number 4-673

Ms. Elizabeth M. Murphy
Secretary, Securities and Exchange Commission
100 F Street, NE
Washington, DC 20549-1090

Dear Ms. Murphy:

I am a law professor at Temple University Beasley School of Law. I research, teach, and write in the areas of corporate law and securities regulation. This comment letter is provided in response to the solicitation by the Securities and Exchange Commission (the "Commission") for comments on the Commission's Cybersecurity Roundtable held on March 26, 2014 (the "Roundtable"). I have written two recent studies relating to cybersecurity and our capital markets. The studies, *The New Investor*, 60 UCLA LAW REVIEW 678 (2013)[1] and *The New Financial Industry*, 65 ALABAMA LAW REVIEW 567 (2014),[2] are submitted with this letter.

I am thus very supportive of the Commission's recent Roundtable and its attention to cybersecurity. I urge continuing attention and efforts to issues relating to cybersecurity and our capital markets. In particular, I would like to highlight four broad issues for the Commission's consideration that are detailed at length in the accompanying studies:

1. Cybersecurity threats to the high-speed, electronically connected modern capital markets can create new systemic risks that I have termed as *Too Fast To Save* and *Too Linked To Fail*.

2. Due to advances in artificial intelligence and financial technology, many financial choices are now being made by hybrid decision-makers that are best characterized as cyborgs, part human and part machine, which do not comport congruently with many traditional modes of securities regulation.

[1] *The New Investor*, 60 UCLA L. REV. 678 (2013) is available at: http://ssrn.com/abstract=2227498.
[2] *The New Financial Industry*, 65 ALA. L. REV. 567 (2014) is available at: http://ssrn.com/abstract=2417988.

3. Incentives, in addition to penalties, should be designed and utilized to encourage firms to swiftly upgrade their cybersecurity capabilities.

4. Private regulation in connection with cybersecurity should be vigorously enhanced and leveraged to better complement government regulation.

I appreciate the opportunity to participate in this process, and would be happy to discuss my comments or any questions the Commission may have with respect to this letter. Any questions about this letter may be directed to Tom.Lin@Temple.edu.

Sincerely,

/s/ Tom C.W. Lin

Attachments:

1. *The New Investor*, 60 UCLA L. REV. 678 (2013)
2. *The New Financial Industry*, 65 ALA. L. REV. 567 (2014)

THE NEW FINANCIAL INDUSTRY

Tom C.W. Lin[*]

Modern finance is undergoing a fundamental transformation. Artificial intelligence, mathematical models, and supercomputers have replaced human intelligence, human deliberation, and human execution. A financial industry once dominated by humans has evolved into one where humans and machines share power. Modern finance is becoming cyborg finance—an industry that is faster, larger, more complex, more global, more interconnected, and less human.

This Article offers an early systemic examination of this ongoing financial transformation, and presents an original set of regulatory principles for governing the emerging, new financial industry. This Article provides a normative and descriptive cartography of this changing financial landscape. It identifies particular perils, systemic risks, and regulatory shortcomings emanating from this financial transformation. It then proposes new guiding principles for the future of financial regulation in response to this sea-change. Drawing from a rich literature of past financial crises and transformations, this Article explores the next big movement in finance and financial regulation. And it offers fresh insights for better addressing the perils and promises emerging from the new financial industry.

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* Associate Professor of Law, Temple University Beasley School of Law. Many thanks to Miriam Baer, Michael Cahill, Stuart Cohn, David Hoffman, Jerold Israel, Jennifer Laurin, Lawrence Lokken, Gregory Mandel, Eleanor Myers, Jason Nance, William Page, David Post, Christopher Slobogin, and workshop participants at American University Washington College of Law, the University of Florida Levin College of Law, and the University of Georgia School of Law for helpful comments and exchanges. Additionally, I am grateful to Amanda Harris and Sara Hoffman for their extraordinary research assistance.

INTRODUCTION

Machines are taking over Wall Street.[1] Artificial intelligence, mathematical models, and supercomputers have replaced human intelligence, human deliberation, and human execution.[2] The modern financial industry is becoming faster, larger, more complex, more global,

1. *See, e.g.*, DAVID J. LEINWEBER, NERDS ON WALL STREET: MATH, MACHINES, AND WIRED MARKETS 31–64 (2009) (chronicling the rise of new, electronic financial markets); Jonathan R. Macey & Maureen O'Hara, *From Markets to Venues: Securities Regulation in an Evolving World*, 58 STAN. L. REV. 563, 563 (2005) ("Advances in technology, combined with the dramatic decrease in the cost of information processing, have conspired to change the way that securities transactions occur."); Saule T. Omarova, *Wall Street as Community of Fate: Toward Financial Industry Self-Regulation*, 159 U. PA. L. REV. 411, 430 (2011) (describing finance as "[a]n increasingly complex marketplace, [with] dependence on fast-changing technology"); Felix Salmon & Jon Stokes, *Bull vs. Bear vs. Bot*, WIRED, Jan. 2011, at 93 ("It's the machines' market now; we just trade in it.").

2. *See* Frank J. Fabozzi et al., *High-Frequency Trading: Methodologies and Market Impact*, 19 REV. FUTURES MKTS. 7, 9–10 (2011) (describing the essential role of computerization in financial trading); Jonathan Keats, *Thought Experiment: Neuroscientist Henry Markram Says He Can Build a Supercomputer Replica of the Human Brain. Now He Has $1.3 Billion to Prove It*, WIRED, June 2013, at 171 (reporting on plans to build a computerized replication of the human brain); Salmon & Stokes, *supra* note 1 ("Algorithms have become so ingrained in our financial system that the markets could not operate without them.").

more interconnected, and less human.[3] An industry once dominated by humans has evolved into one where humans and machines share dominion.

This Article is about that transformation and the regulatory principles that should govern it. This Article offers one of the first systemic examinations of this ongoing financial transformation and presents an original set of regulatory tenets for governing the emerging, new financial industry. [4] This Article normatively and descriptively traces the journey of this financial transformation, highlights promising and perilous paths, explains current regulatory shortcomings, and proposes new guiding principles for the road ahead.

While policymakers, commentators, and scholars continue to look back and study the last financial crisis,[5] this Article looks forward to what is emerging in finance and financial regulation. Drawing on a rich literature of past financial crises and transformations,[6] this Article examines the next big movement in finance and financial regulation.

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3. *See* SCOTT PATTERSON, DARK POOLS: HIGH-SPEED TRADERS, A.I. BANDITS, AND THE THREAT TO THE GLOBAL FINANCIAL SYSTEM 233–78 (2012); Andrew G. Haldane, Exec. Dir. Fin. Stability, Bank of Eng., The Race to Zero: Speech at the International Economic Association Sixteenth World Congress 3 (July 8, 2011) (transcript available at http://www.bankofengland.co.uk/publications/speeches/2011/speech509.pdf) (commenting on fundamental changes in the financial industry over the last century).

4. In a previous article, the author examined the rise of machines in finance and its impact on legal conceptions of the investor. The present Article builds upon the normative and descriptive examination of that publication and extends it to the financial industry and financial regulation at large. *See* Tom C.W. Lin, *The New Investor*, 60 UCLA L. REV. 678, 699–703 (2013).

5. *See, e.g.*, CONG. OVERSIGHT PANEL, SPECIAL REPORT ON REGULATORY REFORM: MODERNIZING THE AMERICAN FINANCIAL REGULATORY SYSTEM: RECOMMENDATIONS FOR IMPROVING OVERSIGHT, PROTECTING CONSUMERS, AND ENSURING STABILITY 3–4 (2009) (suggesting reforms to improve oversight, transparency, and fairness); DEP'T OF THE TREASURY, BLUEPRINT FOR A MODERNIZED FINANCIAL REGULATORY STRUCTURE (2008), *available at* http://www.treasury.gov/press-center/press-releases/Documents/Blueprint.pdf; FIN. CRISIS INQUIRY COMM'N, THE FINANCIAL CRISIS INQUIRY REPORT: FINAL REPORT OF THE NATIONAL COMMISSION ON THE CAUSES OF THE FINANCIAL AND ECONOMIC CRISIS IN THE UNITED STATES (2011), *available at* http://www.gpo.gov/fdsys/pkg/GPO-FCIC/pdf/GPO-FCIC.pdf; S. PERMANENT SUBCOMM. ON INVESTIGATIONS, WALL STREET AND THE FINANCIAL CRISIS: ANATOMY OF A FINANCIAL COLLAPSE (2011), *available at* http://www.hsgac.senate.gov/public/_files/Financial_Crisis/FinancialCrisisReport.pdf; DAVID SKEEL, THE NEW FINANCIAL DEAL (2011); Jeffrey N. Gordon & Christopher Muller, *Confronting Financial Crisis: Dodd-Frank's Dangers and the Case for a Systemic Emergency Insurance Fund*, 28 YALE J. ON REG. 151 (2011); Henry T. C. Hu, *Too Complex to Depict? Innovation, "Pure Information," and the SEC Disclosure Paradigm*, 90 TEX. L. REV. 1601 (2012); Adam J. Levitin, *In Defense of Bailouts*, 99 GEO. L.J. 435 (2011); Andrew W. Lo, *Regulatory Reform in the Wake of the Financial Crisis of 2007–2008*, 1 J. FIN. ECON. POL'Y 4 (2009); Steven L. Schwarcz, *Protecting Financial Markets: Lessons from the Subprime Mortgage Meltdown*, 93 MINN. L. REV. 373 (2008); Frederick Tung, *Pay for Banker Performance: Structuring Executive Compensation for Risk Regulation*, 105 NW. U. L. REV. 1205 (2011); Charles K. Whitehead, *Reframing Financial Regulation*, 90 B.U. L. REV. 1 (2010).

6. *See, e.g.*, RAGHURAM G. RAJAN, FAULT LINES: HOW HIDDEN FRACTURES STILL THREATEN THE WORLD ECONOMY (2010); CARMEN M. REINHART & KENNETH S. ROGOFF, THIS TIME IS DIFFERENT: EIGHT CENTURIES OF FINANCIAL FOLLY xxxix (2009); Lucian A. Bebchuk & Holger Spamann, *Regulating Bankers' Pay*, 98 GEO. L.J. 247 (2010); Chris Brummer, *Stock Exchanges and the*

The objective of this Article is not to perfectly forecast the future of finance, nor is it to present an elegant, quixotic regulatory framework with specific rules to prevent all financial flaws and failures.[7] Rather, the objectives of this Article are more sensible and practical: First, this Article seeks to offer a new and better understanding of the rise of computerization and artificial intelligence in the financial industry and its wide-ranging effects on financial regulation. Second, this Article aims to present a preliminary set of guiding principles for thinking anew about regulatory design in this changing financial landscape. Collectively, this Article attempts to map the path of modern finance and financial regulation, from the recent past to the ongoing present, so as to provide an early guide for the emerging future. Inevitably, such an effort to chart the continuing, complex metamorphosis of modern finance and its regulation will be preliminary, unfinished, and dated. Yet, it is a shift that must be sketched and studied, for the effects of the ongoing financial transformation have become too consequential to ignore or wait.[8]

This Article endeavors this dynamic cartography of modern finance and financial regulation in five parts. Part I charts the road traveled and the road ahead. It offers a retrospective on how technological advances and financial innovations have transformed the financial industry into a new industry that is faster, larger, more complex, more global, more interconnected, and less human. It then previews key attributes of the emerging, new financial industry relating to technological progress,

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New Markets for Securities Laws, 75 U. CHI. L. REV. 1435 (2008); Charles W. Calomiris, *The Subprime Turmoil: What's Old, What's New, and What's Next*, 15 J. STRUCTURED FIN. 6 (2009); Stephen J. Choi & Andrew T. Guzman, *Portable Reciprocity: Rethinking the International Reach of Securities Regulation*, 71 S. CAL. L. REV. 903 (1998); John C. Coffee, Jr. & Hillary A. Sale, *Redesigning the SEC: Does the Treasury Have a Better Idea?*, 95 VA. L. REV. 707 (2009); Joseph A. Grundfest, *Punctuated Equilibria in the Evolution of United States Securities Regulation*, 8 STAN. J.L. BUS. & FIN. 1 (2002); Henry T.C. Hu, *Swaps, the Modern Process of Financial Innovation and the Vulnerability of a Regulatory Paradigm*, 138 U. PA. L. REV. 333 (1989); Howell E. Jackson, *Regulation in a Multisectored Financial Services Industry: An Exploration Essay*, 77 WASH. U. L.Q. 319 (1999); Kathryn Judge, *Fragmentation Nodes: A Study in Financial Innovation, Complexity, and Systemic Risk*, 64 STAN. L. REV. 657, 701 (2012); Donald C. Langevoort, *Chasing the Greased Pig Down Wall Street: A Gatekeeper's Guide to the Psychology, Culture, and Ethics of Financial Risk Taking*, 96 CORNELL L. REV. 1209 (2011); Steven L. Schwarcz, *Systemic Risk*, 97 GEO. L.J. 193, 200 (2008); Jill E. Fisch, *Top Cop or Regulatory Flop? The SEC at 75*, 95 VA. L. REV. 785 (2009); James D. Cox, *Coping In A Global Marketplace: Survival Strategies For A 75-Year-Old SEC*, 95 VA. L. REV. 941 (2009).

7. Financial failures and crises will inevitably occur again. No financial regulatory framework will ever be fail-safe. *See* REINHART & ROGOFF, *supra* note 6, at xxvi ("Of course, financial crises are nothing new. They have been around since the development of money and financial markets.").

8. Charles Reich in his seminal work, *The New Property*, makes a similar concession in his commentary about the then-transforming and transformative role of government on property, wealth, and individualism. *See* Charles A. Reich, *The New Property*, 73 YALE L.J. 733, 733 (1964) ("Inevitably, such an effort must be incomplete and tentative. But it is long past time that we began looking at the transformation taking place around us.").

traditional financial structures, the growth of "shadow banking,"[9] and the role of humans in the future of finance.

Part II highlights threats along the way. It reviews the Flash Crash of May 6, 2010, which, in minutes, destroyed nearly $1 trillion in market capitalization.[10] It forewarns of similar crashes in the future given the increasing reliance of finance on computerized systems. Part II then discusses new crimes and perils as the new financial industry migrates into cyberspace on a grand scale. It warns of threats posed by hackers, spies, criminals, competitors, and other nation-states.

Part III foreshadows new systemic dangers. It asserts that the enhanced speed and interconnectedness of the new financial industry presents two underappreciated systemic risks of speed and connectivity. The risk relating to speed is termed "too fast to save," and the risk relating to connectivity is termed "too linked to fail." Part III argues that these new systemic risks will be at least as challenging and pressing as the widely recognized systemic risk of "too big to fail."[11]

Part IV contends with structural pitfalls. It identifies fundamental shortcomings in the current regulatory framework that render law and regulation unsuitable for better monitoring finance under the prevailing governance model. Part IV explains why core matters relating to jurisdiction, origination, and resource prevent regulators from effectively governing the emerging, new financial industry.

Part V offers a new way forward. Mindful of the perils and pitfalls articulated in the previous Parts, it proposes an original set of regulatory, first principles to better harness the potential and promise of the changing financial landscape. These proposed tenets address issues fundamental to financial regulation including effectiveness, transparency, speed, coordination, bailouts, costs, and accountability. Part V concludes with a reminder that the proposed tenets should serve as principles of regulatory

9. *See* Lo, *supra* note 5, at 13–18 (discussing the emergence of shadow banking in the modern financial infrastructure); Steven L. Schwarcz, *Regulating Shadow Banking: Inaugural Address for the Inaugural Symposium of the Review of Banking & Financial Law*, 31 REV. BANKING & FIN. L. 619, 620–26 (2012) (defining shadow banking).

10. *See generally* U.S. COMMODITY FUTURES TRADING COMM'N & U.S. SECS. AND EXCH. COMM'N, FINDINGS REGARDING THE MARKET EVENTS OF MAY 6, 2010 1–6 (2010) [hereinafter CFTC & SEC FINDINGS], *available at* http://www.sec.gov/news/studies/2010/marketevents-report.pdf (summarizing the Flash Crash).

11. For an overview of the too-big-to-fail systemic risk, see S. PERMANENT SUBCOMM. ON INVESTIGATIONS, *supra* note 5, at 15–17 (reporting on the rise of too-big-to-fail financial institutions); ANDREW ROSS SORKIN, TOO BIG TO FAIL: THE INSIDE STORY OF HOW WALL STREET AND WASHINGTON FOUGHT TO SAVE THE FINANCIAL SYSTEM FROM CRISIS—AND THEMSELVES 538–39 (2009) (discussing the policy challenges presented by "too big to fail" institutions); and Tom C. Frost, *The Big Danger with Big Banks*, WALL ST. J., May 16, 2012, at A12.

design for policymakers as they re-imagine a better, workable framework for the emerging, new financial industry.

I. CYBORG FINANCE

The dramatic and continuing rise of computerization and artificial intelligence over the last three decades has had a profound impact on the financial industry. It has transformed an industry once dominated by humans into one where machines play a significantly larger and more inextricable role. Modern finance is becoming an industry where the main players are no longer entirely human. Rather, the main financial players today are cyborgs: part human and part machine. Modern finance is becoming "cyborg finance," or "cy-fi."[12]

A. A Brief Retrospective

Modern finance evolved into cyborg finance as a result of complimentary advances in technology and financial regulation. New technological advances and financial innovation encouraged regulatory reforms, which in turn spurred more innovation and advances within the financial industry.[13]

Beginning in the 1990s, technological advances made electronic trading a viable alternative to traditional intermediary-based platforms. Electronic communication networks led to direct market access, allowing firms to execute trades on exchanges without going through financial intermediaries.[14] Around the same time, the Securities and Exchange

12. *See* Lin, *supra* note 4, at 682 (introducing the term "cyborg finance"); Salmon & Stokes, *supra* note 1 (reporting on the rise of automated, computerized systems in finance); *see also* SHERRY TURKLE, ALONE TOGETHER: WHY WE EXPECT MORE FROM TECHNOLOGY AND LESS FROM EACH OTHER 152 (2012) ("We are all cyborgs now."); Donna J. Haraway, *A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century*, *in* READINGS IN THE PHILOSOPHY OF TECHNOLOGY 161, 161 (David M. Kaplan ed., 2004) ("A cyborg is a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a creature of fiction."); David J. Hess, *On Low-Tech Cyborgs*, *in* THE CYBORG HANDBOOK 371, 373 (Chris Hables Gray ed., 1995) ("[A]lmost everyone in urban societies could be seen as a low-tech cyborg, because they spend large parts of the day connected to machines . . . .").

13. For a general discussion about the evolution of modern finance, see Robert DeYoung, *Safety, Soundness, and the Evolution of the U.S. Banking Industry,* 92 FED. RES. BANK OF ATLANTA ECON. REV. 41 (2007); Loretta J. Mester, *Commentary: Some Thoughts on the Evolution of the Banking System and the Process of Financial Intermediation*, 92 FED. RES. BANK OF ATLANTA ECON. REV. 67, 67–72 (2007); and Arthur E. Wilmarth, Jr., *The Transformation of the U.S. Financial Services Industry, 1975–2000: Competition, Consolidation, and Increased Risks*, 2002 U. ILL. L. REV. 215 (2002).

14. SAL ARNUK & JOSEPH SALUZZI, BROKEN MARKETS: HOW HIGH FREQUENCY TRADING AND PREDATORY PRACTICES ON WALL STREET ARE DESTROYING INVESTOR CONFIDENCE AND YOUR PORTFOLIO 68–78 (2012).

Commission (SEC) introduced reforms like Regulation Alternative Trading System (Reg ATS) to promote alternative trading platforms and electronic communication networks.[15] During this period, regulators also introduced decimalization to securities pricing, which made electronic trading more profitable as smaller pricing spreads increased trading opportunities.[16] By the end of the 1990s, computers were key players in finance, serving as critical components in financial trading and investment management.[17]

Over the course of the decade that followed, information technology continued to innovate and evolve. Advances in computer science and digitized information spurred more computerization and artificial intelligence in financial trading and investment management. Decreases in the cost of technology also spawned the growth of discount brokerages and other intermediaries that gave more investors greater access to more classes of assets. In response to these advances, the SEC passed Regulation National Market System (Reg NMS) in 2005.[18] Reg NMS was designed to connect disparate electronic marketplaces into one linked national market platform to increase competition and access in finance.[19] Additionally, Reg NMS, coupled with globalization, helped to internationalize financial markets by connecting electronic marketplaces across the globe.

In the years since the implementation of Reg NMS, the use of computerization and artificial intelligence in finance has dramatically accelerated. It has transformed modern finance into cy-fi. A key feature of cyborg finance is the use of supercomputers to analyze risk, manage assets,

15. *See* Regulation ATS, 17 C.F.R. § 242.300(a) (2009); ARNUK & SALUZZI, *supra* note 14; BRIAN R. BROWN, CHASING THE SAME SIGNALS: HOW BLACK-BOX TRADING INFLUENCES STOCK MARKETS FROM WALL STREET TO SHANGHAI 2 (2010); LEINWEBER, *supra* note 1.

16. *See* STAFF OF THE SEC, REPORT TO CONGRESS ON DECIMALIZATION 4 (2012), *available at* http://www.sec.gov/news/studies/2012/decimalization-072012.pdf ("Prior to implementing decimal pricing in April 2001, the U.S. equity market used fractions as pricing increments, and had done so for hundreds of years."); CHRISTOPHER STEINER, AUTOMATE THIS 185 (2012) (discussing how decimalization bolsters electronic trading volumes and profits).

17. *See, e.g.*, RAY KURZWEIL, THE AGE OF SPIRITUAL MACHINES: WHEN COMPUTERS EXCEED HUMAN INTELLIGENCE 70 (2000) ("Not only were the stock, bond, currency, commodity, and other markets managed and maintained by computerized networks, but the majority of buy-and-sell decisions were initiated by software programs . . . ."); Markku Malkamäki & Jukka Topi, *Future Challenges for Securities and Derivative Markets*, *in* 3 RESEARCH IN BANKING AND FINANCE 359, 382 (Iftekhar Hasan & William C. Hunter eds., 2003) ("At the end of [the] 1990s, between 30% and 40% of all U.S. securities were channeled through the Internet and about 15% of all the U.S. equity trades were done on-line."); William M. Bulkeley, *Computers Take on New Role as Experts in Financial Affairs*, WALL ST. J., Feb. 7, 1986.

18. 17 C.F.R. § 242.601 (2005).

19. *See* Regulation NMS, 69 Fed. Reg. 11126-01, at 11161 (proposed Mar. 9, 2004) (codified at 17 C.F.R. §§ 200, 230, 240, 242, 249); *see also* PATTERSON, *supra* note 3, at 49; Laura Nyantung Beny, *U.S. Secondary Stock Markets: A Survey of Current Regulatory and Structural Issues and a Reform Proposal to Enhance Competition*, 2002 COLUM. BUS. L. REV. 399, 426 ("[T]he express purpose of the NMS [is] to promote efficiency and competition across secondary markets.").

and execute trades based on complex algorithmic programs operating at super-speeds.[20] Many of these programs, once successfully installed, can operate completely devoid of human intervention with great profitability.[21]

In terms of risk analysis and asset management, almost every significant financial participant today uses computers with artificial intelligence to assess risk and manage investments.[22] For instance, BlackRock, the world's largest asset management firm, uses its proprietary artificial intelligence program, dubbed Aladdin, to help clients manage risk and capital relating to stocks, bonds, derivatives, and other complex financial instruments.[23] During the financial crisis of 2008 ("the Financial Crisis"), Aladdin even aided the federal government with its critical decisions concerning Bear Stearns, AIG, Citigroup, Fannie Mae, and Freddie Mac.[24]

In terms of trading, the emergence of computerization and artificial intelligence has led to the rise of black-box or algorithmic trading, which refers to the use of incredibly powerful computers to analyze and execute trading opportunities based on complex mathematical models.[25] In the age of cy-fi, almost every financial institution with significant capital employs some form of algorithmic trading.[26] These programs frequently operate exclusively on artificial intelligence, devoid of human input after initial installation.[27] These programs can process massive amounts of information, spot trends, and allocate capital accordingly within seconds.[28] In fact, some programs are so advanced that within fractions of seconds of a securities

20. *See* PATTERSON, *supra* note 3, at 36–38 (describing the rise of powerful, high-speed computers in finance); *see also* FIN. CRISIS INQUIRY COMM'N, *supra* note 5, at 44.

21. *See* PATTERSON, *supra* note 3, at 128–30; David M. Serritella, *High Speed Trading Begets High Speed Regulation: SEC Response To Flash Crash, Rash*, 2010 U. ILL. J.L. TECH. & POL'Y 433, 436 (discussing the automated nature of financial algorithmic programs); Brody Mullins, et al., *Traders Pay for an Early Peek at Key Data*, WALL ST. J., June 13, 2013, at A1 (discussing the value of seconds to traders using computerized programs).

22. For a general discussion of computerized risk models, see Erik F. Gerding, *Code, Crash, and Open Source: The Outsourcing of Financial Regulation to Risk Models and the Global Financial Crisis*, 84 WASH. L. REV. 127, 130–35 (2009).

23. *See* Sheelah Kolhatkar & Sree Vidya Bhaktavatsalam, *The Colossus of Wall Street*, BUS. WK., Dec. 13, 2010, at 62, 66.

24. *Id*.

25. *See* BROWN, *supra* note 15, at 8; ROBERT A. G. MONKS & ALEXANDRA REED LAJOUX, CORPORATE VALUATION FOR PORTFOLIO INVESTMENT: ANALYZING ASSETS, EARNINGS, CASH FLOW, STOCK PRICE, GOVERNANCE, AND SPECIAL SITUATIONS 229 (2011).

26. *See* BROWN, *supra* note 15, at 11.

27. *See* CFTC & SEC FINDINGS, *supra* note 10, at 13–16 (discussing automation in high-frequency trading); PATTERSON, *supra* note 3, at 128–30; Serritella, *supra* note 21, at 436 ("Automation is a crucial element in HFT [high-frequency trading].").

28. *See* Fabozzi et al., *supra* note 2, at 8; Charles Duhigg, *Stock Traders Find Speed Pays, in Milliseconds*, N.Y. TIMES, July 24, 2009, at A17 ("[Algorithmic computer programs] can spot trends before other investors can blink, changing orders and strategies within milliseconds.").

filing or news report, the programs can "read" them and execute trades based on the new information without any human assistance.[29] In the new financial industry, decisions that previously took hours or minutes to analyze and execute by numerous teams of individuals now take only seconds by a single computer.

A prominent form of algorithmic trading is high-frequency trading. High-frequency trading refers to computerized trading that generates positive returns by executing deluges of trades at super speeds.[30] This form of trading normally occurs at rates measured in seconds and milliseconds,[31] with daily volumes measured in the range of billions of units, and valued in the billions of dollars.[32] By 2010, high-frequency trading constituted approximately 30% of all foreign-exchange transactions.[33] In 2011, high-frequency trading made up about 60% of U.S. equity trading[34] and 35 to 40% of European equity trading,[35] with signs of more potential growth in the years to come.

This emphasis on speed in finance has given considerable advantages to market participants who can afford better technology and better real estate so as to reduce the latency of their trade executions through the process of colocation.[36] Latency refers to the period between an order submission and the receipt of an order acknowledgement.[37] If an institution's server is located closer to the server of an exchange or other relevant intermediary, then that institution can lower their latency period and increase their execution speed.[38] As such, market participants with

29. *See* ARNUK & SALUZZI, *supra* note 14, at 121 ("Machine-readable news data feeds enable HFT [high-frequency trading] computers to react within microseconds to news events, beating out traditional institutional and retail investors."); LEINWEBER, *supra* note 1, at 31–88, 109–34; Helen Coster, *Search and Disrupt*, FORBES, Sept. 26, 2011, at 60 (reporting on software that summarizes federal securities filings in seconds).

30. *See* Concept Release on Equity Market Structure, 75 Fed. Reg. 3594, 3598 (Jan. 21, 2010) (codified at 17 C.F.R. pt. 242); IRENE ALDRIDGE, HIGH-FREQUENCY TRADING: A PRACTICAL GUIDE TO ALGORITHMIC STRATEGIES AND TRADING SYSTEMS 1 (2010).

31. Fabozzi et al., *supra* note 2, at 8.

32. *See* Eric Dash & Christine Hauser, *As Dizzying Week Ends on Wall St., Dangers Linger*, N.Y. TIMES, Aug. 13, 2011, at A1.

33. Neil Shah, *High-Speed Traders Dive into Forex Despite Doubts,* WALL ST. J., Apr. 25, 2011, http://online.wsj.com/article/SB10001424052748704677404576284921020282968.html.

34. Graham Bowley, *Fast Traders, In Spotlight, Battle Rules*, N.Y. TIMES, July 18, 2011, at A1.

35. Fabozzi et al., *supra* note 2, at 8.

36. *See* BROWN, *supra* note 15, at 63; PATTERSON, *supra* note 3, at 230 ("The new hierarchy would be all about who owned the most powerful computers, the fastest links between markets, the most sophisticated algorithms—and the inside knowledge of how the market's plumbing was put together.").

37. *See* BROWN, *supra* note 15, at 64.

38. *See* Fabozzi et al., *supra* note 2, at 10 ("It is estimated that for each 100 miles the server is located away from the matching engine, 1 millisecond of delay is added to [the transmittal and execution time] . . . .").

more resources can arguably outperform other participants on a regular basis, even if all participants receive actionable information simultaneously.[39] While market participants with better resources have always had some advantages in execution over other participants,[40] the differences this time may be differences in kind rather than degrees.

In retrospect, over the last few decades, advances in technology and artificial intelligence accompanied by complementary regulatory reforms have fundamentally transformed modern finance into cyborg finance. It has turned an industry once based primarily on human interactions into one that is drastically less human, faster, larger, more global, more complex, and more interconnected.[41]

B. A Modest Preview

Previewing the future of cyborg finance is difficult given the dynamism of modern finance and technology. Yet, past developments and contemporary changes offer glimpses of the emerging future. Four potential characteristics of the emerging new financial industry are particularly noteworthy.

First, the use of computers and artificial intelligence will likely persistently rise in finance with lower cost barriers to entry. In 1965, Gordon Moore, the founder of Intel, coined what would later be termed "Moore's Law," which predicted that components on integrated circuits would increase exponentially about every two years and costs would fall correspondingly, leading to incredible technological progressions.[42] Since the 1960s, computing power and capacity have only grown increasingly better, faster, smaller, and cheaper.[43] A single iPhone today possesses more computing power than all of NASA during the first lunar mission.[44] In addition to being stronger, computer power has also become smarter. Through computerized data aggregation and analyses, colloquially known

39. *See, e.g.,* James B. Stewart, *Fair Play Measured in Slivers of a Second*, N.Y. TIMES, Jul. 13, 2013, at B1.

40. STEINER, *supra* note 16, at 121.

41. *See, e.g.*, PATTERSON, *supra* note 3, at 281–322; Salmon & Stokes, *supra* note 1, at 90.

42. *See* NICHOLAS CARR, THE BIG SWITCH: REWIRING THE WORLD, FROM EDISON TO GOOGLE 58 (2008); Gordon E. Moore, *Cramming More Components Onto Integrated Circuits*, 86 PROCEEDINGS OF THE IEEE 82, 82–83 (1998).

43. *See* NICHOLAS CARR, THE SHALLOWS: WHAT THE INTERNET IS DOING TO OUR BRAINS 83 (2011) ("[T]he price of a typical computing task has dropped by 99.9 percent since the 1960s."); ORG. FOR ECON. CO-OPERATION AND DEV., 255 21ST CENTURY TECHNOLOGIES: PROMISES AND PERILS OF A DYNAMIC FUTURE 9 (1998) (stating that "[f]aster, cheaper, [and] smaller" are the key objectives of the technology sector); Chip Walter, *Kryder's Law*, SCIENTIFIC AM., Aug. 2005, at 32.

44. MICHIO KAKU, PHYSICS OF THE FUTURE: HOW SCIENCE WILL SHAPE HUMAN DESTINY AND OUR DAILY LIVES BY THE YEAR 2100 21 (2011).

as Big Data, information technology is constantly providing new insights into the world.[45] As technology continues to progress in capacity and capability, finance—like other industries—will continue to adopt computers and artificial intelligence as key operational inputs.[46] The future intellectual and physical infrastructure of finance and other industries will likely be one based more and more on computerization and artificial intelligence, creating an omni-computing existence where the workings and manifestations of computerized data analyses become like oxygen—necessary but unnoticed.

Second, technological advances and corresponding market changes will make traditional financial frameworks, like public stock exchanges and human brokers, less relevant.[47] For instance, algorithmic trading has already advanced so much that exchange floors manned by human traders have been rendered relics of a bygone era.[48] Today, most equities are traded in private electronic markets using fully computerized systems rather than in public exchanges like the New York Stock Exchange (NYSE) or the NASDAQ.[49] In recent years, more than half of the trading of equities listed on the NYSE takes place in electronic exchanges.[50] In fact, in 2013, two

45. *See, e.g.*, VIKTOR MAYER-SCHONBERGER & KENNETH CUKIER, BIG DATA: A REVOLUTION THAT WILL TRANSFORM HOW WE LIVE, WORK, AND THINK 6–10 (2013); NATE SILVER, THE SIGNAL AND THE NOISE: WHY SO MANY PREDICTIONS FAIL—BUT SOME DON'T 9–10 (2012); Andrew McAfee & Erik Brynjolfsson, *Big Data: The Management Revolution*, HARV. BUS. REV., Oct. 2012, at 60–68; Ashlee Vance, *The Data Knows*, BUS. WK., Sept. 12, 2011, at 71.

46. *See* ERIK BRYNJOLFSSON & ANDREW MCAFEE, THE SECOND MACHINE AGE: WORK, PROGRESS AND PROSPERITY IN A TIME OF BRILLIANT TECHNOLOGIES 13–39 (2014); CARR, *supra* note 42, at 45–46 (reporting on the proliferation of computers in society); David H. Autor et al., *The Skill Content of Recent Technological Change: An Empirical Exploration*, 118 Q.J. ECON. 1279, 1322 (2003) (studying how computerization increases the substitution of machinery for human labor in certain situations); W. Brian Arthur, *The Second Economy*, MCKINSEY Q., Oct. 2011, at 92 (discussing how computerization and artificial intelligence have replaced human labor in many industries); Mary Childs, *Computers Elbow Traders Aside*, BUS. WK., Nov. 19, 2012, at 48; Bill Wasik, *Welcome to the Programmable World*, WIRED, June 2013, at 140.

47. *See* Donald C. Langevoort & Robert B. Thompson, *"Publicness" in Contemporary Securities Regulation After the JOBS Act*, 101 GEO. L.J. 337, 347 (2013) ("Today, liquidity is now much more possible outside of traditional exchanges. In the new millennium, cheap information and low communication costs have expanded markets . . . ."); Ben Paynter, *The Exchange Blew Up*, BUS. WK., March 18, 2013, at 58; Jacob Bunge, *BATS, Direct Edge in Talks to Merge*, WALL ST. J., Aug. 24, 2013, at B1 (reporting on the merger of two large electronic exchanges).

48. *See, e.g.*, 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, 866 (2008) ("Exchange trading floors are fast fading into history as the trading of stocks and derivative instruments moves to electronic communications networks (ECNs) that simply match trades by computers through algorithms.").

49. Nathaniel Popper, *Public Exchanges Duel with Newcomers over Trade Transparency*, N.Y. TIMES, June 27, 2012, at B1.

50. Nelson D. Schwartz & Louise Story, *Surge of Computer Selling After Apparent Trading Glitch Sends Stocks Plunging*, N.Y. TIMES, May 7, 2010, at B7.

leading electronic trading exchanges merged;[51] and the IntercontinentalExchange, an electronic derivatives and commodities exchange, announced a takeover of the NYSE.[52] That same year, the NYSE made preparations to operate without human traders in the event of a major disaster.[53] It is probably safe to predict that in the near future, human traders will no longer work the NYSE's famed trading floor in their traditional roles; the exchange will become like a façade on a movie set. Additionally, these changes in financial technology will likely allow more individuals to invest in a wider array of assets.[54] Online brokers, like Charles Schwab, already offer investment options that were not available to investors in eras past without well-connected financial intermediaries.[55]

Third, cyborg finance will likely expand the "shadow banking" system as it grows darker, more complex, more global, but not necessarily more profitable.[56] While significant volumes of trading still take place on public exchanges, a growing volume of trades are taking place in less-regulated private exchanges and "dark pools."[57] A dark pool is an electronic trading network that facilitates anonymous trading and is hidden from the general marketplace.[58] Private exchanges and dark pools are particularly attractive to investors, many of whom prefer to trade securities without losing informational advantages to competitors that may mimic their trades.[59] These opaque financial forums also facilitate innovative and complex transactions and strategies because they are less regulated.[60] Moreover,

51. Michael J. De La Merced and Nathaniel Popper, *Two Exchanges to Merge, Taking On Larger Rivals*, N.Y. TIMES, Aug. 27, 2013, at B1.

52. Ben Protess & Nathaniel Popper, *Exchange Sale Reflects New Realities of Trading*, N.Y. TIMES, Dec. 21, 2012, at A1.

53. Jacob Bunge, *NYSE Revamps Disaster Plan*, WALL ST. J., Mar. 9, 2013, at B1.

54. *See, e.g.*, Nathaniel Popper, *Complex Investments Prove Risky as Savers Chase Bigger Payoff*, N.Y. TIMES, Feb. 11, 2013, at A1.

55. CHARLES SCHWAB INVESTMENT PRODUCTS, http://www.schwab.com/public/schwab/investing/accounts_products/investment (last visited Feb. 1, 2014).

56. *See, e.g.*, GARY B. GORTON, SLAPPED BY THE INVISIBLE HAND: THE PANIC OF 2007 6–9 (2010) (noting the growing importance of the shadow banking system); SKEEL, *supra* note 5 (discussing deregulation and financial innovation in connection to shadow banking); Lo, *supra* note 5, at 13–18 (describing the expansive shadow banking system); Schwarcz, *supra* note 9, at 619–42.

57. *See* Regulation of Non-Public Trading Interest, Exchange Act Release No. 34-60997 (Nov. 13, 2009); Mary L. Schapiro, Chairman, SEC, Statement on Dark Pool Regulation Before the Commission Open Meeting (Oct. 21, 2009) (transcript available at http://www.sec.gov/news/speech/2009/spch102109mls.htm); ARNUK & SALUZZI, *supra* note 14; LEINWEBER, *supra* note 1, at 79 (discussing the growth of dark pools and alternative trading systems in recent years); PATTERSON, *supra* note 3, at 61–62; Matthew Philips, *Where Has All the Trading Gone*?, BUS. WK., May 14, 2012, at 49 (reporting on the migration of trading from public exchanges to dark pools).

58. BROWN, *supra* note 15, at 116.

59. *See id*.

60. *See* Schwarcz, *supra* note 9, at 619–42.

unlike traditional exchanges, which are partially constrained by spatial and geographic limitations, private exchanges and dark pools exist in cyberspace, a frontier without such limitations.[61] In the past few years, rather than defend the benefits of well-regulated, transparent trading, traditional exchanges have begun to create opaque electronic networks to capture the growing computerized trading market.[62] Increased participation in shadow banking coupled with lower costs of technology will likely lead to greater competition and lower profit margins.[63]

Fourth, humans will likely remain critical players in the future of cyborg finance. Advances in the speed, precision, and convenience of computerized systems have led many in finance to view such systems as the antidotes to the follies of human thought and human action.[64] After all, computers process deluges of data faster and better than humans, computers do not suffer from emotional fits or irrational impulses, and computers do not fatigue the way humans do. As a result of these advantages, there exists an understandable enchantment with advanced technologies in finance and beyond.[65] And at the same time, there also exists an equally understandable lamentation of the fall of humans in the face of rising technology.[66] Yet, such easy sentiments about the demise of humans are misplaced. Humans, after all, possess arguably the most powerful and complex of computing machineries, the human brain, which contains billions of neurons and trillions of synaptic connections.[67] And lest we forget, the Financial Crisis occurred partially because many prevalent,

61. *See, e.g.*, David R. Johnson & David Post, *Law and Borders—The Rise of Law in Cyberspace*, 48 STAN. L. REV. 1367, 1367 (1996); Lawrence Lessig, *The Law of the Horse: What Cyberlaw Might Teach*, 113 HARV. L. REV. 501, 514–22 (1999).

62. Popper, *supra* note 49.

63. *See* Matthew Philips, *How the Robots Lost*, BUS. WK., June 10, 2013, at 64, 66 (discussing the decrease in profits of high-frequency traders due to competition).

64. EMANUEL DERMAN, MODELS.BEHAVING.BADLY.: WHY CONFUSING ILLUSION WITH REALITY CAN LEAD TO DISASTER, ON WALL STREET AND IN LIFE 143–87 (2011).

65. Computers today excel over humans in tasks beyond the mechanical and rote to the subjective and judgmental. Computers with artificial intelligence can grade essays, select movie scripts, predict court decisions, review legal documents, and spot out lies. *See* CARR, *supra* note 43, at 223 (discussing computerized review of essays); Joe Dysart, *A New View of Review*: *Predictive Coding Vows to Cut E-Discovery Drudgery*, A.B.A. J., Oct. 1, 2011, at 26; Theodore W. Ruger et al., *The Supreme Court Forecasting Project: Legal and Political Science Approaches to Predicting Supreme Court Decisionmaking*, 104 COLUM. L. REV. 1150, 1150 (2004); Anne Eisenberg, *Software that Listens for Lies*, N.Y. TIMES, Dec. 4, 2011, at BU5; Malcolm Gladwell, *The Formula*, NEW YORKER, Oct. 16, 2006, at 139 (reporting on software that predicts the potential success of screenplays based on their narrative elements).

66. *See* JARON LANIER, YOU ARE NOT A GADGET: A MANIFESTO 24–30 (2010) (lamenting the self-subordination of humans to technology).

67. ELLEN E. PASTORINO & SUSANN M. DOYLE-PORTILLO, WHAT IS PSYCHOLOGY? 355 (2011).

"smart" computerized risk models failed to properly account for the collapse of the U.S. housing market and its deleterious economic effects.[68]

With the ascension of artificially intelligent machines driven by data, humans are actually needed more than ever.[69] Humans are needed to gather and create the data that is the lifeblood of artificial intelligence.[70] Humans are needed to design and create the algorithms and programs for the computers.[71] Humans are needed to attest to the veracity and utility of the computerized systems.[72] Artificially intelligent machines, despite their advances, are still devoid of the awareness, sophistication, and judgment of human intelligence.[73] Computerized modeling of a financial world populated by humans will remain flawed and limited.[74] Data about the past can only give so much insight about the future. Thus, humans will likely remain key players in the future of cyborg finance.

II. CRASHES AND CRIMES

While the new financial industry presents many great opportunities for investors and financial institutions, it also presents grave perils. The enhanced speed and linkage of finance can make industry participants more vulnerable to volatile crashes and cybercrimes.

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68. *See, e.g.*, ANTHONY SAUNDERS & LINDA ALLEN, CREDIT RISK MANAGEMENT IN AND OUT OF THE FINANCIAL CRISIS: NEW APPROACHES TO VALUE AT RISK AND OTHER PARADIGMS 31 (3d ed. 2010); Amir E. Khandani & Andrew W. Lo, *What Happened to the Quants in August 2007?: Evidence From Factors and Transactions Data,* 5 J. INV. MGMT. 5, 5–9 (2007); Paul Krugman, *How Did Economists Get It So Wrong?*, N.Y. TIMES MAG., Sept. 6, 2009, at 36 ("There was nothing in the prevailing models suggesting the possibility of the kind of collapse that happened last year.").

69. RISHI K. NARANG, INSIDE THE BLACK BOX: THE SIMPLE TRUTH ABOUT QUANTITATIVE TRADING xi (2009).

70. *See* IAN AYRES, SUPER CRUNCHERS: WHY THINKING-BY-NUMBERS IS THE NEW WAY TO BE SMART 124–26 (2007); Steve Lohr, *Google Schools Its Algorithm*, N.Y. TIMES, Mar. 6, 2011, at WK 4 ("Computers are only as smart as their algorithms—man-made software recipes for calculation . . . .").

71. NARANG, *supra* note 69, at xi.

72. Shvetank Shah et al., *Good Data Won't Guarantee Good Decisions*, HARV. BUS. REV., Apr. 2012, at 23.

73. *See* STEPHEN BAKER, FINAL JEOPARDY: MAN VS. MACHINE AND THE QUEST TO KNOW EVERYTHING 148–69 (2011) (discussing the limitations of artificial intelligence). *But see* JAMES BARRAT, OUR FINAL INVENTION: ARTIFICIAL INTELLIGENCE AND THE END OF THE HUMAN ERA 7–8 (2013).

74. *See* CLAYTON M. CHRISTENSEN ET AL., HOW WILL YOU MEASURE YOUR LIFE? 14 (2012) ("People often think that the best way to predict the future is by collecting as much data as possible . . . . But this is like driving a car looking only at the rearview mirror—because data is only available about the past."); Jón Daníelsson, *The Emperor Has No Clothes: Limits to Risk Modeling*, 26 J. BANKING & FIN. 1273, 1274 (2002); Krugman, *supra* note 68 ("[E]conomists, as a group, mistook beauty, clad in impressive-looking mathematics, for truth.").

A. Flash Crashes

The accelerated speed of cyborg finance means faster executions, faster market-making, and faster profits. But the accelerated speed also means faster ascents and faster crashes at speeds previously unattainable, posing challenges previously unimaginable.

On May 6, 2010, the world witnessed a stock market crash of incredible volatility and velocity.[75] In less than thirty minutes, approximately $1 trillion in market value vanished from the U.S. stock market. [76] That episode in financial history is now simply referred to as the Flash Crash.[77]

An SEC and Commodity Futures Trading Commission (CFTC) joint investigation following the crash revealed that the Flash Crash was initiated by a futures order from a Kansas mutual fund company.[78] With a high-speed, automated computer program, the mutual fund company, Waddell & Reed, created an order to sell $4.1 billion of E-Mini S&P futures contracts at approximately 2:32 p.m.[79] The program executed the order "without regard to price or time,"[80] and completed it in about twenty minutes.[81] In years past, an order of this size would have taken several hours or days to complete.[82]

Within minutes of the fulfillment of Waddell & Reed's order, other computerized programs executed corresponding high-speed trades in the futures and equity markets that caused significant volatility in the Dow Jones Industrial Average (Dow), S&P futures, other futures contracts, and domestic equities.[83] Within the span of twenty minutes after Waddell & Reed's initial trade, S&P futures experienced a 3% drop,[84] and the Dow experienced a 9.16% drop.[85] During the Dow's rapid free fall, share prices in blue-chip stocks like 3M and Proctor & Gamble suffered losses nearing or exceeding 20%, or billions of dollars in market capitalization.[86] Other stocks also experienced severe volatility during this brief period.

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75. CFTC & SEC FINDINGS, *supra* note 10, at 1.
76. Haldane, *supra* note 3, at 2.
77. Graham Bowley, *Lone Sale of $4.1 Billion in Contracts Led to 'Flash Crash' in May*, N.Y. TIMES, Oct. 2, 2010, at B1.
78. CFTC & SEC FINDINGS, *supra* note 10, at 2; Bowley, *supra* note 77.
79. *Id*.
80. Bowley, *supra* note 77 (quoting CFTC & SEC FINDINGS, supra note 10, at 2).
81. CFTC & SEC FINDINGS, *supra* note 10, at 2.
82. *See id*.
83. *Id*. at 1–4.
84. *Id*. at 3.
85. *See* Serittella, *supra* note 21, at 435.
86. CFTC & SEC FINDINGS, *supra* note 10, at 84–85.

Accenture, a leading consulting company, saw its shares fall by over 99%, from $40 to $0.01.[87] Shares of the famed auction house, Sotheby's, increased three thousand-fold, from $34 to $99,999.99.[88] At the end of the rollercoaster trading day, the major futures and equity indexes closed with losses of about 3% relative to the previous day.[89]

In the aftermath, the SEC and CFTC joint inquiry did not blame black-box traders and automated computerized programs entirely for causing the Flash Crash. Instead, the investigation noted that such traders and programs played a critical role in eroding liquidity and exacerbating volatility on the day of the Flash Crash.[90]

While another crash matching the velocity and magnitude of the Flash Crash has yet to materialize, there have been many smaller and more isolated lightning crashes,[91] including one in 2013 that caused the NASDAQ to suspend trading of its securities for three hours during a normal trading day.[92] Nevertheless, some experts and policymakers speculate that as finance accelerates and automates, it will only be a matter of time before another major crash like the Flash Crash occurs again.[93]

B. Cy-Fi Crimes

Threats of new financial crimes accompany the emergence of cyborg finance. Cy-fi's heavy reliance on computerized systems to store

87. *Id*. at 83; Haldane, *supra* note 3, at 2.

88. Haldane, *supra* note 3, at 2.

89. CFTC & SEC FINDINGS, *supra* note 10, at 1.

90. *Id*. at 6.

91. *See* Graham Bowley, *The Flash Crash, in Miniature*, N.Y. TIMES, Nov. 9, 2010, at B1 (reporting on the occurrence of smaller flash crashes); Jacob Bunge, et al., *Goldman's Misfire Rattles Options*, WALL ST. J., Aug. 21, 2013, at C1; Amy Chozick & Nicole Perlroth, *Twitter Speaks, Markets Listen, and Fears Rise*, N.Y. TIMES, April 29, 2013, at A1 (describing the stock market crash caused by a false tweet); Shen Hong, *Everbright Securities Fiasco Casting a Shadow*, WALL ST. J., Aug. 21, 2013, at C3; Edward E. Kaufman, Jr. & Carl M. Levin, Op-Ed, *Preventing the Next Flash Crash,* N.Y. TIMES, May 6, 2011, at A27 (discussing mini-crashes since the Flash Crash); Matt Krantz, *Mini Flash Crashes Worry Traders*, USA TODAY, May 17, 2011, *available at* http://www.usatoday.com/money/markets/2011-05-16-mini-flash-crashes-market-worry_n.htm; Nathaniel Popper, *Wave of Runaway Trades Spread Turmoil Across Wall St.*, N.Y. TIMES, Aug. 2, 2012, at A1 (discussing market instability caused by computerized trading relating to Facebook's initial public offering and a rogue computer program related to Knight Trading); Nathaniel Popper, *BATS Flaw Not So Rare, Data Shows*, N.Y. TIMES, Mar. 29, 2012, at B1 (reporting on the volatility surrounding the initial public offering of BATS Global Markets, an electronic stock exchange pioneer).

92. *See* E.S. Browning and Scott Patterson, *Complex Systems Get Blame*, WALL ST. J., Aug. 23, 2013, at C1; Nathaniel Popper, *Pricing Problem Suspends NASDAQ for Three Hours*, N.Y. TIMES, Aug. 23, 2013, at A1.

93. *See* Kaufman, Jr. & Levin, *supra* note 91 ("[A]lgorithmic trading has caused mini-flash crashes since, and surveys suggest that most investors and analysts believe it's only a matter of time before the Big One.").

information, analyze data, and manage capital renders it particularly vulnerable to cybercrimes.[94] The new financial industry is essentially a high-tech industry where software codes, computerized systems, intellectual property, and technological infrastructure represent some of the industry's most valuable assets.[95] Many serious crimes against financial institutions now involve computers as the weapons of choice and cyberspace as the preferred setting.[96] For instance, with the proliferation of automated trading platforms, simply by injecting bad data and false trades into the system, cyber criminals can cause significant financial damage without guns and from the comforts of a remote location.[97] General Keith Alexander, the head of the National Security Agency and the U.S. Cyber Command in 2013, called the loss of American business secrets and intellectual property to cyber criminals "the greatest transfer of wealth in history."[98]

With the emergence of crimes in cyborg finance, a new lineup of criminal suspects is also emerging. Episodes from recent history suggest that financial firms must protect their interests from various, elusive antagonists including employees, competitors, hackers, and other nation-states.[99] In 2009, a former Goldman Sachs programmer was arrested for allegedly stealing the firm's algorithmic trading codes.[100] In 2011, hackers

94. *See* Duncan B. Hollis, *Why States Need an International Law for Information Operations*, 11 LEWIS & CLARK L. REV. 1023, 1042 (2007) (speculating about computer viruses that incapacitate stock markets); Scott Patterson, *CME Was the Victim of 'Cyberintrusion' in July*, WALL ST. J., Nov. 16, 2013, at B5; Michael Riley & Ashlee Vance, *The Code War*, BUS. WK., July 25, 2011, at 52.

95. *See* BROWN, *supra* note 15, at 49 (discussing the urgent need for black-box firms to safeguard successful strategies for as long as possible); David Barboza & Kevin Drew, *Security Firm Sees Global Cyberspying*, N.Y. TIMES, Aug. 4, 2011, at A11 ("Cybersecurity is now a major international concern, with hackers gaining access to sensitive corporate and military secrets, including intellectual property."); Alex Berenson, *Arrest over Trading Software Illuminates a Secret of Wall St*., N.Y. TIMES, Aug. 24, 2009, at A1 (noting the importance of computer programs to financial institutions).

96. Riley & Vance, *supra* note 94.

97. *Id*. at 56.

98. John Seabrook, *Network Insecurity*, NEW YORKER, May 20, 2013, at 64 (quoting Gen. Keith Alexander).

99. *See* SEC v. Dorozhko, 574 F.3d 42, 44–46 (2d Cir. 2009) (opining on a case involving hackers who traded on illicitly-acquired, material, nonpublic information); MARK BOWDEN, WORM: THE FIRST DIGITAL WORLD WAR 48 (2011) ("Today the most serious computer predators are funded by rich criminal syndicates and even nation-states, and their goals are far more ambitious."); INTELLIGENCE & NAT'L SEC. ALLIANCE, CYBER INTELLIGENCE: SETTING THE LANDSCAPE FOR AN EMERGING DISCIPLINE 7–9 (2011); SCOTT PATTERSON, THE QUANTS: HOW A NEW BREED OF MATH WHIZZES CONQUERED WALL STREET AND NEARLY DESTROYED IT 107–16 (2010) (discussing the theft of trade secrets from hedge funds); Michael Joseph Gross, *Silent War*, VANITY FAIR, July 2013, at 98; Nicole Perlroth, *Hunting for Syrian Hackers' Chain of Command*, N.Y. TIMES, May 18, 2013, at B1 (reporting on the difficulties of tracing hackers); Nathaniel Popper, *Wall Street's Exposure to Hacking Laid Bare*, N.Y. TIMES, July 26, 2013, at B1.

100. *See* Azam Ahmed, *Ex-Programmer Is Sentenced to 8 years for Stealing Code from Goldman*, N.Y. TIMES, Mar. 19, 2011, at B2; Reed Albergotti, *Questions Linger in Goldman Code*

threatened Bank of America with stolen, corporate information.[101] In 2012, large, coordinated attacks, some attributable to Iran, dubbed "Operation High Roller," targeted American and international financial institutions.[102] In 2013, hackers infiltrated the Associated Press's Twitter account to falsely broadcast an attack on the White House that temporarily erased $136 billion in market value.[103] Furthermore, in recent years, China has been suspected of serious cybercrimes against American business interests.[104]

Due to the amorphous and anonymous nature of cybercrimes, and the unwillingness of corporate victims to come forward, they can be difficult to prevent, trace, and prosecute.[105] Recognizing the seriousness of cybercrimes against the financial system and other American interests,[106] the federal government has responded to this emerging threat with more intense, strategic cyberspace studies[107] and aggressive cyber-defense

Case, WALL ST. J., June 14, 2013, at C1. *But see* Michael Lewis, *Goldman's Greek Tragedy*, VANITY FAIR, Sept. 2013, at 312.

101. Nelson D. Schwartz, *Facing a New Type of Threat From WikiLeaks, a Bank Plays Defense*, N.Y. TIMES, Jan. 3, 2011, at B1.

102. DAVE MARCUS & RYAN SHERSTOBITOFF, MCAFEE/GUARDIAN ANALYTICS, DISSECTING OPERATION HIGH ROLLER 3 (2012), *available at* http://www.mcafee.com/us/resources/reports/rp-operation-high-roller.pdf; Nicole Perlroth, *Attacks on 6 Banks Frustrate Customers*, N.Y. TIMES, Oct. 1, 2012, at B1; Nicole Perlroth & Quentin Hardy, *Bank Hacks Were Work Of Iranians, Officials Say*, N.Y. TIMES, Jan. 9, 2013, at B1.

103. Chozick and Perlroth, *supra* note 91.

104. *See* Barboza & Drew, *supra* note 95; Sanger et al., *China's Army Seen as Tied to Hacking Against U.S.*, N.Y. TIMES, Feb. 19, 2013, at A1; David E. Sanger and Mark Landler, *U.S. and China Will Hold Talks About Hacking*, N.Y. TIMES, June 2, 2013, at A1.

105. *See, e.g.*, BOWDEN, *supra* note 99, at 48–53 (describing challenges in creating a cybersecurity defense system); 2 ROCCI LUPPICINI, HANDBOOK OF RESEARCH ON TECHNOETHICS 542 (2009) (acknowledging difficulties in tracing the origins of cyberattacks); Sarah Gordon & Richard Ford, *On the Definition and Classification of Cybercrime*, 2 J. COMPUTER VIROLOGY 13, 13 (2006) ("Despite the fact that the word 'Cybercrime' has entered into common usage, many people would find it hard to define the term precisely."); Oona A. Hathaway et al., *The Law of Cyber-Attack*, 100 CALIF. L. REV. 817, 874–77 (2012) (opining on legal challenges to addressing cyberattacks); Michael Joseph Gross, *Enter the Cyber-Dragon*, VANITY FAIR, Sept. 2011, at 220 ("Because virtual attacks can be routed through computer servers anywhere in the world, it is almost impossible to attribute any hack with total certainty."); Christopher Matthews, *Cybertheft Victims Itchy to Retaliate*, WALL ST. J., June 3, 2013, at B6; Chris Strohm et al., *Cyber Attack? What Cyber Attack?*, BUS. WK., Apr. 15, 2013, at 40 (reporting on the reluctance of companies to disclose cyber attacks).

106. *See* TERRORNOMICS 117 (Sean S. Costigan & David Gold, eds. 2007) (noting the FBI estimated that cybercrime costs the U.S. $400 billion annually).

107. *See, e.g.*, DEP'T OF DEF., CYBERSPACE POLICY REPORT (Nov. 2011), *available at* http://www.defense.gov/home/features/2011/0411_cyberstrategy/docs/NDAA%20Section%20934%20Report_For%20webpage.pdf; SEC DIV. OF CORP. FIN., CF DISCLOSURE GUIDANCE: TOPIC NO. 2: CYBERSECURITY (Oct. 13, 2011), *available at* http://sec.gov/divisions/corpfin/guidance/cfguidance-topic2.htm#_ednref1; THE WHITE HOUSE, INTERNATIONAL STRATEGY FOR CYBERSPACE: PROSPERITY, SECURITY, AND OPENNESS IN A NETWORKED WORLD (May 2011), *available at* http://www.whitehouse.gov/sites/default/files/rss_viewer/international_strategy_for_cyberspace.pdf.

programs.[108] In 2012 alone, the Air Force spent about $4 billion on its cyber programs,[109] and the Labor Department, in response to cyber threats, improved the computer security of its valuable economic data.[110] In 2013, it was revealed that President Obama possessed broad powers relating to cyberstrikes against our enemies.[111] That same year, President Obama also issued an executive order aimed at enhancing cybersecurity.[112] Despite these efforts, as cyborg finance grows and evolves, industry and government sentinels must remain vigilant of the growing and evolving criminal threats against the new financial industry. It should not be surprising if most significant financial crimes of the future are cybercrimes.

III. EMERGING SYSTEMIC RISKS

As the financial system evolves and grows, so do its systemic risks.[113] In recent years, the systemic risk of "too big to fail" has garnered much attention.[114] "Too big to fail" refers to the systemic risk where large financial intuitions become too critical to the economy, so much so that government has to bail out any of such faltering private firms with public funds. [115] The emergence of cyborg finance has borne two new systemic risks: one related to connectivity that the author terms "too linked to fail" and the other related to speed that the author terms "too fast to save."[116]

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108. James Bamford, *The Silent War*, WIRED, July 2013, at 90.

109. *See* Julian E. Barnes, *Pentagon Digs in on Cyberwar Front*, WALL ST. J., July 6, 2012, at A4 (stating that "[o]verall the Air Force spends about $4 billion a year on its cyber programs").

110. John H. Cushman Jr., *Guarding the Numbers*, N.Y. TIMES, July 17, 2012, at B1.

111. David E. Sanger & Thom Shanker, *Broad Powers Seen for Obama in Cyberstrikes*, N.Y. TIMES, Feb. 4, 2013, at A1.

112. Exec. Order No. 13636, 78 Fed. Reg. 11739 (Feb. 12, 2013), *available at* http://www.whitehouse.gov/the-press-office/2013/02/12/executive-order-improving-critical-infrastructure-cybersecurity.

113. *See* Hal S. Scott, *The Reduction of Systemic Risk in the United States Financial System*, 33 HARV. J.L. & PUB. POL'Y 671, 673 (2010) ("Going forward, the central problem for financial regulation . . . is to reduce systemic risk.").

114. *See, e.g.*, S. PERMANENT SUBCOMM. ON INVESTIGATIONS, *supra* note 5, at 15–17 (reporting on the rise of too-big-to-fail financial institutions); SORKIN, *supra* note 11 (discussing the policy challenges presented by "too big to fail" institutions); Frost, *supra* note 11.

115. *See, e.g.*, 12 C.F.R. § 1320.1 (2011); Amir E. Khandani, Andrew W. Lo & Robert C. Merton, *Systemic Risk and the Refinancing Ratchet Effect* 38 (Harv. Bus. Sch. Fin., Working Paper No. 147892, 2012), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1472892 ("[S]ystemic risk . . . arises when large financial losses affect important economic entities that are unprepared for and unable to withstand such losses, causing a cascade of failures and widespread loss of confidence.").

116. The author previously introduced these terms in a prior publication. *See* Lin, *supra* note 4, at 711–17.

A. Too Linked to Fail

In the age of cyborg finance, numerous financial participants and products coexist in an expansive, global financial web that crosses institutions, industries, instruments, and states, creating a systemic risk of "too linked to fail." Today, commercial banks, investment banks, hedge funds, sovereign funds, mutual funds, and other financial participants are all involved, intermediated, and interconnected like never before, operating in a single financial network with numerous intertwined products and transactions.[117] JPMorgan Chase, for instance, is linked to a host of counterparties through a wide-range of services and products including investment banking, commercial banking, lending, market-making, trading, clearing, custodial servicing, and prime brokering.[118] Moreover, these modern, hi-tech financial links can be difficult to break cleanly and be inherently prone to accidents, as described by Charles Perrow in his seminal study of the risks of technology, *Normal Accidents*.[119]

In eras past, the failures of one nation-state, one financial institution, or one financial instrument could have been more readily isolated by geography. In the new financial industry, geographic borders matter little as financial participants and products have grown more linked than ever. For instance, the collateralized debt obligations (CDOs) and mortgage-backed securities (MBSs) that played such critical roles in the Financial Crisis frequently linked thousands of mortgages, hundreds of CDOs, and hundreds of payment tranches across multiple financial institutions.[120] Like never before, the failings of one nation-state, one financial institution, or one financial instrument can affect all nation-states, all institutions, and all instruments.[121]

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117. *See* Markus K. Brunnermeier, *Deciphering the Liquidity and Credit Crunch 2007–2008*, 23 J. ECON. PERSPS. 77, 96 (2009) (discussing the financial system's "interwoven network of financial obligations"); Robin Greenwood & David S. Scharfstein, *How to Make Finance Work*, at 107; HAL S. SCOTT, COMM. ON CAPITAL MKTS. REGULATION, INTERCONNECTEDNESS AND CONTAGION (2012), *available at* http://www.aei.org/files/2013/01/08/-interconnectedness-and-contagion-by-hal-scott_153927406281 .pdf.

118. JPMorgan Chase & Co., Annual Report (Form 10-K) (Feb. 29, 2012), *available at* http://www.sec.gov/Archives/edgar/data/19617/000001961713000221/corp10k2012.htm.

119. *See* CHARLES PERROW, NORMAL ACCIDENTS: LIVING WITH HIGH-RISK TECHNOLOGIES 4–5 (1999); *see also* Anna Gelpern & Adam J. Levitin, *Rewriting Frankenstein Contracts: Workout Prohibitions in Residential Mortgage-Backed Securities*, 82 S. CAL. L. REV. 1075, 1076 (2009); Judge, *supra* note 6, at 701–11 (commenting on the "stickiness" of modern financial products); Adam J. Levitin & Tara Twomey, *Mortgage Servicing*, 28 YALE J. ON REG. 1, 58 (2011).

120. Kenneth E. Scott & John B. Taylor, Op-Ed., *Why Toxic Assets Are So Hard to Clean Up*, WALL ST. J., July 20, 2009, at A13.

121. *See* LESSONS FROM THE FINANCIAL CRISIS: CAUSES, CONSEQUENCES, AND OUR ECONOMIC FUTURE 128 (Robert W. Kolb ed., 2010) ("The failure of just one large financial institution might lead to the failure of one or more other institutions that would then spread to yet more financial institutions

Distinct from "too big to fail," this emerging systemic risk of "too linked to fail" includes smaller participants and products, whose failures may ripple across the system because of their linkages regardless of their value or size despite not being classified as systemically important financial institutions.[122] In 1998, the Federal Reserve initiated a $3.6 billion industry-led bailout for Long-Term Capital Management, a hedge fund with less than two hundred employees, because its failure would have created significant losses for many investment banks and caused widespread panic on Wall Street.[123] Since then, hedge funds and other financial intermediaries have only grown larger in size and number, further exacerbating the risks of "too linked to fail."[124] More recent events involving individual institutions and individual nation-states also signal the emergence of "too linked to fail." Between 2008 and 2013, the failings of Bear Stearns and Lehman Brothers,[125] along with the sovereign debt crises of Greece, Italy, and Spain all individually, and collectively, created serious strains on the global financial system. [126]

Further complicating the risks of "too linked to fail" is the fact that many financial participants engage in similar and interdependent strategies.[127] As such, many of these strategies may be similarly flawed due

in a contagion that was feared might end in the collapse of the entire financial system."); Judge, *supra* note 6, at 659 (arguing that new linked products in the modern financial system generate new sources of systemic risk); Serritella, *supra* note 21, at 437 (noting the potential perils emanating from "the interconnectivity of financial markets and their participants, as well as increased interconnections between securities and their derivatives").

122. *See* Schwarcz, *supra* note 6, at 200 (discussing the systemic risks caused by financial intermediation and disintermediation); Hong, *supra* note 91 (reporting on the impact of a trading glitch at a medium-sized Chinese brokerage); FINANCIAL STABILITY BOARD, ASSESSMENT METHODOLOGIES FOR IDENTIFYING NON-BANK NON-INSURER GLOBAL SYSTEMICALLY IMPORTANT FINANCIAL INSTITUTIONS, Jan. 8, 2014, *available at*: http://www.financialstabilityboard.org/publications/r_140108.pdf.

123. *See* ROGER LOWENSTEIN, WHEN GENIUS FAILED: THE RISE AND FALL OF LONG-TERM CAPITAL MANAGEMENT xviii–xx (2000); FRANK PARTNOY, INFECTIOUS GREED: HOW DECEIT AND RISK CORRUPTED THE FINANCIAL MARKETS 261 (2003).

124. *See* Whitehead, *supra* note 5, at 5 ("Although hedge funds grew by 260% between 1999 and 2004 to become a one trillion dollar business, they were largely exempt from regulation under the federal securities and investment advisory laws.").

125. *See* Bryan Burrough, *Bringing Down Bear Stearns*, VANITY FAIR, Aug. 2008, at 106; Carrick Mollenkamp et al., *Lehman's Demise Triggered Cash Crunch Around Globe*, WALL ST. J., Sept. 29, 2008, at A1; Andrew Ross Sorkin, *Bids to Halt Financial Crisis Reshape Landscape of Wall St.*, N.Y. TIMES, Sept. 15, 2008, at A1.

126. *See* Clive Crook, *Who Lost the Euro?*, BUS. WK., May 24, 2012, at 12. euro; Peter Coy, *Greece: Why the Beast is Back*, BUS. WK., May 30, 2011, at 11; Carol Matlack & Jeff Black, *Exit the Euro Zone? Think Before You Leap*, BUS. WK., Sept. 19, 2011, at 15.

127. *See* Concept Release on Equity Market Structure, Exchange Act Release No. 34-61358, 75 Fed. Reg. 3594, 3611 (proposed Jan. 21, 2010) (codified at 17 C.F.R. pt. 242) ("[M]any proprietary firms potentially could engage in similar or connected trading strategies that, if such strategies generated significant losses at the same time, could cause many proprietary firms to become financially

to shared conceptual biases.[128] As a result, the failing of one participant or one product could not only adversely impact others, but could also create vicious cycles of volatility for the entire global financial system as trades cascade and generate feedback loops and spillover effects of serious consequences.[129]

As cyborg finance expands, the systemic perils posed by "too linked to fail" will only grow more challenging and more pressing in the coming years as the complexity and multiplicity of linkages create greater risks and opportunities for error.[130]

B. Too Fast to Save

In the new financial industry of cyborg finance, financial transactions operate at incredible velocities. Billions of transactions worth trillions of dollars move through cables and spectra across seas and states at the speed of milliseconds.[131] The accelerated velocity has resulted in faster executions and also faster investment turnover. "At the end of World War II, the average holding period for a stock was four years. By 2000, it was eight months. By 2008, it was two months. And by 2011 it was *twenty-two seconds* . . . ."[132] And the future of cy-fi only appears to be accelerating as financial engineers chase the speed of light with new technology like quantum computing.[133] Such velocity and acceleration give rise to a new systemic risk of "too fast to save."

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distressed and lead to large fluctuations in market prices."); Bernard S. Donefer, *Algos Gone Wild: Risk in the World of Automated Trading Strategies*, 5 J. TRADING 31, 32 (2010).

128. Geoffrey P. Miller & Gerald Rosenfeld, *Intellectual Hazard: How Conceptual Biases in Complex Organizations Contributed to the Crisis of 2008*, 33 HARV. J.L. & PUB. POL'Y 807, 810 (2010).

129. *See* BROWN, *supra* note 15, at 7; PATTERSON, *supra* note 3, at 9–10 (discussing the financial dangers of "a vicious self-reinforcing feedback loop"); Louise Story & Graham Bowley, *Market Swings Are Becoming New Standard*, N.Y. TIMES, Sept. 12, 2011, at A1.

130. *See* Henry T.C. Hu & Bernard Black, *Debt, Equity and Hybrid Decoupling: Governance and Systemic Risk Implications*, 14 EUR. FIN. MGMT. 663, 691 (2008) ("The longer the ownership chain . . . the greater the potential for agency costs and valuation errors to creep in."); Judge, *supra* note 6, at 685; *see also* Steven L. Schwarcz, *Regulating Complexity in Financial Markets*, 87 WASH. U. L. REV. 211, 215 (2009).

131. *See* Fabozzi et al., *supra* note 2, at 8.

132. PATTERSON, *supra* note 3, at 46.

133. *See, e.g.*, Concept Release on Equity Market Structure, Exchange Act Release No. 34-61358, 75 Fed. Reg. 3594, 3610 (proposed Jan. 21, 2010) (codified at 17 C.F.R. pt. 242) (acknowledging the accelerating speed of modern financial markets); A. D. Wissner-Gross & C. E. Freer, *Relativistic Statistical Arbitrage*, 82 PHYSICAL REV. E 056104 (2010) (studying arbitrage opportunities for trading near the speed of light); Graham Bowley, *The New Speed of Money*, N.Y. TIMES, Jan. 2, 2011, at BU1 ("Almost each week, it seems, one exchange or another claims a new record: Nasdaq, for example, says its time for an average order 'round trip' is 98 microseconds—a mind-numbing speed equal to 98 millionths of a second."); Quentin Hardy, *Testing a New Class of*

While the accelerated speed of finance can be beneficial in terms of efficiencies, the accelerated speed also increases risks of error, volatility, market fragmentation, and malfeasance before anyone can stop it.[134] A single misinformed or rogue trader can cause material damage to a financial institution or the entire system in a very short amount of time. In 2008, a trader at Société Générale, the storied French investment bank, nearly destroyed the firm with $69 billion in unauthorized positions over a period of several months.[135] In 2011, another rogue trader at UBS, a leading Swiss investment bank, caused losses of $2.3 billion.[136]

Beyond human traders, automated programs pose even more serious systemic perils related to speed. Automated programs responding to bad data or nefarious stimuli can cause catastrophic harm to financial institutions before remedial or rescue measures can be implemented.[137] Automated programs operating at warp speeds can exacerbate volatility and reduce liquidity during periods of tumult by eliminating trading positions in the marketplace.[138] The Flash Crash serves as a prime example of the problems of "too fast to save":

> For the first time in financial history, machines can execute trades far faster than humans can intervene. That gap is set to widen. In some respects the 2010 Flash Crash and the 1987 stock market crash have common genes – algorithmic amplification of stress. But they differ in one critical respect. Regulatory intervention could feasibly have forestalled the 1987 crash. By the time of the Flash Crash, regulators might have blinked—literally, blinked—and missed their chance.[139]

Speedy Computer, N.Y. TIMES, Mar. 22, 2013, at B1; Matthew Philips, *Trading at the Speed of Light*, BUS. WK., April 2, 2012, at 46.

134. *See* FRANK PARTNOY, WAIT: THE ART AND SCIENCE OF DELAY 43 (2012); PERROW, *supra* note 119, at 71 (discussing the tendency for failures or "accidents" to compound upon one another); Haldane, *supra* note 3, at 15; s*ee also* Fabozzi et al., *supra* note 2, at 29 (discussing how emphasis on speed and technology fragments the financial industry); Matthew Baron et al., The Trading Profits of High Frequency Traders (Nov. 2012) (unpublished manuscript) (available at http://conference.nber.org/confer//2012/MMf12/Baron_Brogaard_Kirilenko.pdf) (finding that high-frequency traders profit at the expense of ordinary investors); Floyd Norris, *In Markets' Tuned-Up Machinery, Stubborn Ghosts Remain*, N.Y. TIMES, Aug. 23, 2013, at B1.

135. Nicola Clark, *Ex-Trader Gets 3 Years*, N.Y. TIMES, Oct. 6, 2010, at B1.

136. Julia Werdigier, *Revealing Details of Rouge Trades, UBS Raises Loss Estimate to $2.3 Billion*, N.Y. TIMES, Sept. 19, 2011, at B3.

137. *See* THOMAS NEAL FALKENBERRY, HIGH FREQUENCY DATA FILTERING: A REVIEW OF THE ISSUES ASSOCIATED WITH MAINTAINING AND CLEANING A HIGH FREQUENCY FINANCIAL DATABASE (2002), *available at* http://www.tickdata.com/pdf/Tick_Data_Filtering_White_Paper.pdf; Fabozzi et al., *supra* note 2, at 11.

138. PARTNOY, *supra* note 134.

139. Haldane, *supra* note 3, at 15.

Additionally, cyborg finance's emphasis on speed has also meant that traditional, institutional safeguards have been sacrificed for velocity and efficiency, making it more difficult to prevent such calamitous episodes. While such episodes may have occurred in eras past, they would have taken longer to execute and, therefore, allowed more time for intervention.

As cyborg finance accelerates, the systemic perils posed by "too fast to save" will only grow more apparent and more difficult in the coming years.

IV. CURRENT REGULATORY SHORTCOMINGS

Legal change frequently trails technological change.[140] Old laws and old regulations become blunt in the face of sharp, new financial developments.[141] As technological advances transform modern finance into cyborg finance, law's lagging performance has grown more apparent and more consequential. [142] The current regulatory framework's shortcomings can be partially traced to matters of jurisdiction, origination, and resource.

A. Matters of Jurisdiction

Sovereign and regulatory boundaries frequently bound law and regulation.[143] Yet cyborg finance is unencumbered by such quaint boundaries as it operates in a global marketplace, crosscutting states and regulators.[144] This jurisdictional dissonance helps to explain part of the

140. Lyria Bennett Moses, *Recurring Dilemmas: The Law's Race to Keep up with Technological Change*, 2007 U. ILL. J.L. TECH. & POL'Y 239, 239 (2007).

141. *See* Tara Bhupathi, *Technology's Latest Market Manipulator? High Frequency Trading: The Strategies, Tools, Risks, and Responses*, 11 N.C. J.L. & TECH. 377, 377–78 (2010) ("Rapid technological advances have . . . caus[ed] the legal world to either choose to judicially adapt old laws and policies to the new digital situations or to legislatively create new doctrines to deal with unforeseen challenges."); Stephen J. Choi & Andrew T. Guzman, *National Laws, International Money: Regulation in a Global Capital Market*, 65 FORDHAM L. REV. 1855, 1856–57 (1997); Whitehead, *supra* note 5, at 2–5 (noting the lack of regulatory innovation in response to financial innovation).

142. *See* REINHART & ROGOFF, *supra* note 6, at 224–25 (discussing the high costs of financial crises and failures).

143. *See* Morrison v. Nat'l Austl. Bank Ltd., 130 S. Ct. 2869, 2885 (2010) ("Like the United States, foreign countries regulate their domestic securities exchanges and securities transactions occurring within their territorial jurisdiction."); EEOC v. Arabian Am. Oil Co., 499 U.S. 244, 248 (1991) ("It is a longstanding principle of American law 'that legislation of Congress, unless a contrary intent appears, is meant to apply only within the territorial jurisdiction of the United States.'") (quoting Foley Bros. v. Filardo, 336 U.S. 281, 285 (1949)).

144. *See* BROWN, *supra* note 15, at 149 ("Advancements in electronic trading technology have rapidly accelerated the globalization of equity markets . . . ."); Johnson & Post, *supra* note 61, at 1367 (discussing the need for new conceptions of jurisdiction with the emergence of the Internet); Lawrence Lessig, *The Path of Cyberlaw*, 104 YALE L.J. 1743, 1743–45 (1995); Cox, *supra* note 6, at 945 ("As technology has made national borders seamless, it challenges the territorial orientation of securities regulations."); *see also* JACK GOLDSMITH & TIM WU, WHO CONTROLS THE INTERNET?: ILLUSIONS OF A BORDERLESS WORLD vii–viii (2006) (finding that the Internet is "becoming bordered");

current regulatory framework's shortcomings in governing financial innovation.

Because of the jurisdictional dissonance between government regulators and the regulated, financial industry participants and products exist in spaces with varying degrees of governance. In some spaces, multiple competing regulators govern participants and products across various territories and agencies with rules that overlap and conflict.[145] For instance, a complex multiplicity of regulators in the United States and the United Kingdom govern investment banks with intercontinental presence.[146] In other spaces, financial participants and products exist in regulatory penumbras with little oversight.[147] As an example, the credit default swap markets operated with few regulations and little oversight for many years prior to the Financial Crisis.[148]

The jurisdictional dissonance between the regulators and the regulated has encouraged financial players to engage in games of regulatory arbitrage within and across nations, by skirting and leaping ahead of existing law, and by moving between shadow finance and regulated finance.[149] The jurisdictional gaps and gulfs among regulators often serve as fertile ground for financial innovation and malfeasance.[150] As cy-fi continues to push and

145. *See* Fisch, *supra* note 6, at 787 (discussing jurisdictional conflict among regulators).

146. *See* Jack Ewing, *Global Rules for Banks Draw Near*, N.Y. TIMES, Sept. 11, 2010, at B1 (discussing the complexities in creating and standardizing banking rules internationally).

147. *See, e.g.*, ALEXANDER DAVIDSON, HOW THE GLOBAL FINANCIAL MARKETS REALLY WORK: THE DEFINITIVE GUIDE TO UNDERSTANDING INTERNATIONAL INVESTMENT AND MONEY FLOWS 17 (2009) (discussing shadow banking and financial regulation); Robert A. Eisenbeis, *Agency Problems and Goal Conflicts in Achieving Financial Stability: The Case of the EMU*, *in* THE STRUCTURE OF FINANCIAL REGULATION 232, 235 (David G. Mayes & Geoffrey E. Wood eds., 2007) (explicating on state and federal financial regulation conflicts); James J. Park, *The Competing Paradigms of Securities Regulation*, 57 DUKE L.J. 625, 665 (2007) (suggesting that regulatory competition creates regulatory gamesmanship opportunities).

148. *See* James E. Kelly, *Transparency and Bank Supervision*, 73 ALB. L. REV. 421, 424 (2010) (noting regulatory gaps relating to "hedge funds; derivatives markets; off balance sheet entities; the credit ratings agencies; firms' disclosure of risk, valuation, and compensation policies; securitized and structured products"); Whitehead, *supra* note 5, at 34 ("[Credit default swaps] were also exempt from regulation under the Securities Act of 1933 and the Securities Exchange Act of 1934, and were preempted from state gaming or bucketshop laws under the Commodity Exchange Act.") (footnote omitted); Gretchen Morgenson, *First Comes the Swap*. *Then It's the Knives*., N.Y. TIMES, June 1, 2008, at BU1; Interview by Michael Kirk with Brooksley Born, Chair 1996–1999, Commodity Futures Trading Comm'n (Aug. 28, 2009), *available at* http://www.pbs.org/wgbh/pages/frontline/warning/interviews/born.html ("When I was chair of the Commodity Futures Trading Commission [CFTC], I became aware of how quickly the over-the-counter derivatives market was growing, how little any of the federal regulators knew about it.").

149. *See* Victor Fleischer, *Regulatory Arbitrage*, 89 TEX. L. REV. 227, 229 (2010); Edward F. Greene & Elizabeth L. Broomfield, *Promoting Risk Mitigation, Not Migration: A Comparative Analysis of Shadow Banking Reforms by the FSB, USA and EU*, 8 CAP. MKTS. L.J. 6, 14–15 (2013); Robin Greenwood and David S. Scharfstein, *How to Make Finance Work*, at 107.

150. *See, e.g.*, GILLIAN TETT, FOOL'S GOLD: HOW THE BOLD DREAM OF A SMALL TRIBE AT J.P. MORGAN WAS CORRUPTED BY WALL STREET GREED AND UNLEASHED A CATASTROPHE 39–47 (2009)

break traditional regulatory boundaries based on jurisdiction, law must seek new paradigms to better address this shortcoming.[151]

B. Matters of Origination

Law is built on reaction, precedent, and predictability,[152] but cyborg finance is built on initiative, innovation, and change.[153] Financial regulations often do not originate organically; instead, they are the children of busts and scandals and become orphans in boom times.[154] The aftermath of the Great Depression led to the creation of the SEC and the modern federal securities regulatory framework.[155] The Enron and WorldCom scandals served as catalysts for the Sarbanes Oxley Act.[156] The Financial Crisis sowed the seeds of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank).[157] In response to the Flash Crash, regulators implemented new rules to address high-frequency trading.[158] Finance innovation, in contrast, originates organically as market participants create and change in the dynamic pursuit of profit.

(discussing how the derivatives market originated from regulatory evasion); Charles W. Calomiris, *Financial Innovation, Regulation, and Reform*, 29 CATO J. 65, 65 (2009) (explaining how financial innovation is often borne out of "sidestepping regulatory restrictions").

151. *See, e.g.*, Choi & Guzman, *supra* note 6, at 904–08; Merritt B. Fox, *Securities Disclosure in a Globalizing Market: Who Should Regulate Whom*, 95 MICH. L. REV. 2498, 2501–03 (1997).

152. *See, e.g.*, Frederick G. Kempin, Jr., *Precedent and Stare Decisis: The Critical Years, 1800 to 1850*, 3 AM. J. LEGAL HIST. 28, 28 (1959) ("The modern doctrine of stare decisis as applied in the United States is a general policy of all courts to adhere to the ratio decidendi of prior cases decided by the highest court in a given jurisdiction . . . .").

153. *See, e.g.*, Henry T.C. Hu, *Misunderstood Derivatives: The Causes of Informational Failure and the Promise of Regulatory Incrementalism*, 102 YALE L.J. 1457, 1479 (1993) ("To stay competitive, banks constantly introduce new financial products because margins on products decline quickly."); Eamonn K. Moran, *Wall Street Meets Main Street: Understanding the Financial Crisis*, 13 N.C. BANKING INST. 5, 33 (2009) (discussing the financial innovation behind mortgage-backed securities and collateralized debt obligations).

154. *See* ERIK F. GERDING, LAW, BUBBLES, AND FINANCIAL REGULATION 2–3 (2013) Stuart Banner, *What Causes New Securities Regulation? 300 Years of Evidence*, 75 WASH. U. L.Q. 849, 850 (1997) ("[M]ost of the major instances of new securities regulation in the past three hundred years of English and American history have come right after crashes."); John C. Coffee, Jr., *The Political Economy of Dodd-Frank: Why Financial Reform Tends To Be Frustrated and Systemic Risk Perpetuated*, 97 CORNELL L. REV. 1019, 1020 (2012) ("[O]nly after a catastrophic market collapse can legislators and regulators overcome the resistance of the financial community and adopt comprehensive 'reform' legislation."); Grundfest, *supra* note 6, at 1 ("[E]very dramatic change in the structure of our securities laws has been provoked by a perceived failure in the capital markets that stimulated a regulatory response.").

155. JACK E. KIGER ET AL., ACCOUNTING PRINCIPLES 409 (1984).

156. Larry E. Ribstein, *Bubble Laws*, 40 HOUS. L. REV. 77, 83 (2004).

157. SKEEL, *supra* note 5, at 43–59.

158. *See* Troy A. Paredes, Comm'r, SEC, Speech by SEC Commissioner: Remarks at the Symposium on "Hedge Fund Regulation and Current Developments" (June 8, 2011) (transcript available at http://www.sec.gov/news/speech/2011/spch060811tap.htm) (remarking on new regulatory proposals following the Flash Crash).

Because of this dissonance in origination, law frequently lags behind finance. New financial products and problems frequently lack elegant legal guidance and remedies. In some cases, the swiftness of financial innovation simply laps the slowness of rulemaking.[159] In other cases, mistimed, mismatched, and misinformed regulations create the bases for future financial problems.[160] This reactionary approach to rulemaking has led some leading corporate law scholars to call such an approach to financial regulation, "quack corporate governance."[161]

Because of this dissonance in origination, law has fallen gravely short in effectively governing financial markets. As cy-fi continues to innovate and evolve, law must re-examine its sources of origination in order to be more effective.[162]

C. Matters of Resource

There exists a significant resource asymmetry between participants in cyborg finance and the government regulators that oversee them. While the pursuit of profits drives financial firms to invest in technology and expertise, regulatory funding lacks a similar driving force and is often constrained by politics.[163]

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159. *See*, SEQUENCING?: FINANCIAL STRATEGIES FOR DEVELOPING COUNTRIES 133 (Alison Harwood & Bruce L. R. Smith eds., 1997); Ben Protess & Jessica Silver-Greenberg, *Senate Report Said to Fault JPMorgan on Loss*, N.Y. TIMES, March 5, 2013, at B1 (reporting on huge losses from risky trading while regulators have spent years trying to finalize and implement the Volcker Rule to curb such trading activities).

160. *See, e.g.*, Calomiris, *supra* note 150, at 67 ("Risk-taking was driven by government policies; government's *actions* were the root problem, not government *inaction*.").

161. *See* Stephen M. Bainbridge, *Dodd-Frank: Quack Federal Corporate Governance Round II*, 95 MINN. L. REV. 1779, 1821 (2011); Roberta Romano, *The Sarbanes-Oxley Act and the Making of Quack Corporate Governance*, 114 YALE L. J. 1521 (2005).

162. *See, e.g.*, Evan J. Criddle, *Fiduciary Administration: Rethinking Popular Representation in Agency Rulemaking*, 88 TEX. L. REV. 441, 448–49 (2010) (proposing a new regulatory model based on fiduciary duties); Randy J. Kozel & Jeffrey A. Pojanowski, *Administrative Change*, 59 UCLA L. REV. 112, 115 (2011) (suggesting a regulatory model based on "prescriptive reasoning").

163. *See Testimony on Budget and Management of the U.S. Securities Exchange Commission: Hearing Before the H. Comm. on Fin. Servs., & the Subcomm. on Capital Mkts., Ins., and Gov't-Sponsored Enters. of the H. Comm. on Fin. Servs.*, 112th Cong. (2011) (statement of Robert Khuzami et al., Dirs., Secs. Exch. Comm'n), *available at* http://www.sec.gov/news/testimony/2011/ts031011 directors.htm ("Over the past decade, the SEC has faced significant challenges in maintaining a staffing level and budget sufficient to carry out its core mission. The SEC experienced three years of frozen or reduced budgets . . . that forced a reduction of 10 percent of the agency's staff. Similarly, the agency's investments in new or enhanced IT systems declined about 50 percent . . . ."); Arthur Levitt Jr., Op-Ed, *Don't Gut the S.E.C.*, N.Y. TIMES, Aug. 8, 2011, at A19 (opining on the funding and political constraints on the SEC); Mark Maremont & Deborah Solomon, *Missed Chances: Behind SEC's Failings: Caution, Tight Budget, '90s Exuberance*, WALL ST. J., Dec. 24, 2003, at A1; Richard Rubin, *House Panel Endorses Budget Cuts at IRS, Consumer Bureau*, BLOOMBERG, June 16, 2011, *available at* http://www.bloomberg.com/news/2011-06-16/house-panel-endorses-budget-cuts-at-irs-consumer-bureau-1-.html ("[Because of budget cuts], the SEC wouldn't be able to carry out the new

Resource limitations can directly impact regulators on important matters of technology and expertise. In terms of technology, industry participants invest millions of dollars into the technology that is at the heart of cy-fi, while regulators lack similar resources to keep pace.[164] For instance, while the financial industry pushes into the new frontiers of technology, the federal government still has agencies that use floppy disks to submit information to the Federal Register in the year 2013. [165] In terms of expertise, private cy-fi participants can earn millions of dollars and continue to deepen their expertise.[166] Government regulators generally earn a fraction of that income with fewer opportunities for expertise development.[167] These significant compensation disparities have made it difficult for regulators to attract and retain talent.[168] Given the technology and complexity behind cyborg finance, effective regulation requires regulators that have sufficient technological capacity and financial comprehension to understand the industry that they seek to regulate.[169]

Moreover, regulated firms also expend significant influence to lobby policymakers, while regulators lack a similar influence.[170] A deleterious

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responsibilities it received in the Dodd-Frank law."); James B. Stewart, *As a Watchdog Starves, Wall St. Is Tossed a Bone*, N.Y. TIMES, July 16, 2011, at A1 (discussing the small budgets of financial regulators like the SEC).

164. Nathaniel Popper & Ben Protess, *To Regulate High-Speed Traders, S.E.C. Turns to One of Them*, N.Y. TIMES, Oct. 8, 2012, at B1.

165. Jada F. Smith, *Slowly They Modernize: A Federal Agency that Still Uses Floppy Disks*, N.Y. TIMES, Dec. 7, 2013, at A14.

166. *See, e.g.*, U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-11-654, SEC: EXISTING POST-EMPLOYMENT CONTROLS COULD BE FURTHER STRENGTHENED (2011), *available at* http://www.gao.gov/new.items/d11654.pdf (studying the revolving door between the SEC and the private sector); MICHAEL SMALLBERG, PROJECT ON GOV'T OVERSIGHT, DANGEROUS LIAISONS: REVOLVING DOOR AT SEC CREATES RISK OF REGULATORY CAPTURE (2013), *available at* http://pogoarchives.org/ebooks/20130211-dangerous-liaisons-sec-revolving-door.pdf; JAMES Q. WILSON ET AL., AMERICAN GOVERNMENT: INSTITUTIONS & POLICIES 279 (11th ed. 2008) ("Every year, hundreds of people leave important jobs in the federal government to take more lucrative positions in private industry.").

167. *See, e.g.*, U.S. GOV'T ACCOUNTABILITY OFFICE, *supra* note 166; WILSON, *supra* note 166, at 279. While this has traditionally been the case, in the last few decades, the compensation gap between those in the industry and those in government regulating the industry has grown exponentially. Admittedly, better compensated financial regulators and monitors do exist, namely private industry and intra-institution regulators like stock exchange officials, in-house attorneys, and compliance officers. Nevertheless, the commentary herein focuses on external, governmental regulators, who arguably serve as the most prominent and consequential financial regulators.

168. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, *supra* note 166; Edward Wyatt, *Study Questions Risk of S.E.C. Revolving Door*, N.Y. TIMES, Aug. 6, 2012, at B2.

169. *See, e.g.*, PATTERSON, *supra* note 3, at 230 ("The new hierarchy would be all about who owned the most powerful computers, the fastest links between markets, the most sophisticated algorithms—and the inside knowledge of how the market's plumbing was put together."); Hu, *supra* note 6, at 412; Fisch, *supra* note 6, at 820.

170. *See* Roberta S. Karmel, *IOSCO's Response to the Financial Crisis*, 37 J. CORP. L. 849, 853 (2012) ("Where regulated industries have so much power and influence over lawmakers, there is a lack of political will to engage in vigorous regulation even when regulators perceive the dangers of

consequence of this influence is that financial regulators can become "captured" by the industry.[171] Prior to the Financial Crisis, partially due to industry lobbying, credit default swaps[172] and hedge funds[173] were left largely unregulated under existing rules. Following the Financial Crisis, industry lobbyists were (and are) at the forefront of helping to draft financial reform rules and regulations.[174]

As a result of the resource disparities between the regulators and the regulated, it has been challenging for regulators to meaningfully police financial industry participants.[175] The net effect is a marketplace where large segments are poorly regulated or regulated only on paper. [176] As cy-fi continues to advance, policymakers must examine ways to narrow the resource disparities between the regulators and the regulated with new funding sources and new paradigms of financial governance.[177]

V. REGULATORY PRINCIPLES FOR THE NEW FINANCIAL INDUSTRY

Regulating the new financial industry of cyborg finance will be one of the most important endeavors for government and industry policymakers in the coming years. While actual and potential challenges presented by cy-fi are many, serious, and real,[178] so are its actual and potential benefits. Thus, regulatory efforts to govern it must be sensible and thoughtful, and they

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insufficient market place standards."); Rebecca M. Kysar, *The Sun Also Rises: The Political Economy of Sunset Provisions in the Tax Code*, 40 GA. L. REV. 335, 392 (2006) ("Through campaign contributions and lobbyists, these [interest] groups seek legislative votes favorable to their interests from politicians."); *see also* MANCUR OLSON, THE LOGIC OF COLLECTIVE ACTION: PUBLIC GOODS AND THE THEORY OF GROUPS 33–36 (2d ed. 1971).

171. *See, e.g.*, Saule T. Omarova, *The Quiet Metamorphosis: How Derivatives Changed the "Business of Banking,"* 63 U. MIAMI L. REV. 1041, 1077 (2009) (analyzing industry "capture" of the Office of the Comptroller of Currency).

172. *See* 7 U.S.C. § 16(e)(2) (2006); Frank Partnoy & David A. Skeel, Jr., *The Promise and Perils of Credit Derivatives*, 75 U. CIN. L. REV. 1019, 1046–47 (2007); Whitehead, *supra* note 5, at 34.

173. Troy A. Paredes, *On the Decision to Regulate Hedge Funds: The SEC's Regulatory Philosophy, Style, and Mission*, 2006 U. ILL. L. REV. 975, 976–1001.

174. *See* JEFF CONNAUGHTON, THE PAYOFF: WHY WALL STREET ALWAYS WINS (2012); ROBERT G. KAISER, ACT OF CONGRESS: HOW AMERICA'S ESSENTIAL INSTITUTION WORKS, AND HOW IT DOESN'T 127–41 (2013); Eric Lipton & Ben Protess, *Banks' Lobbyists Help in Drafting Bills on Finance*, N.Y. TIMES, May 24, 2013, at A1.

175. It should be noted that despite asymmetric resources, the SEC has recently had some high profile victories against better-resourced participants in the financial industry. *See* Devin Leonard, *Outmanned, Outgunned, And On a Roll*, BUS. WK., April 23, 2012, at 60–66.

176. Serritella, *supra* note 21, at 441–42.

177. *See* Omarova, *supra* note 1, at 427 (advocating for more private regulation as a form of new governance); *see also* Orly Lobel, *The Renew Deal: The Fall of Regulation and the Rise of Governance in Contemporary Legal Thought*, 89 MINN. L. REV. 342, 343–44 (2004) (describing a new governance model based on de-centralization, localization, and collaboration).

178. *See* Derek E. Bambauer, *Conundrum*, 96 MINN. L. REV. 584, 598–603 (2011) (describing the challenges of regulating cyberspace issues).

must not inhibit the promise and "generativity" of cy-fi.[179] Toward that end, this Part of the Article proposes a preliminary set of first principles for cyborg finance that should be considered by policymakers in creating a better regulatory framework for the emerging, new financial industry.

A. Embrace Reality

Policymakers should embrace the functional realities of the new financial industry in terms of its individual and institutional participants when designing regulations for cyborg finance.[180] Policymakers may need to update antiquated paradigms of reasonable individual investors and elegantly compartmentalized institutions in order to better regulate the financial industry.

In terms of individuals, financial regulators have long operated under the assumption that individual participants in the financial industry are rational actors of neo-classical economic theory who invest for the long term.[181] Financial regulation for the mythical rational actor is fairly simple: equip him with the requisite information, and he would then perfectly process that information and make the utility-maximizing decision.[182] Thus, transparency and disclosure have been longtime hallmarks of financial regulation.[183]

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179. *See* LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD 8–16 (2002) (arguing that misguided regulations can inhibit the potential of new technology); Jonathan L. Zittrain, *The Generative Internet*, 119 HARV. L. REV. 1974, 1980–81 (2006).

180. *See, e.g.*, Ronald Coase, *Saving Economics from the Economists*, HARV. BUS. REV., Dec. 2012, at 36 (arguing that policymakers need to focus on the realities of the world in order to remain effective and relevant).

181. *See* Regulation NMS, Exchange Act Release No. 34-51808, 70 Fed. Reg. 37,496, 37,500 (June 29, 2005) ("Indeed, the core concern for the welfare of long-term investors . . . was first expressed in the foundation documents of the Exchange Act itself."); Joan MacLeod Heminway, *Female Investors and Securities Fraud: Is the Reasonable Investor a Woman?*, 15 WM. & MARY J. WOMEN & L. 291, 297 (2009); David A. Hoffman, *The "Duty" to Be a Rational Shareholder*, 90 MINN. L. REV. 537, 537–39 (2006); Margaret V. Sachs, *Materiality and Social Change: The Case for Replacing "the Reasonable Investor" with "the Least Sophisticated Investor" in Inefficient Markets*, 81 TUL. L. REV. 473, 475 (2006).

182. *See* GARY S. BECKER, THE ECONOMIC APPROACH TO HUMAN BEHAVIOR 14 (1976) (advocating use of the economic approach for understanding human behavior); JOEL SELIGMAN, THE TRANSFORMATION OF WALL STREET: A HISTORY OF THE SECURITIES AND EXCHANGE COMMISSION AND MODERN CORPORATE FINANCE 39–40 (3d ed. 2003); Troy A. Paredes, *Blinded by the Light: Information Overload and Its Consequences for Securities Regulation*, 81 WASH. U. L.Q. 417, 418 (2003).

183. *See, e.g.*, SELIGMAN, *supra* note 182; Tom C.W. Lin, *A Behavioral Framework for Securities Risk*, 34 SEATTLE U. L. REV. 325, 336 (2011) ("In practice, this assumption has produced a regulatory framework that emphasizes more information over less information, more disclosure over better disclosure, quantity over quality.").

In order to remain effective, financial regulators need to better embrace the reality that actual individuals and investors are not rational actors.[184] A voluminous body of behavioral law and economics literature suggests that actual investors suffer from cognitive quirks, such as overconfidence and status quo bias, which affect their ability to process information perfectly and make optimal decisions consistently.[185] Admittedly, following the Financial Crisis, there has been greater awareness of the fallacies of the rational actor as the reasonable investor assumption.[186]

Beyond the imperfect assumption of investor rationality, with the emergence of cyborg finance, regulators also need to be more mindful that new investors have capabilities unmatched by previous paradigms of investors.[187] Given the inextricable technology that is at the heart of modern finance, new investors are essentially cyborgs—part human, part machine. New investors are faster, smarter, more global, and less human; they should be regulated accordingly.[188]

In terms of institutions, for too long financial regulation has been organized on elegantly compartmentalized institutional categories.[189] Distinct regulators oversaw commercial banks, thrifts, broker-dealers, and investment banks, respectively, for much of the last seven decades.[190] But

184. *See* Stephen J. Choi & A.C. Pritchard, *Behavioral Economics and the SEC*, 56 STAN. L. REV. 1, 2 (2003); Christine Jolls et al., *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471, 1473–76 (1998); Richard A. Posner, *Rational Choice, Behavioral Economics, and the Law*, 50 STAN. L. REV. 1551, 1552–56 (1998).

185. *See* DANIEL KAHNEMAN, THINKING, FAST AND SLOW 377–85 (2011); Robert B. Ahdieh, *The Visible Hand: Coordination Functions of the Regulatory State*, 95 MINN. L. REV. 578, 625 (2010) ("Over the last twenty years, psychologists and experimental economists have collected significant evidence that the rationality assumption of neoclassical economics fares poorly in the real world."); Ehud Guttel & Alon Harel, *Matching Probabilities: The Behavioral Law and Economics of Repeated Behavior*, 72 U. CHI. L. REV. 1197, 1197–200 (2005); Robert J. Shiller, *Measuring Bubble Expectations and Investor Confidence*, 1 J. PSYCHOL. & FIN. MKTS. 49, 50–52 (2000) (studying investor overconfidence); Herbert A. Simon, *A Behavioral Model of Rational Choice*, 69 Q.J. ECON. 99 (1955).

186. *See, e.g.*, *The Financial Crisis and the Role of Federal Regulators: Hearing Before the H. Comm. on Oversight and Gov't Reform*, 110th Cong. 46 (2008) (statement of Alan Greenspan, Former Chairman of the Fed. Reserve Bd.) (acknowledging that he "found a flaw in the [neoclassical] model that . . . defines how the world works"); Richard A. Posner, *How I Became a Keynesian*, NEW REPUBLIC, Sept. 23, 2009, at 34.

187. *See* Lin, *supra* note 4, at 699–703 (discussing a new investor paradigm in cyborg finance).

188. *See, e.g.*, CLIVE THOMPSON, SMARTER THAN YOU THINK: HOW TECHNOLOGY IS CHANGING OUR MINDS FOR THE BETTER 6 (2013) ("At their best, today's digital tools help us see more, retain more, communicate more.")

189. *See* Anita K. Krug, *Escaping Entity-Centrism In Financial Services Regulation*, 113 COLUM. L. REV. 2039, 2049 (2013) ("Financial services regulation embodies entity-centrism, in that it is largely premised on the notion that the entity is the appropriate unit of regulation."); U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-08-32, FINANCIAL REGULATION: INDUSTRY TRENDS CONTINUE TO CHALLENGE THE FEDERAL REGULATORY STRUCTURE 4–5 (2007); Jackson, *supra* note 6, at 332–39; Whitehead, *supra* note 5, at 2–3.

190. *See, e.g.*, Michael S. Barr, *The Financial Crisis and the Path of Reform*, 29 YALE J. ON REG. 91, 97 (2012) ("Before Dodd-Frank, major financial firms were regulated according to their formal

in recent years, financial institutions operate and penetrate across old categories, rendering such categorizations quaint and arbitrary.[191] Sophisticated financial industry participants today frequently exist less as singular entities and more as a collection of entities. JPMorgan Chase, for example, through subsidiary companies and limited partnerships, has significant operations in commercial banking, investment banking, consumer finance, financial processing, and private equity.[192] Smaller entities, like hedge funds and private equity groups, also work across multiple segments of the financial industry. As a result of this financial evolution, the old categorical approach to financial regulation does not match the functional realities of the new marketplace.

This mismatched categorical approach to regulation can have significant consequences on the effectiveness of regulation. The categorical approach, for instance, largely presumes that if individual categories and individual institutions were safeguarded and stabilized, then the entire financial system would be safeguarded and stabilized.[193] While elegant, this syllogism is false. Efforts targeted at protecting individual institutions or select categories of institutions by industry players and regulators can result in actions and consequences that harm the entire system given the crosscutting, linked realities of the new financial industry.[194] Borrowing lessons and language from property law, attempts at imposing categorical regulation to cross-categorical industry participants can lead to financial tragedies of the commons, where due to misguided regulations, firms

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labels—as banks, thrifts, investment banks, insurance companies, and the like—rather than according to what they actually did."); Gary Gorton, *Bank Regulation When "Banks" and "Banking" Are Not the Same*, 10 OXFORD REV. ECON. POL'Y 106, 107 (1994); Heidi Mandanis Schooner & Michael Taylor, *United Kingdom and United States Responses to the Regulatory Challenges of Modern Financial Markets*, 38 TEX. INT'L L.J. 317, 328–29 (2003) (noting that financial regulatory mandates are largely categorically-driven); *see generally* MARK JICKLING & EDWARD V. MURPHY, CONG. RESEARCH SERV., R40249, WHO REGULATES WHOM? AN OVERVIEW OF U.S. FINANCIAL SUPERVISION (2010).

191. *See* Howell E. Jackson, *The Expanding Obligations of Financial Holding Companies*, 107 HARV. L. REV. 507, 509 (1994) ("[T]oday's financial giants . . . now operate in multiple sectors of the industry, typically through a network of subsidiaries specializing in deposit-taking, insurance underwriting, securities activities, and various other financial services."); Robert C. Merton, *Financial Innovation and the Management and Regulation of Financial Institutions*, 19 J. BANKING & FIN. 461, 466–70 (1995); Schwarcz, *supra* note 5, at 374–75.

192. *See* JPMorgan Chase & Co., Annual Report (Form 10-K) 1 (Feb. 29, 2012) ("[JPMorgan Chase] is a leader in investment banking, financial services for consumers and small businesses, commercial banking, financial transaction processing, asset management and private equity.").

193. MARKUS KONRAD BRUNNERMEIER ET AL., THE FUNDAMENTAL PRINCIPLES OF FINANCIAL REGULATION xv (2009).

194. *See Id*. ("It is perhaps banal by now to point out that the reason why we try to prevent banking crises is that the costs to society are invariably enormous and exceed the private cost to individual financial institutions."); Beverly J. Hirtle et al., *Macroprudential Supervision of Financial Institutions: Lessons from the SCAP* 1 (Fed. Reserve Bank of N.Y., Staff Report No. 409, 2009), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1515800.

undertake self-serving, aggressive actions, such as overcapitalizing their reserves, which may harm the entire system in the long run.[195] Alternatively, such attempts could also lead to financial tragedies of the anticommons, where regulatory restrictions cause industry participants to underutilize available capital to the detriment of the financial system and the economy.[196]

Following the Financial Crisis, there have been greater regulatory efforts to recognize the cross-categorical nature of financial participants.[197] Many of the provisions in Dodd-Frank were intended to better regulate large financial institutions with cross-categorical presence.[198] With the emergence of cyborg finance, those efforts should be redoubled as cy-fi has made it possible for more institutional participants to operate across more traditional categories at higher speeds and greater magnitudes. In the new financial industry, one institution can perform functions that in eras past would have required multiple investment banks, commercial banks, and brokerages to act in concert. The fact of the matter is that many financial industry participants work across traditional categories of regulation. And thus, they should be regulated in modes that break away from stale, isolated categories.[199]

In sum, in order to effectively regulate cyborg finance, as a matter of first principles, policymakers should embrace the emerging individual and institutional realities of finance, and should be mindful of the fact that old paradigms of governance may be ill-suited and inadequate for the new financial industry.

B. Enhance Disclosure

When thinking about regulating cyborg finance, policymakers should enhance the old financial regulatory tool of disclosure.[200] By thoughtfully building upon existing disclosure rules and practices, policymakers can create a familiar, yet smarter framework for cy-fi.[201]

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195. *See* Garrett Hardin, *The Tragedy of the Commons*, 162 SCI. 1243, 1244–45 (1968) (explaining the tragedy of commons concept).

196. *See* Michael A. Heller, *The Tragedy of Anticommons: Property in the Transition From Marx to Markets*, 111 HARV. L. REV. 621, 624 (1998) (introducing the tragedy of anticommons concept).

197. *See* CONG. OVERSIGHT PANEL, *supra*, note 5, at 22–24, 29.

198. Judge, *supra* note 6, at 659.

199. *See* Schwarcz, *supra* note 5, at 374 (calling old modes of financial regulation focused on banks "anachronistic"); Whitehead, *supra* note 5, at 42 (advocating for a new "supra-functional approach" to financial regulation that is not limited by "function, categories, or intermediaries").

200. *See* Hu & Black, *supra* note 130, at 693.

201. *See, e.g.*, Jose A. Lopez, *Disclosure as a Supervisory Tool: Pillar 3 of Basel II* 1 (Fed. Reserve Bank of S.F., Econ. Letter 2003-22, 2003), *available at* http://www.frbsf.org/publications/economics/letter/2003/el2003-22.pdf ("The principle underlying

The existing federal securities regime is largely based on the straightforward motivation to "substitute a philosophy of full disclosure for the philosophy of *caveat emptor*."[202] Currently, publicly traded companies are required to make periodic and timely disclosures to the investing public. The working assumption is that with good disclosures, the financial market, like other efficient markets, would inform and govern itself and allocate capital accordingly.[203] Despite inherent flaws and notable setbacks, this disclosure-oriented framework has worked fairly well in terms of creating a growing economy and robust capital markets in America.[204] Nonetheless, in the aftermath of the Financial Crisis, many policymakers and commentators have suggested that prior to the crisis regulators allowed the financial industry participants to provide too little disclosure and operate in the shadows.[205]

With the emergence of cyborg finance, in order to maintain an efficient marketplace, policymakers should examine how they can adapt and update old disclosure practices to an industry that is more complex and more technologically driven than ever before.[206] The vast array of interlinked, complex instruments moving around the cyborg financial infrastructure is a departure from the relatively simple financial industry of the past where instruments like bonds and stocks dominated the marketplace.[207] The

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Pillar 3 is that improved public disclosure of relevant information should enhance market discipline and hence its potential usefulness to bank supervisors."); Robert P. Bartlett, III, *Making Banks Transparent*, 65 VAND. L. REV. 293 (2012) (advocating for enhanced disclosure as a tool for better financial regulation); Hu, *supra* note 5, at 1607–12 (suggesting a new disclosure paradigm based on "pure information" and new technology); Steven L. Schwarcz, *Rethinking the Disclosure Paradigm in a World of Complexity*, 2004 U. ILL. L. REV. 1, 16–17.

202. SEC v. Capital Gains Research Bureau, Inc., 375 U.S. 180, 186 (1963).

203. *See* BECKER, *supra* note 182; Hu, *supra* note 5, at 1607; Arthur Fleischer, Jr., *"Federal Corporation Law": An Assessment*, 78 HARV. L. REV. 1146, 1148–49 (1965) ("Because disclosure is designed to provide investors with the data necessary to make informed judgments, the information required may encompass all aspects of corporate life, and consequently all aspects of corporate life may be affected." (footnote omitted)).

204. *See, e.g.*, OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, BUDGET OF THE UNITED STATES GOVERNMENT, FISCAL YEAR 2006, 20–21 (2005), *available at* http://www.gpo.gov/fdsys/pkg/BUDGET-2006-BUD/pdf/BUDGET-2006-BUD-7.pdf (detailing the rise of the U.S. gross domestic product since 1940); Bengt Holmstrom & Steven N. Kaplan, *The State of U.S. Corporate Governance: What's Right and What's Wrong?*, 15 J. APPLIED CORP. FIN. 8, 8 (Spring 2003) ("Despite the alleged flaws in its governance system, the U.S. economy has performed very well, both on an absolute basis and particularly relative to other countries."); s*ee* CHARLES ROXBURGH ET AL., MCKINSEY GLOBAL INST., GLOBAL CAPITAL MARKETS: ENTERING A NEW ERA 9 (2009) (depicting the growth of U.S. capital markets).

205. *See* CONG. OVERSIGHT PANEL, *supra*, note 5, at 13–15.

206. Accurate timely information has long been a hallmark of efficient capital markets. *See, e.g.,* Eugene F. Fama, *Efficient Capital Markets: A Review of Theory and Empirical Work*, 25 J. FIN. 383, 404 (1970); Ronald J. Gilson & Reinier H. Kraakman, *The Mechanisms of Market Efficiency*, 70 VA. L. REV. 549, 550–66 (1984) (explaining that informed trading is a prerequisite for efficient markets).

207. Even in traditional financial markets, information asymmetry was a huge problem for market participants. *See* Bernard S. Black, *Information Asymmetry, the Internet, and Securities Offerings*, 2 J.

current paradigm is built on the disclosure of material information written in "plain English" by firms and issuers.[208] While informative, the current paradigm may be ill-suited and inadequate to depict the complex risks and realties of cyborg finance.[209] In a marketplace with vast complex links and linked products, investors and participants in the various lower chains of cy-fi may be seriously under-informed or misinformed by the current disclosure paradigm that cannot fully depict this complex financial web.[210] At best, firms and issuers are only capable of depicting one piece of a much larger mosaic. Therefore, more information in terms of volume and variety may need to be disclosed in order to better inform market participants.[211]

Mindful of new technological capabilities, policymakers should examine new ways to leverage technology towards creating a better, more workable disclosure framework. Policymakers should move beyond quaint beliefs that regulated disclosures are intended to be read by average, reasonable investors, so they must be written in "plain English."[212] The reality is that most reasonable investors do not educate themselves through raw, regulated disclosures, which at times can amount to information overload for many average investors.[213] Rather, in the age of cy-fi, professionals using artificial intelligence programs process regulated disclosures in ways and at speeds previously unimaginable.[214] Investors in the new financial industry may need to depend less on the depicted

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SMALL & EMERGING BUS. L. 91, 92 (1998) ("[T]he single largest cost that stands between issuers and investors is the problem of asymmetric information.").

208. *See* Presentation of Information in Prospectuses, 17 C.F.R. § 230.421(b) (2013) ("You must present the information in a prospectus in a clear, concise and understandable manner."); Plain English Disclosure, Securities Act Release No. 7497, Exchange Act Release No. 39,593, Investment Company Act Release No. 23,011, 63 Fed. Reg. 6370 (Feb. 6, 1998); OFFICE OF INVESTOR EDUC. & ASSISTANCE, SEC, A PLAIN ENGLISH HANDBOOK: HOW TO CREATE CLEAR SEC DISCLOSURE DOCUMENTS 4 (1998).

209. *See* Hu, *supra* note 5, at 1608 (arguing that conventional disclosure methodoligies "are especially limited in their ability to convey the pertinent quantitative aspects of financial innovations and of banks involved in such innovations"); Donald C. Langevoort, *Organized Illusions: A Behavioral Theory of Why Corporations Mislead Stock Market Investors (and Cause Other Social Harms)*, 146 U. PA. L. REV. 101, 135–46 (1997).

210. *See, e.g.*, BD. OF GOVERNORS OF THE FED. RESERVE SYS., REPORT TO THE CONGRESS ON RISK RETENTION 41 (2010), *available at* http://federalreserve.gov/boarddocs/rptcongress/securitization/riskretention.pdf ("Participants in securitization markets—originators, securitizers, rating agencies, and investors—have come to recognize that investors may have less information than other members of the securitization chain, particularly about the credit quality of the underlying assets.").

211. *See* Judge, *supra* note 6, at 690–96 (commenting on how financial complexity leads to information loss and dangerous consequences).

212. *See supra* note 208.

213. Paredes, *supra* note 182.

214. *See* Hu, *supra* note 5, at 1607 (suggesting that a new disclosure paradigm can be "facilitated by innovations in computer and Internet technologies").

disclosures of firms and issuers.[215] Advances in information technology have made it possible for market participants to process information that is more voluminous, more complex, and more unfiltered at faster rates than ever before.[216] As such, policymakers can reform the volume and variety of information disclosed to include more unfiltered data so that all investors can benefit directly or indirectly from that information. Sophisticated investors can benefit from that information using their superior technical capacity and financial expertise to analyze it; and ordinary investors can benefit from repackaged presentations of that information from market entrepreneurs, in addition to more accurate prices in a market with better information.[217]

Following the Financial Crisis, policymakers have taken actions to better leverage technology to enhance disclosure. Dodd-Frank requires the disclosure of swap prices and volume data "as soon as technologically practicable."[218] The SEC has also adopted a "consolidated audit trail" rule to make it easier for regulators to monitor and track the complex securities clearinghouse infrastructure.[219] At the end of 2013, pursuant to the Jumpstart Our Business Startups Act (the "JOBS Act"),[220] the SEC also issued a comprehensive study on how to modernize disclosure processes.[221]

In sum, as a matter of first principles, policymakers should aim to enhance the traditional regulatory tool of disclosure for cyborg finance. Through a fresh recognition of present financial complexities and technological capacities, policymakers may be able to upgrade an old tool for a new time.[222] While enhanced disclosure by itself will not cure all

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215. *See id*. at 1610 (arguing that "[i]f the investor is given the opportunity to see reality itself with his own eyes, he could come much closer to pure information, the objective truth in all of its quantitative and qualitative dimensions").

216. *See id*. ("With advances in computer and Internet technologies, it is no longer essential for an investor to rely exclusively on intermediary depictions."); *cf*. Schwarcz, *supra* note 130, at 221 (opining that regardless of disclosed information "[c]omplexity can deprive investors and other market participants of the understanding needed for markets to operate effectively").

217. *See* Zohar Goshen & Gideon Parchomovsky, *The Essential Role of Securities Regulation*, 55 DUKE L.J. 711, 714–15 (2006) (discussing the important informational role of sophisticated investors).

218. Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act), Pub. L. No. 111-203, 124 Stat. 1376 (2010) (to be codified in scattered sections of the U.S. Code). In the years since the passage of Dodd-Frank, the CFTC has made progress towards enhancing transparency in the swaps market. *See* Interpretive Guidance and Policy Statement Regarding Compliance with Certain Swap Regulations, 78 Fed. Reg. 45,292 (July 26, 2013).

219. 17 C.F.R. § 242.613 (2013).

220. Pub. L. No. 112-106 (2012).

221. STAFF OF THE SEC, REPORT ON REVIEW OF DISCLOSURE REQUIREMENTS IN REGULATION S-K (2013), *available at*: http://www.sec.gov/news/studies/2013/reg-sk-disclosure-requirements-review.pdf.

222. *See* Hu, *supra* note 5, at 1608–10 (proposing a new disclosure paradigm based on new technology and "pure information"); Judge, *supra* note 6, at 712 ("Better disclosure, by its nature, should reduce information loss, and increased transparency could reduce the magnitude of the

potential financial flaws and failures arising from the complexity of cyfi,[223] it will be a meaningful early step towards that elusive goal.

C. Slow Down

In contemplating smarter regulations for cyborg finance, policymakers should consider ways to create safer speeds and smarter brakes for finance as a key principle of future regulation.[224] The velocity at which much of cyfi currently operates, fractions of seconds, can create serious problems for the financial system and its participants.[225] This is not to suggest that policymakers should, as a matter of principle, favor a dilatory financial system. Rather, this suggests that policymakers should favor a more thoughtful, deliberative pace for finance. While high speeds contain significant benefits, they also contain high risks that can be catastrophic.

In the aftermath of the Flash Crash, domestic policymakers, regulators, and scholars have begun to pay greater attention to the effects of high velocities on finance.[226] Regulators at the national exchanges and the SEC proposed and implemented new rules aimed at sensibly slowing the speed of finance in the form of new circuit breakers designed to pause trading during periods of high volatility. Shortly after the Flash Crash, the national exchanges proposed more stringent circuit breakers in the event of dramatic

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coordination challenges that lead to stickiness."); Saule T. Omarova, *Rethinking the Future of Self-Regulation in the Financial Industry*, 35 BROOK. J. INT'L L. 665, 684 (2010) ("[T]he key to managing an increasingly complex financial system is timely access to, and ability to process, relevant market information."); Richard H. Thaler and Will Tucker, *Smarter Information, Smarter Consumers*, HARV. BUS. REV., Jan.–Feb. 2013, at 45–54.

223. *See* Robert P. Bartlett, III, *Inefficiencies in the Information Thicket: A Case Study of Derivative Disclosures During the Financial Crisis*, 36 J. CORP. L. 1, 7 (2010); Steven Davidoff & Claire Hill, *Limits of Disclosure*, 36 SEATTLE U. L. REV. 599, 604 (2013); Hu, *supra* note 5, at 1603–10 (discussing the various limits of disclosure).

224. *See* Frank Partnoy, *Don't Blink: Snap Decisions and Securities Regulation*, 77 BROOK. L. REV. 151, 155 (2011) (espousing the virtues of slower speeds in financial markets).

225. *See infra* Part III.B (describing the dangers of the accelerating velocity of finance).

226. *See, e.g.*, Charles K. Whitehead, *The Goldilocks Approach: Financial Risk and Staged Regulation*, 97 CORNELL L. REV. 1267, 1283–89 (2012) (explicating on risky, accelerated, and high-volume financial trading); Baron et al., *supra* note 134 (finding that high-frequency traders profit at the expense of ordinary investors). For general commentary on the effects of short-term, voluminous trading, see Fischer Black, *Noise*, 41 J. FIN. 529, 532–33 (1986); Robert Bloomfield et al., *How Noise Trading Affects Markets: An Experimental Analysis*, 22 REV. FIN. STUD. 2275, 2300 (2009); Robert Pollin et al., *Securities Transaction Taxes for U.S. Financial Markets*, 29 E. ECON. J. 527, 534–36 (2003); Joseph E. Stiglitz, *Using Tax Policy To Curb Speculative Short-Term Trading*, 3 J. FIN. SERVICES RES. 101, 102–05 (1989); Lawrence H. Summers & Victoria P. Summers, *When Financial Markets Work Too Well: A Cautious Case for a Securities Transactions Tax*, 3 J. FIN. SERVICES RES. 261, 264–69 (1989).

market decreases.[227] In the years since the Flash Crash, the SEC has also implemented a series of new circuit breakers for single stocks and entire markets to better manage the velocity of cyborg finance.[228] In addition to circuit breakers, policymakers should also consider kill switches for high speed systems,[229] and multi-location dissemination points for sensitive public information, like unemployment data, to minimize the significance of co-location and speed.

Policymakers abroad have similarly recognized the institutional and systemic risks of the accelerating velocity of finance. Internationally, regulators in Australia, Canada, France, Germany, and Hong Kong have utilized various mechanisms, including speed restrictions, volume limits, transaction fees, stress tests, and trading curbs to better manage the supersonic speed of finance.[230] For instance, in 2013, the Royal Bank of Canada, with the support of its regulators and some Canadian banks, purposely slowed customer trade orders to avoid the speed of high-frequency traders and dark pools so as to better fulfill such orders.[231]

While the accelerating speed has been quite beneficial to many market participants, as those speeds approach the speed of light they may contain more risks than rewards to the financial system. Thus, policymakers should adopt regulations aimed at moderating the velocities of finance as a designing principle for regulating cyborg finance.

D. Mind the Gaps

Policymakers should adhere to a principle of minding gaps in designing regulations for cyborg finance. Modern finance has frequently innovated and mutated at the regulatory breaks and market crevices of the financial system.[232] Every regulatory candle lit casts a new shadow within the system. Policymakers should be more aware of gaps created by regulations

227. *See, e.g.*, Notice of Filing of Proposed Rule Change to Update Rule 6121 and Amend Rule 6440, SEC Release No. 34-65430 (Sept. 28, 2011), *available at* http://www.sec.gov/rules/sro/finra/2011/34-65430.pdf.

228. CFTC & SEC FINDINGS, *supra* note 10, at 7; *Investor Bulletin: New Measures to Address Market Volatility*, SEC, Last Updated April 9, 2013, http://www.sec.gov/investor/alerts/circuitbreakersbulletin.htm.

229. Luis A. Aguilar, Comm'r, "Addressing Market Instability through Informed and Smart Regulation" at Practicing Law Institute's SEC Speaks in 2013 Program, Washington, D.C. (Feb. 22, 2013) (transcript available at http://www.sec.gov/News/Speech/Detail/Speech/1365171492386#.UthfBr9jRtK) (discussing the concept of kill switches for financial markets).

230. Nathaniel Popper, *As U.S. Discusses Limits on High-Speed Trading, Other Nations Act*, N.Y. TIMES, Sept. 27, 2012, at B1.

231. Nathaniel Popper, *Bank Gains by Putting the Brakes on Traders*, N.Y. TIMES, June 26, 2013, at B1.

232. Judge, *supra* note 6, at 659.

and market operations given the accelerated pace and growing complexity of cy-fi.[233]

Market participants design new instruments and transactions to take advantage of apertures in the financial system.[234] In some cases, gaps in financial markets provided fertile ground for financial innovation and regulatory arbitrage.[235] For instance, mortgage-backed securities and new forms of securitized assets originated partially because the market then lacked more efficient mechanisms to manage liabilities related to mortgages.[236] In other related cases, gaps in financial regulations created rich openings for new financial products. Credit default swaps, for instance, were created to circumnavigate commodities and securities regulations.[237] In both cases, gaps in the financial markets created fertile penumbras for shadow banking to blossom.[238] Some scholars have already speculated that new post-crisis regulations such as increased capital reserve requirements and rules on futures and swaps will create new gaps and shadows for financial regulators and industry participants.[239]

Since the Financial Crisis, policymakers have made strides towards better minding the gaps in the financial system by broadening the mandates of existing regulators and also by creating new regulators. Before the Financial Crisis, "no regulator or supervisor had the authority to look across the full sweep of the financial system—including less-regulated segments—and take action when it perceived a threat."[240] The post-crisis financial reform efforts led to the creation of the Financial Services Oversight Counsel, the National Bank Supervisor, the Consumer Financial Protection Bureau, and other government regulators geared towards filling

233. *See, e.g.*, Schwarcz, *supra* note 130, at 212–13 (discussing complexity "as the greatest financial-market challenge of the future").

234. *See* Calomiris, *supra* note 150 ("Financial innovations often respond to regulation by sidestepping regulatory restrictions that would otherwise limit activities in which people wish to engage.").

235. *See* Fleischer, *supra* note 149 ("Regulatory arbitrage exploits the gap between the economic substance of a transaction and its legal or regulatory treatment, taking advantage of the legal system's intrinsically limited ability to attach formal labels that track the economics of transactions with sufficient precision."); Frank Partnoy, *Financial Derivatives and the Costs of Regulatory Arbitrage*, 22 J. CORP. L. 211, 227 (1997) ("Regulatory arbitrage consists of those financial transactions designed specifically to reduce costs or capture profit opportunities created by differential regulations or laws.").

236. *See, e.g.*, Judge, *supra* note 6, at 670–73 (summarizing the origins of mortgaged-backed securities).

237. *See* Coffee, Jr. & Sale, *supra* note 6, at 727, 731–37 (mentioning Congress's failure to give the SEC authority over credit default swap). *See generally* Partnoy & Skeel, Jr., *supra* note 172.

238. *See* RAJAN, *supra* note 6, at 16; Gary Gorton & Andrew Metrick, *Regulating the Shadow Banking System*, *in* BROOKINGS PAPERS ON ECON. ACTIVITY 261 (2010), *available at* http://www.brookings.edu/~/media/projects/bpea/fall%202010/2010b_bpea_gorton.pdf.

239. GORTON, *supra* note 56, at 167–69.

240. Barr, *supra* note 190, at 99–100.

perceived regulatory gaps.[241] While these steps may begin to help alleviate some of the risks associated with the gaps of the old financial system, policymakers must also be mindful of new gaps created by the dynamism of cyborg finance.[242]

As cy-fi emerges and evolves, policymakers should, as a principled matter, craft rules that help regulators better mind the gaps of cyborg finance because it is in those openings that risks mutate and rewards blossom.[243]

E. Coordinate

Policymakers should operate with the principle of promoting smarter coordination in designing regulations for cyborg finance. The coordinating function of law and regulation can create greater uniformity and lower transactional costs for the financial system while promoting interagency competition and accountability.[244] Similar to how market participants take advantage of gaps in the financial system, they also take advantage of uncoordinated regulations by engaging in highly profitable and dangerous games of arbitrage and evasion.[245] As cy-fi evolves, it will grow more complex, cutting across regulatory and sovereign boundaries through cables and spectra in cyberspace. Criminal laws pertaining to cybercrimes,

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241. *See* 12 U.S.C. § 5301 (2012); U.S. DEP'T OF TREASURY, FINANCIAL REGULATORY REFORM: A NEW FOUNDATION: REBUILDING FINANCIAL SUPERVISION AND REGULATION 3 (2010), *available at* http://www.treasury.gov/initiatives/Documents/FinalReport_web.pdf; *see, e.g.*, Barr, *supra* note 190, at 109 ("The Dodd-Frank Act took several key steps toward reorganizing the U.S. federal regulatory system and reducing regulatory arbitrage . . . . [M]uch more could have been done to close gaps and relieve tensions arising from fragmentation."); U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-09-358, SECURITIES AND EXCHANGE COMMISSION: GREATER ATTENTION NEEDED TO ENHANCE COMMUNICATION AND UTILIZATION OF RESOURCES IN THE DIVISION OF ENFORCEMENT 3–8 (2009), *available at* http://www.gao.gov/assets/290/288156.pdf.

242. *See* Judge, *supra* note 6, at 659 ("[R]eforms adopted to produce a more stable financial system are unlikely to achieve that aim unless complemented by efforts to address the corresponding changes they are likely to induce in the capital markets.")

243. *See, e.g.*, Hu, *supra* note 153, at 1502–03 (discussing the regulatory duty to monitor the systemic impact of financial innovation).

244. *See* Scott A. Beaulier et al., *Knowledge, Economics, and Coordination: Understanding Hayek's Legal Theory*, 1 N.Y.U. J.L. & LIBERTY 209, 211–15 (2005); Jody Freeman & Jim Rossi, *Agency Coordination in Shared Regulatory Space*, 125 HARV. L. REV. 1131, 1133 (2012) ("Coordination can also help to preserve the functional benefits of shared or overlapping authority, such as promoting interagency competition and accountability, while minimizing dysfunctions like discordant policy."); Charles K. Whitehead, *Destructive Coordination*, 96 CORNELL L. REV. 323, 325 (2011) ("In the financial markets, coordination helps to minimize costs and promote stability."); *see also* Richard H. McAdams, *A Focal Point Theory of Expressive Law*, 86 VA. L. REV. 1649, 1666–68, 1676–78 (2000) (explaining how law serves as a coordinating nexus for disparate individual actions); Cass R. Sunstein, *Problems with Rules*, 83 CALIF. L. REV. 953, 969–71 (1995) (discussing how legal rules mitigate collective action problems by encouraging coordination).

245. Whitehead, *supra* note 5, at 36–37.

for instance, are largely limited by sovereign jurisdiction even though the criminals and their financial crimes can cross multiple countries.[246] As financial market participants continue to innovate and grow with little regard for sovereign and regulatory borders, policymakers must explore new paradigms for coordination that break away from antiquated models based primarily on jurisdiction, be it sovereign jurisdiction or regulatory jurisdiction.[247]

In order to govern effectively and efficiently, policymakers must design regulations that promote smarter coordination among the regulators and the regulated to minimize thoughtless redundancies.[248] In practice, this may lead to more standardization among industry participants and regulators creating greater efficiencies.[249] To reduce transaction costs, participants may use more standardized forms and boilerplate provisions to create new industry conventions consistent with new regulations.[250] For instance, the International Swaps and Derivatives Association (ISDA), an industry organization, has already developed a robust body of standardized contracts, forms, terminology, and practices for industry participants.[251] Similarly, financial regulators across jurisdictions may develop common standards to ease doing business internationally and aid in achieving regulatory aims.[252]

Following the recent financial crisis, policymakers have initiated some steps aimed at promoting smarter coordination given the disastrous consequences of discordant policies prior to the crisis.[253] Through the enactment of Dodd-Frank, Congress has given regulators greater mandates to standardize banking capital reserves requirements and to stress test banks.[254] Similarly, Dodd-Frank also created new regulators and updated old ones to better harmonize the financial regulatory framework in order to

246. Hathaway et al., *supra* note 105, at 877.

247. *See* Chris Brummer, *Post-American Securities Regulation*, 98 CALIF. L. REV. 327, 328–30 (2010) (summarizing challenges relating to coordination faced by American regulators); Judge, *supra* note 6, at 702–07 (discussing the "coordination challenges" of complex financial products).

248. *See* Freeman & Rossi, *supra* note 244, at 1138–39 (critiquing various agency rulemaking problems).

249. *See, e.g.*, NOURIEL ROUBINI & STEPHEN MIHM, CRISIS ECONOMICS: A CRASH COURSE IN THE FUTURE OF FINANCE 193–94 (2010) (promoting standardization in pursuit of financial stability).

250. *See* Robert B. Ahdieh, *The Strategy of Boilerplate*, 104 MICH. L. REV. 1033, 1053–55 (2006).

251. *See* Sean M. Flanagan, *The Rise of a Trade Association: Group Interactions Within the International Swaps and Derivatives Association*, 6 HARV. NEGOT. L. REV. 211, 240–49 (2001).

252. *See id*.

253. *See* Ahdieh, *supra* note 185, at 585 ("The heart of the financial crisis, however, was a failure of coordination.").

254. 12 U.S.C. §§ 5322, 5365 (2012).

meet the realities of the marketplace.[255] Internationally, similar efforts have been made to promote smarter regulation. The Basel III Accord, for instance, standardized capital reserve metrics for banks in many countries including the United States, those in the United Kingdom, and Japan.[256]

It is important to note that this principle of promoting coordination is not a call for an extraterritorial super-regulator devoid of respect for agency borders and sovereign jurisdictions. While too little coordination is problematic, too much coordination can also create serious risks. Too much coordination could lead to "destructive coordination,"[257] which could result in thoughtless herd behavior by regulators and participants.[258] Too much coordination can also erode competition among regulators with different areas of focus and expertise.[259] Rather than too much or too little coordination, this principle calls for smarter coordination: coordination that thinks anew about harmonizing financial regulation beyond traditional spaces bounded by anachronistic notions of jurisdiction, coordination that reduces redundancies thoughtfully while retaining the benefits of competition among regulators.[260]

F. Trust but Verify

Mindful of the structural limitations of government-oriented, top-down regulation, policymakers should place more trust in sensible private regulation by industry participants as part of regulating cyborg finance in concert with public regulation by government regulators. To better complement government regulations, policymakers can better leverage the

255. *See, e.g.*, 12 U.S.C. §§ 5321, 5322 (2012) (establishing the Financial Stability Oversight Council to monitor systemic risks and coordinate preemptive responses).

256. *See* BANK FOR INT'L SETTLEMENTS, BASEL COMM. ON BANKING SUPERVISION, BASEL III: A GLOBAL REGULATORY FRAMEWORK FOR MORE RESILIENT BANKS AND BANKING SYSTEMS 12–17, 27–28 (2011), *available at* http://www.bis.org/publ/bcbs189.pdf.

257. *See* Whitehead, *supra* note 244, at 326 ("By promoting coordination, regulations and standards can erode key presumptions underlying financial risk management, reducing its effectiveness and magnifying the systemic impact of a downturn in the financial markets.").

258. *See* BANK FOR INT'L SETTLEMENTS, COMM. ON THE GLOBAL FIN. SYS., LONG-TERM ISSUES IN INTERNATIONAL BANKING 31 (CGFS Publications No. 41, 2010), *available at* http://www.bis.org/publ/cgfs41.pdf ("[C]onvergence to a single risk assessment or risk management framework . . . would encourage herd behaviour and weaken financial stability.").

259. *See* Stavros Gadinis, *The Politics of Competition in International Financial Regulation*, 49 HARV. INT'L L.J. 447, 448–50 (2008); Park, *supra* note 147, at 626–28.

260. *See* FRANK H. EASTERBROOK & DANIEL R. FISCHEL, THE ECONOMIC STRUCTURE OF CORPORATE LAW 13–14 (1991) (praising the benefits of regulations that encourage competition); ROBERTA ROMANO, THE GENIUS OF AMERICAN CORPORATE LAW 148 (1993); *see also* Freeman & Rossi, *supra* note 244, at 1193–96 (discussing ways to improve regulatory coordination); Kathryn Judge, *Interbank Discipline*, 60 UCLA L. REV. 1262, 1281 (2013) (examining why and how banks can discipline one another).

expertise, proximity, and resources of industry participants, through existing industry regulatory groups and market mechanisms, to create governance tools that are more knowledgeable and more responsive to the issues facing the financial markets.[261] It is important to note that many financial industry participants are already governed by internal compliance policies, private industry rules, and financial customs.[262] Thus, the threshold inquiry is not about whether to permit private regulation or not, but about how best to design and partner private, industry-oriented regulation to complement public, government-oriented regulation.[263]

Private regulation, when appropriately designed, can break through some of the structural limitations of jurisdiction, origination, and resource faced by government regulators. In terms of jurisdiction, industry participants are not bound by the same issues of agency and sovereign boundaries as governmental regulators.[264] An American investment bank headquartered in New York can readily help monitor and discipline the financial soundness of a Spanish counterpart headquartered in Madrid through various financial instruments and transactions.[265] Similarly, private electronic networks can require foreign participants in those private spaces

261. *See, e.g.*, BANK FOR INT'L SETTLEMENTS, BASEL COMM. ON BANKING SUPERVISION, CONSULTATIVE DOCUMENT: PILLAR 3 (MARKET DISCIPLINE), SUPPORTING DOCUMENT TO THE NEW BASEL CAPITAL ACCORD 1 (2001), *available at* http://www.bis.org/publ/bcbsca10.pdf ("[M]arket discipline has the potential to reinforce capital regulation and other supervisory efforts to promote safety and soundness in banks and financial systems."); Ross P. Buckley, *The Role and Potential of Self-Regulatory Organizations: The Emerging Markets Traders Association from 1990 to 2000*, 6 STAN. J.L. BUS. & FIN. 135, 135–37 (2000); Omarova, *supra* note 1, at 413–16 (espousing the virtues of private financial regulation).

262. *See generally* Judge, *supra* note 260, at 1286–88; Miriam Hechler Baer, *Governing Corporate Compliance*, 50 B.C. L. REV. 949, 950 (2009); Gerding, *supra* note 22.

263. For general commentary on public-private partnerships in financial regulation, see William A. Birdthistle & M. Todd Henderson, *Becoming A Fifth Branch*, 99 CORNELL L. REV. 1, 12–24 (2013); Roberta S. Karmel, *Should Securities Industry Self-Regulatory Organizations Be Considered Government Agencies?*, 14 STAN. J.L. BUS. & FIN. 151, 151–55 (2008); Marianne K. Smythe, *Government Supervised Self-Regulation in the Securities Industry and the Antitrust Laws: Suggestions for an Accommodation*, 62 N.C. L. REV. 475, 480–87 (1984).

264. *See* Omarova, *supra* note 1, at 418 ("Unconstrained by matters of formal jurisdiction, private firms are also better equipped to monitor and manage their activities and risks on a global basis as an integrated economic enterprise."); Rolf H. Weber & Douglas W. Arner, *Toward a New Design for International Financial Regulation*, 29 U. PA. J. INT'L L. 391, 392–96 (2007).

265. *See* John C. Coffee, Jr., *Systemic Risk After Dodd-Frank: Contingent Capital and the Need for Regulatory Strategies Beyond Oversight*, 111 COLUM. L. REV. 795 (2011); Elena Cubillas, Ana Rosa Fonseca & Francisco González, *Banking Crises and Market Discipline: International Evidence*, 36 J. BANKING & FIN. 2285 (2012); Douglas D. Evanoff, *Preferred Sources of Market Discipline*, 10 YALE J. ON REG. 347, 350 (1993); Douglas D. Evanoff, Julapa A. Jagtiani & Taisuke Nakata, *Enhancing Market Discipline in Banking: The Role of Subordinated Debt in Financial Regulatory Reform*, 63 J. ECON. & BUS. 1 (2011); David G. Oedel, *Private Interbank Discipline*, 16 HARV. J.L. & PUB. POL'Y 327, 330 (1993). *But see* David A. Skeel, Jr. & Thomas H. Jackson, *Transaction Consistency and the New Finance in Bankruptcy*, 112 COLUM. L. REV. 152, 164 (2012) (detailing "the now-infamous Repo 105 transactions that Lehman employed at the end of each quarter to disguise the amount of its leverage" to fool regulators and counterparties).

to adhere to certain rules without facing the same jurisdictional issues that may be encountered by the SEC and other government regulators.[266] Because cy-fi participants exist across multiple jurisdictions, sensible private regulatory mechanisms can be an effective governance feature of a new framework for dealing with jurisdictional obstacles faced by government regulators.[267]

In terms of origination, relative to government regulators, industry participants are driven less by market booms and busts to create sensible regulation given their expertise and proximity to the daily operations of finance. Given the speed and complexity of cyborg finance,[268] regulatory needs will be dynamic and accelerated as well, perhaps too fast for the slog of governmental legislation and rulemaking.[269] In contrast to government fiats that are reactions to the latest scandal, scare, or bust, industry participants, in some cases, can be more knowledgeable than government regulators about how best to craft and refine rules and practices as needed.[270] Moreover, because of the interconnectedness of cy-fi, many of the participants share a stake in the soundness and stability of the system.[271] A recent study suggested that many of the largest banks in the country had substantial credit exposures to one another.[272] Mindful of these shared interests, policymakers should design regulations that encourage institutions to regulate and moderate one another. For instance, policymakers can encourage market-based mechanisms, like special debt securities, that better position investment banks to monitor the financial soundness of their peers and counterparties by being watchful of the pricing of the assets being used as collateral among and between institutions.[273]

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266. *See* Brummer, *supra* note 6, at 1450–63.

267. *See* Omarova, *supra* note 1, at 431 (discussing the capacity of financial participants "to regulate and monitor their own activities and risks on a seamlessly global, cross-border basis").

268. *See* Andrew W. Lo & Robert C. Merton, *Preface to the Annual Review of Financial Economics*, 1 ANN. REV. FIN. ECON. 1, 12 (2009) ("[T]he implementation of financial innovation is likely to be more rapid because the threshold for change is lower.").

269. Hu, *supra* note 153, at 1463.

270. *See, e.g.*, Hu, *supra* note 6, at 412 (suggesting that regulators may not possess sufficient expertise to effectively regulate some complex financial products); Judge, *supra* note 260, at 1296–97.

271. *See, e.g.*, JPMorgan Chase & Co., Annual Report (Form 10-K) 10 (Feb. 29, 2012) ("The financial condition of JPMorgan Chase's customers, clients and counterparties, including other financial institutions, could adversely affect the Firm."); Omarova, *supra* note 1, at 422, 443–47 (articulating shared, collective interests as the bases of meaningful private regulation in the financial industry).

272. *See* Judge, *supra* note 260, at 1283–84; Letter from The Clearing House et al., to Jennifer J. Johnson, Sec'y, Bd. of Governors of the Fed. Reserve Sys. C-3 (Apr. 27, 2012), *available at* http://www.aba.com/ABASA/Documents/Dodd-Frank-Sections-165166-Comment-Letter.pdf.

273. *See, e.g.*, Charles W. Calomiris, *Blueprints for a New Global Financial Architecture*, *in* INTERNATIONAL FINANCIAL MARKETS: THE CHALLENGE OF GLOBALIZATION 259, 270−72 (Leonardo Auernheimer ed., 2003) (recommending that banks hold debt in one another to promote stability); Craig H. Furfine, *Banks as Monitors of Other Banks: Evidence from the Overnight Federal Funds Market*, 74 J. BUS. 33, 54 (2001) ("[B]anks with higher profitability, fewer problem loans, and higher capital ratios

In terms of resources, industry participants do not face the same political and budgetary constraints as government regulators. Instead, private regulation would be driven by industry incentives for profit, certainty, and sustainability.[274] For instance, because cyborg finance is so reliant on expensive, advanced information technology, private industry may be better positioned, in terms of resources, to leverage technology and expertise to monitor and manage risk in partnership with government regulators.[275] In an era of growing mandates and shrinking budgets, policymakers should consider sensible private regulation as a tool for overcoming their resource challenges.[276]

This advocacy for private regulation as a first principle for regulating cyborg finance should not be mistaken as a call for deregulation or an abdication of the state's role in financial governance. It is understood that the financial industry cannot perfectly regulate itself.[277] As such, this principle is not advocating for exclusive private regulation or self-regulation. Rather, this proposed principle is an invitation for thinking

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pay lower interest rates . . . ."); John Geanakoplos, *Solving the Present Crisis and Managing the Leverage Cycle*, 16 FED. RES. BANK OF N.Y. ECON. POL'Y REV. 101, 104 (2010) ("[T]he best way to monitor leverage is to do it at the *security* level by keeping track of haircuts on all the different kinds of assets used as collateral, including in the repo market and in the housing market.").

274. *See* Jonathan R. Macey & Elizabeth H. Garrett, *Market Discipline by Depositors: A Summary of the Theoretical and Empirical Arguments*, 5 YALE J. ON REG. 215, 220 (1988) ("The likelihood that regulators are as effective as private parties at designing methods to control bank risk is slight, because unlike private parties, regulators do not have their own funds at stake . . . .").

275. *See* Kenneth A. Bamberger, *Technologies of Compliance: Risk and Regulation in a Digital Age*, 88 TEX. L. REV. 669, 685–87, 689–92 (2010); Judge, *supra* note 260, at 1296–97 (discussing how financial institutions, unlike government regulators, can "hire the best and the brightest personnel available").

276. *See, e.g.,* SEC, FY 2014 CONGRESSIONAL BUDGET JUSTIFICATION (2014), *available at* http://www.sec.gov/about/reports/secfy14congbudgjust.pdf; William Alden, *For 2 Wall Street Regulators, More Belt-Tightening*, N.Y. TIMES: DEALBOOK, (Jan. 14, 2014), http://dealbook.nytimes.com/2014/01/14/for-2-wall-street-regulators-more-belt-tightening/; Matthew Philips, *The CFTC Is Drowning in Data*, BUS. WK., Nov. 4, 2013, at 35–36. ("The CFTC's budget has risen from $111 million to about $200 million over the past five years, but that's coincided with a more than tenfold increase in the size of the markets it oversees.")

277. *See, e.g.*, Baer, *supra* note 262, at 950–56 (critiquing internal compliance programs); Brooksley Born, *Foreword: Deregulation: A Major Cause of the Financial Crisis*, 5 HARV. L. & POL'Y REV. 231, 242–43 (2011) ("The causative role of deregulation and inadequate regulation in the financial crisis demonstrates the fallacies of reliance on self-regulation in a field central to the American economy and the welfare of the American people."); Kimberly D. Krawiec, *The Return of the Rogue*, 51 ARIZ. L. REV. 127, 128–32 (2009) (discussing flaws of self-regulated risk management); Langevoort, *supra* note 6, at 1214; Macey & O'Hara, *supra* note 1 (theorizing that profit-maximizing may conflict with private, industry-oriented regulation); Leo E. Strine, Jr., *Our Continuing Struggle with the Idea that For-Profit Corporations Seek Profit*, 47 WAKE FOREST L. REV. 135, 136 (2012) ("In the end, policy makers should not delude themselves about the corporation's ability to police itself; government still has a critical role in setting the rules of the game."); *Morgan Stanley's Mack: "We Cannot Control Ourselves"*, N.Y. TIMES: DEALBOOK, (Nov. 19, 2009), http://dealbook.blogs.nytimes.com/2009/11/19/morgan-stanleys-mack-we-cannot-control-ourselves/ (quoting Morgan Stanley CEO John Mack as stating "[w]e cannot control ourselves").

anew about financial governance, about balancing and partnering traditional government-oriented regulation with more industry-oriented regulation.[278] If cy-fi is a manifestation of Lawrence Lessig's famous observation that "code is law,"[279] then the industry participants, who are at the forefront of creating and implementing the code, should also be key partners at the forefront of creating and implementing the law.[280] There are significant advantages to private industry regulation in terms of expertise, proximity, and incentives that should be harnessed "to serve public goals."[281] Thus, policymakers should place more trust in industry-based frameworks for regulation coupled with sensible government oversight in theorizing a new regulatory framework for cyborg finance.

G. Customize

Policymakers, in designing regulations for cyborg finance, should prefer narrowly tailored, customized rules whenever possible and favor broadly construed, categorical rules only when necessary. Customization would help minimize the harmful, unintended, and unanticipated consequences of one-size-fits-all, comprehensive rules.[282] Customization would allow regulators and industry participants to carefully target areas where risks are most significant without inhibiting the potential rewards from areas where risks are manageable.[283]

Because financial regulatory reform efforts historically follow busts, scandals, or scares,[284] policymakers tend to react and overreact in an

278. *See* Cristie L. Ford, *New Governance, Compliance, and Principles-Based Securities Regulation*, 45 AM. BUS. L.J. 1, 27–28 (2008); Lobel, *supra* note 177, at 468 ("There is a tendency to equate shifts from top-down regulation with deregulation, privatization, and devolution. The new governance paradigm resists this dichotomized world and requires ongoing roles for government and law.").

279. LAWRENCE LESSIG, CODE: VERSION 2.0, 5 (2006).

280. *See* Gerding, *supra* note 22, at 184–85; Joel R. Reidenberg, *Lex Informatica: The Formulation of Information Policy Rules Through Technology*, 76 TEX. L. REV. 553, 565–69 (1998).

281. Jody Freeman, *The Private Role in Public Governance*, 75 N.Y.U. L. REV. 543, 549 (2000).

282. *See* J.B. Ruhl & James Salzman, *Mozart and the Red Queen: The Problem of Regulatory Accretion in the Administrative State*, 91 GEO. L.J. 757, 814 (2003) ("The unintended consequences of a rule thus emerge from the complex interactions between the full set of rules and the human behaviors they motivate."); Whitehead, *supra* note 226, at 1270 (opining that there is "a real risk that new rules will have unanticipated consequences, particularly in a system as complex as today's financial markets").

283. Judge, *supra* note 6, at 724.

284. *See* Whitehead, *supra* note 5, at 2 ("Financial regulation is often reactive. New regulation seals up leaks in the financial system – usually following a crisis, a shift in the markets, or other change that threatens financial stability.").

omnibus manner.[285] As financial crises grow in size, so do the regulatory responses to those crises. The Glass-Steagall Act of 1933, which was implemented following the Great Depression, ran 37 pages; Dodd-Frank is contained in 848 pages with thousands of pages' worth of additional rules.[286] The so-called "Volcker Rule" alone which stemmed from Dodd-Frank is contained in 964 pages, including an 893-page preamble.[287] The rule involved 18,223 comments and 1,238 days of rulemaking.[288]

Moreover, regulations promulgated by such efforts in down times usually become deregulated in good times—creating a consequential and costly cycle of over-regulation, deregulation, and re-regulation.[289] In order to prevent the last crisis from repeating itself, policymakers frequently use sledgehammers rather than scalpels in creating new regulations, which may be politically and psychologically satisfying, but not necessarily most workable and effective.[290] Mandating that diverse groups of banks and other financial institutions adhere to the same rules, irrespective of their differences, can reduce institutional and systemic welfare as capital is obtusely shifted from productive efforts to costly compliance efforts.[291] Additionally, a "one-size-fits-all" regulatory approach may "force risk migration rather than mitigation."[292] For instance, when new rules on futures and swaps were promulgated some institutions simply "futurized" swaps by converting them into futures to receive more favorable regulatory

285. *See* Banner, *supra* note 154; Erik F. Gerding, *The Next Epidemic: Bubbles and the Growth and Decay of Securities Regulation*, 38 CONN. L. REV. 393, 418–24 (2006); Grundfest, *supra* note 6; Tom C.W. Lin, *Vistas of Finance*, 61 UCLA L. REV. DISCOURSE 78, 85 (2013).

286. Andrew G. Haldane, Exec. Dir., Fin. Stability, Bank of Eng., The Dog and the Frisbee, Speech at the Federal Reserve Bank of Kansas City's 36th Economic Policy Symposium: The Changing Policy Landscape, Jackson Hole, Wyoming 8 (Aug. 31, 2012), *available at* http://www.bankofengland.co.uk/publications/Documents/speeches/2012/speech596.pdf.

287. *See* Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds, 12 C.F.R. §§ 44, 248, 351, 255 (2013).

288. Peter Coy, et al., *1,238 days, 18,223 comments, 71-page rule, 893-page preamble, 5 agencies, 1 man*, BUS. WK., Dec. 16, 2013, at 41.

289. *See* GERDING, *supra* note 154, at 137–39; NOLAN MCCARTY ET AL., POLITICAL BUBBLES: FINANCIAL CRISES AND THE FAILURE OF AMERICAN DEMOCRACY 14–15 (2013); Coffee, *supra* note 154, at 1029 (calling this phenomenon, the "Regulatory Sine Curve"); Patricia A. McCoy et al., *Systemic Risk Through Securitization: The Result of Deregulation and Regulatory Failure*, 41 CONN. L. REV. 1327, 1333 (2009); Omarova, *supra* note 1, at 416 (discussing the "never-ending spiral of rulemaking and rule evading"); Reuters, *Global Banking Regulators Agree to Ease Capital Rule,* N.Y. TIMES, Jan. 13, 2014, at B6; *see also* Susan Rose-Ackerman, *Defending the State: A Skeptical Look at "Regulatory Reform" in the Eighties*, 61 U. COLO. L. REV. 517, 520–22 (1990).

290. *See* Greene & Broomfield, *supra* note 149, at 8 ("[The current regulatory approach] subjects diverse entities to a 'one-size-fits-all' regulatory approach, ignoring the different causes of risk, and also further complicating legal obligations for entities that are often already subject to other complex regulatory regimes.").

291. *See* RAJAN, *supra* note 6, at 174–75.

292. Greene & Broomfield, *supra* note 149, at 8.

treatment.[293] When these types of unintended and unanticipated consequences occur over large portions of the industry, senseless and broad regulations can inhibit the progression and recovery of the entire financial system and economy.

Given the complexity of cyborg finance and the diversity of its participants,[294] a first principle towards customization makes much sense. In a financial marketplace where participants come in all forms and sizes, broad categorical rules should be favored only when necessary, and narrowly customized rules should be preferred whenever possible. While customization may require more diligence and may be less politically satisfying, it may ultimately prove to be more sensible and effective in the long run.

H. Incentivize

In designing regulation for cyborg finance, as a matter of principle, policymakers should use affirmative incentives in addition to negative penalties to help encourage industry participants to behave sensibly.[295] This first principle of using affirmative incentives in designing a regulatory framework for cy-fi is rooted in the belief that individuals and institutions do not react equally or with perfect rationality to rewards and punishments, so policymakers need to sensibly use both towards achieving their goals.[296] While penalties and punishments may be psychologically, politically, and administratively more satisfying following financial misbehavior,[297]

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293. Katy Burne, *Traders Seek Harmonization in New Futures, Swaps Rules*, WALL ST. J., Jan. 30, 2013, http://online.wsj.com/article/SB10001424127887323701904578274704132048858.html.

294. *See, e.g.*, Hu, *supra* note 5, at 1713 ("The modern process of financial innovation has resulted in financial strategies and other products, as well as major financial institutions, that are far more complex than in the past.").

295. *See* MICHAEL G. AAMODT, INDUSTRIAL/ORGANIZATIONAL PSYCHOLOGY: AN APPLIED APPROACH 349–54 (7th ed. 2013) (providing an overview of reward versus punishment in organizational settings).

296. *See* Paul H. Robinson & John M. Darley, *Does Criminal Law Deter? A Behavioural Science Investigation*, 24 OXFORD J. LEGAL STUD. 173, 174 (2004) ("[E]ven if they know the legal rules and perceive a cost-benefit analysis that urges compliance, potential offenders commonly cannot or will not bring such knowledge to bear to guide their conduct in their own best interests, such failure stemming from a variety of social, situational, or chemical influences."); Tobias Wächter et al., *Differential Effect of Reward and Punishment on Procedural Learning*, 29 J. NEUROSCIENCE 436, 436 (2009) ("Our results suggest that reward and punishment engage separate motivational systems with distinctive behavioral effects and neural substrates."). *But see* Gary S. Becker, *Crime and Punishment: An Economic Approach*, 76 J. POL. ECON. 169, 172–80 (1968).

297. *See* Miriam H. Baer, *Choosing Punishment*, 92 B.U. L. REV. 577, 579 (2012) ("[P]ublic actors have ample reason to 'choose' punishment over other forms of government action as a means of attracting and maintaining public support."); Max Minzner, *Why Agencies Punish*, 53 WM. & MARY L. REV. 853, 854–57 (2012); Jeffrey J. Rachlinski & Forest Jourden, *The Cognitive Components of Punishment*, 88 CORNELL L. REV. 457, 485 (2003); Paul H. Robinson & John M. Darley, *Intuitions of*

incentives may be more effective in preventing and correcting such misbehavior in the future. Incentives, when properly calibrated and designed, can be incredibly powerful regulatory tools for governing individuals and institutions in the face of complexity.[298]

On the individual level, policymakers can design incentives that better link executive compensation with risk management to encourage cy-fi leaders to broaden their focus beyond short-term profits. Prior to the Financial Crisis, many corporate stakeholders encouraged equity compensation as a tool to better align the interests of executives with the interests of shareholders.[299] In theory, equity compensation would lead to better governance to the benefit of shareholders.[300] In practice, equity compensation led to significant appreciation in executive compensation that did not always correspond with performance;[301] and sometimes it encouraged excessive risk-taking that caused significant harms to shareholders and other industry participants in the long run.[302] Immediately

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Justice: Implications for Criminal Law and Justice Policy, 81 S. CAL. L. REV. 1, 3–4 (2007) (contending that intuition, not reason, may be the main motivator for punishment); William J. Stuntz, *The Pathological Politics of Criminal Law*, 100 MICH. L. REV. 505, 507 (2001) ("[A]ll change in criminal law seems to push in the same direction—toward more liability . . . ."); Neil Vidmar & Dale T. Miller, *Sociopsychological Processes Underlying Attitudes Toward Legal Punishment*, 14 L. & SOC'Y REV. 565, 565 (1980) ("Punishment . . . defines social boundaries, vindicates norms, and provides an outlet for the psychological tensions aroused by deviant acts.").

298. *See* RICHARD H. THALER & CASS R. SUNSTEIN, NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH, AND HAPPINESS 8 (2008); Gerrit De Geest & Giuseppe Dari-Mattiacci, *The Rise of Carrots and the Decline of Sticks*, 80 U. CHI. L. REV. 341, 345 (2013) (suggesting that "carrots" are superior to "sticks" in the face of complexity); Manuel A. Utset, *Financial System Engineering*, 32 REV. BANKING & FIN. L. 371, 417–27 (2013) (discussing trade-offs in managing financial complexities).

299. *See* LUCIAN BEBCHUK & JESSE FRIED, PAY WITHOUT PERFORMANCE: THE UNFULFILLED PROMISE OF EXECUTIVE COMPENSATION 1 (2004); Holmstrom & Kaplan, *supra* note 204, at 12; Edward B. Rock, *Adapting to the New Shareholder-Centric Reality*, 161 U. PA. L. REV. 1907, 1917–18 (2013).

300. *See* Michael C. Jensen & Kevin J. Murphy, *Performance Pay and Top-Management Incentives*, 98 J. POL. ECON. 225, 226 (1990).

301. *See* Lucian Bebchuk & Yaniv Grinstein, *The Growth of Executive Pay*, 21 OXFORD REV. ECON. POL'Y 283, 289, 290 tbl.4 (2005); Daniel Costello, *The Drought Is Over (at Least for C.E.O.'s)*, N.Y. TIMES, Apr. 10, 2011, at BU1.

302. *See* Press Release, Bd. of Governors of the Fed. Reserve Sys., Federal Reserve Issues Proposed Guidance on Incentive Compensation (Oct. 22, 2009) (quoting Fed. Reserve Chairman Ben S. Bernanke) ("Compensation practices at some banking organizations have led to misaligned incentives and excessive risk-taking, contributing to bank losses and financial instability."); Bebchuk & Spamann, *supra* note 6, at 255–74; Lucian A. Bebchuk et al., *The Wages of Failure: Executive Compensation at Bear Stearns and Lehman 2000–2008*, 27 YALE J. ON REG. 257, 273–76 (2010); Vicente Cuñat & Maria Guadalupe, *Executive Compensation and Competition in the Banking and Financial Sectors*, 33 J. BANKING & FIN. 495, 496 (2009); Heidi Mandanis Schooner, *Who Determines When Enough Is Enough? Refocusing Regulatory Limitations on Banks' Compensation Practices*, 37 B.C. L. REV. 861, 867–68 (1996). *But see* Joel F. Houston & Christopher James, *CEO Compensation and Bank Risk: Is Compensation in Banking Structured to Promote Risk Taking?*, 36 J. MONETARY ECON. 405, 408 (1995) (stating that the authors could find "no evidence that equity-based compensation is used to promote risk taking in banking").

before the Financial Crisis, executives of financial firms were compensated significantly in equity relative to executives at nonfinancial firms.[303] For instance, preceding the Financial Crisis, the financial executives with the largest equity stakes in their companies were the CEOs of Bear Stearns, Lehman Brothers, Merrill Lynch, and Countrywide.[304] Post-crisis, all of those companies were seen by many as having taken excessive risks.[305]

Following the crisis, some scholars and industry experts have suggested introducing subordinated debt,[306] long-term equity,[307] and representative baskets of securities[308] into executive compensation packages to better balance profit motives with risk management motives. Pursuant to Dodd-Frank, regulators have also promulgated new guidelines on how to better structure compensation to discourage imprudent, myopic risk-taking through mechanisms such as compensation claw-backs.[309] Given the incredible speed of cyborg finance, properly calibrated incentives should also be used to encourage executives to better balance short-term desires for profit with long-term interests in risk management.

On the institutional level, policymakers can also use incentives to better achieve regulatory aims. Given the vulnerabilities of cyborg finance to threats in cyberspace, one clear regulatory aim would be greater cyber security. A punishment-based approach to achieving that goal would be to penalize industry participants who do not meet certain government-mandated benchmarks on cyber security by levying a severe fine. Alternatively, an incentive-based approach would be to encourage industry participants to enhance their cyber defense by giving tax credits or allowing participants to write off their investments earlier through bonus depreciation or increased deductions of such expenditures.[310] Following the Financial Crisis, Congress, pursuant to the American Recovery and Reinvestment Act, used various tax mechanisms to incentivize businesses to make capital investments to help stimulate the economy.[311] Similar incentives can be utilized to motivate financial industry participants to act

303. Tung, *supra* note 5, at 1222.

304. Sallie Krawcheck, *Four Ways to Fix Banks*, HARV. BUS. REV., June 2012, at 108–09.

305. *Id.*

306. Tung, *supra* note 5, at 1207.

307. Sanjai Bhagat & Roberta Romano, *Reforming Executive Compensation: Focusing and Committing to the Long-Term*, 26 YALE J. ON REG. 359, 359 (2009).

308. Bebchuk & Spamann, *supra* note 6, at 248–53.

309. *See* Guidance on Sound Incentive Compensation Policies, 75 Fed. Reg. 36,395 (June 25, 2010).

310. *See* I.R.S., CAT. NO. 13081F, PUBLICATION 946, HOW TO DEPRECIATE PROPERTY 3–24 (2012), *available at* http://www.irs.gov/pub/irs-prior/p946--2011.pdf (explaining bonus depreciation and increased deductions).

311. I.R.S., BONUS DEPRECIATION AND INCREASED SECTION 179 DEDUCTION UNDER THE AMERICAN RECOVERY AND REINVESTMENT ACT (Oct. 24, 2012)

more expediently towards achieving regulatory goals, like enhancing cyber security, in the new financial industry.

Additionally, on the institutional level, policymakers can also create better mechanisms to manage and monitor incentives so that transactions are driven by the fortunes of principals, and not by the fees of agents.[312] Being self-interested agents, financial intermediaries and gatekeepers such as auditors, investment banks, and credit ratings agencies can at times encourage transactions that harm long-term institutional and systemic stability for short-term fees.[313] Policymakers can perhaps dedicate more regulatory resources to examining fee structures for their distortive and harmful effects so as to better align financial incentives with regulatory objectives.

This principle of using incentives as well as penalties should not be misconstrued as one aimed at sparing the rods of punishment to spoil industry, nor should it be mistaken as rewarding bad financial behavior. Bad and dangerous financial actions should be punished, but punishments alone are insufficient to remedy financial flaws and failures.[314] Moreover, circumstances and negative externalities at times render penalties impractical and counterproductive.[315] Rather than just penalize bad and dangerous acts, this principle promotes using smart, affirmative incentives to better manage and prevent such harmful actions in the first place.

I. Promote Self-Insurance

A key principle in creating regulations for cyborg finance should be the promotion of self-insurance mechanisms within the industry. Private failures of industry participants should have private solutions. Private losses should not require public bailouts, whenever possible.

During the recent financial crisis, some of the most unpopular and controversial regulatory actions of the government were the bailouts of faltering private businesses. These public bailouts of private failures

312. Kathryn Judge, *Fee Effects*, 98 IOWA L. REV. 1517, 1529–34 (2013).

313. *See, e.g.*, Lawrence A. Cunningham, *Too Big to Fail: Moral Hazard in Auditing and the Need to Restructure the Industry Before It Unravels*, 106 COLUM. L. REV. 1698, 1699–1722 (2006); Frank Partnoy, *How and Why Credit Rating Agencies Are Not Like Other Gatekeepers*, in FINANCIAL GATEKEEPERS: CAN THEY PROTECT INVESTORS? 59–65 (Yasuyuki Fuchita & Robert E. Litan eds., 2006).

314. *See, e.g.*, John Braithwaite, *What's Wrong with the Sociology of Punishment*, 7 THEORETICAL CRIMINOLOGY 5, 15–30 (2003); Tracey L. Meares et al., *Updating the Study of Punishment*, 56 STAN. L. REV. 1171, 1172–96 (2004).

315. *See, e.g.*, Andrew Ross Sorkin, *Realities Behind Prosecuting Big Banks*, N.Y. TIMES, March 12, 2013, at B1 (reporting that the size of some banks renders them too difficult to prosecute because of negative social externalities).

resulted in the strange phenomena of the American government owning significant stakes in large, faltering, American corporations.[316] In 2008, the government invested $85 billion in the insurance giant, AIG, in exchange for majority ownership stake.[317] Between 2008 and 2009, the government purchased $45 billion of securities, or a 34% ownership stake in the financial firm, Citigroup.[318] Between 2008 and 2009, $82 billion in public funds poured into the American auto industry.[319] This resulted in the government, at various times, owning 8% of Chrysler,[320] 60% of General Motors,[321] and 56% of GMAC,[322] General Motor's financing affiliate.

Following the Financial Crisis, policymakers and scholars have contemplated various self-insurance mechanisms to prevent future public bailouts. For instance, American and international policymakers have raised capital reserve requirements for large financial institutions to ensure that losses can be better covered by the firms themselves.[323] Additionally, there have been proposals for levying transaction fees on financial institutions to create an insurance fund.[324] Beyond government-oriented initiatives, there have also been suggestions to create industry-oriented mechanisms to share costs in the event of another financial crisis, and bankruptcy law reforms to better address the complex structure of financial institutions in the event of future liquidations and breakdowns.[325] Mindful of moral hazards and other considerations emanating from past insurance

316. Marcel Kahan & Edward B. Rock, *When the Government Is the Controlling Shareholder*, 89 TEX. L. REV. 1293, 1297 (2011).

317. Press Release, Bd. of Governors of the Fed. Reserve Sys., Federal Reserve Board, with Full Support of the Treasury Department, Authorizes the Federal Reserve Bank of New York to Lend up to $85 Billion to the American International Group (Sept. 16, 2008).

318. *See* Jeff Zeleny & Eric Dash, C*itigroup Nears Payback Deal; Obama to Press Banks for Help*, N.Y. TIMES, Dec. 14, 2009, at A1.

319. Nick Bunkley, *G.M. Repays U.S. Loan, While Chrysler Posts Improved Quarterly Results*, N.Y. TIMES, Apr. 22, 2010, ab B3.

320. *Id*.

321. *See* Bill Vlasic & Nick Bunkley, *Obama Is Upbeat for G.M. Future on a Day of Pain*, N.Y. TIMES, June 2, 2009, at A1.

322. Binyamin Appelbaum, *U.S. to Give $3.8 Billion More in Aid to GMAC; Move Makes Government the Majority Owner of Troubled Auto Lender*, WASH. POST, Dec. 31, 2009, at A1.

323. *See* Dodd-Frank Wall Street Reform and Consumer Protection Act § 171, 12 U.S.C. § 5371 (Supp. IV 2010); BASEL COMM. ON BANKING SUPERVISION, *supra* note 256, at 3; *see also* ANAT ADMATI & MARTIN HELLWIG, THE BANKERS' NEW CLOTHES: WHAT'S WRONG WITH BANKING AND WHAT TO DO ABOUT IT 94–100 (2013).

324. *See, e.g*., Let Wall Street Pay for the Restoration of Main Street Act of 2009, H.R. 4191, 111th Cong. (2009).

325. *See* Kenneth Ayotte & David A. Skeel, Jr., *Bankruptcy or Bailouts*?, 35 J. CORP. L. 469, 470–75 (2010); Onnig H. Dombalagian, *Requiem for the Bulge Bracket?: Revisiting Investment Bank Regulation*, 85 IND. L.J. 777, 836–43 (2010); Gordon & Muller, *supra* note 5, at 205–06; Jonathan C. Lipson, *The Shadow Bankruptcy System*, 89 B.U. L. REV. 1609, 1664–68 (2009).

funds like the Federal Deposit Insurance Corporation (FDIC),[326] which protects the funds of depositors at insured banks,[327] policymakers can better design sensible self-insurance programs for the new financial industry.[328]

As cyborg finance continues to evolve and grow, so will its risks and the potential for significant losses. To create a fully self-insuring financial system that never needs public bailouts is perhaps an elusive goal, as policymakers are unlikely to permit the entire financial system to collapse.[329] Nonetheless, policymakers should pursue regulations that promote mechanisms for self-insurance, so that public bailouts of the magnitude of past financial crises can be better mitigated in future financial crises.

J. Review, Renew, Reform, or Relinquish

In designing regulations for cyborg finance, policymakers should create a framework that better accounts for its dynamic nature by defaulting to a principle of predetermined reassessment. In practice, this means that whenever sensible, policymakers should favor temporary rules with sunset provisions and preset opportunities for review over permanent or "lasting" rules.[330] This would apply to both new laws and rules that regulated

326. *See, e.g.*, Jens Forssbaeck, *Ownership Structure, Market Discipline, and Banks' Risk-Taking Incentives Under Deposit Insurance*, 35 J. BANKING & FIN. 2666, 2666 (2011) ("What deposit insurance does is to remove depositors' incentives to discipline the bank by charging a risk premium commensurate with the bank's risk level, their own costs of monitoring, and other agency-related costs . . . ."); Macey & Garrett, *supra* note 274 (suggesting that deposit insurance could reduce market discipline and lead to greater systemic risk); William Poole, *Moral Hazard: The Long-Lasting Legacy of Bailouts*, 65 FIN. ANALYSTS J. 17, 21 (2009).

327. *See* 12 U.S.C. § 1821 (2006) (establishing the FDIC).

328. *See* Charles W. Calomiris, *Is Deposit Insurance Necessary? A Historical Perspective*, 50 J. ECON. HIST. 283, 284 (1990); Richard S. Grossman, *Deposit Insurance, Regulation, and Moral Hazard in the Thrift Industry: Evidence from the 1930's*, 82 AM. ECON. REV. 800, 802–03 (1992); Jonathan R. Macey & Geoffrey P. Miller, *Bank Failures, Risk Monitoring, and the Market for Bank Control*, 88 COLUM. L. REV. 1153, 1155, 1165 (1988); Patricia A. McCoy, *The Moral Hazard Implications of Deposit Insurance: Theory and Evidence*, *in* 5 CURRENT DEVELOPMENTS IN MONETARY AND FINANCIAL LAW 417, 423–25 (Int'l Monetary Fund Legal Dep't ed., 2008).

329. *See, e.g.*, Oliver Hart & Luigi Zingales, *Curbing Risk on Wall Street*, 2010 NAT'L AFFAIRS 20, 21 (opining on the pragmatic need for bailouts to safeguard the financial system during periods of serious distress); Levitin, *supra* note 5, at 439 ("Bailouts are an inevitable feature of modern economies . . . ."); Jonathan R. Macey & James P. Holdcroft, Jr., *Failure is an Option: An Ersatz-Antitrust Approach to Financial Regulation*, 120 YALE L.J. 1368, 1370 (2011) ("Policymakers . . . cannot credibly commit to refrain from supporting large, important financial institutions" when inaction could seriously threaten financial stability.").

330. *See, e.g.*, Jacob E. Gersen, *Temporary Legislation*, 74 U. CHI. L. REV. 247, 298 (2007) ("Normatively, temporary legislation should not be globally eschewed, and at least in specific policy domains such as responses to newly recognized risk, there should be a presumptive preference in favor of temporary legislation."); George K. Yin, *Temporary-Effect Legislation, Political Accountability, and Fiscal Restraint*, 84 N.Y.U. L. REV. 174, 187–94 (2009) (espousing the benefits of temporary legislation for budgeting purposes); Romano, *supra* note 161, at 1600–02. *But see* STEPHEN BREYER,

industry as well as those that deregulated industry. This principle of predetermined reassessment and its practical features are neither new nor radical. Tax legislation, in this country, frequently has had sunset provisions and preset reviews,[331] and the same is true for legislation in other areas of the law in our history.[332]

Because of prevalent rulemaking pathologies and cognitive biases,[333] financial rulemaking in response to the last crisis and past problems can quickly grow stale in a dynamic marketplace.[334] Policymakers, like most individuals, are bad judges of risk.[335] They often overreact and overestimate risk, especially in the aftermath of crises or catastrophes.[336] Moreover, policymakers, again, like most individuals, suffer from status quo bias, where they become attached to the current state of affairs with no rational basis.[337] Such pathologies and biases can create costly issues for industry participants, regulators, and the entire financial system.[338] Absent

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REGULATION AND ITS REFORM 366–67 (1982) (disfavoring sunset provisions as a way to reform administrative law); Coffee, *supra* note 154, at 1023–26 (arguing against sunset provisions in financial regulation); Rebecca M. Kysar, *Lasting Legislation*, 159 U. PA. L. REV 1007, 1009–10 (2011) (favoring lasting or permanent legislation over temporary legislation).

331. *See* Joint Comm. On Taxation, *List of Expiring Federal Tax Provisions*, *2009–2020* (JCX-3-10), Jan. 29, 2010, *available at* https://www.jct.gov/publications.html?func=startdown&id=3646; William G. Gale & Peter R. Orszag, *Sunsets in the Tax Code*, 99 TAX NOTES 1553, 1554–57 (2003).

332. Kysar, *supra* note 330, at 1014–21 (summarizing the history of temporary legislation).

333. *See, e.g.*, David A. Dana, *A Behavioral Economic Defense of the Precautionary Principle*, 97 NW. U. L. REV. 1315, 1324–25 (2003) (explaining cognitive biases towards recent and immediate losses and its impact on rulemaking); Jolls et al., *supra* note 184, at 1473; John O. McGinnis & Michael B. Rappaport, *Symmetric Entrenchment: A Constitutional and Normative Theory*, 89 VA. L. REV. 385, 444 (2003) (suggesting that sunset provisions do not suffer from the "special problems of public choice, aberrational majorities, partisanship, or imperfect psychological heuristics"); Jeffrey J. Rachlinski & Cynthia R. Farina, *Cognitive Psychology and Optimal Government Design*, 87 CORNELL L. REV. 549, 603–06 (2002) (discussing how to craft rules and legislation that better account for behavioral tendencies).

334. *See* Calomiris, *supra* note 6, at 43 (opining that the financial system "will probably undergo significant changes over the next few years"); Gersen, *supra* note 330, at 271 ("Empirically, it is true that new policy initiatives are often enacted in the immediate aftermath of realized or recognized risks.").

335. *See* CASS R. SUNSTEIN, RISK AND REASON: SAFETY, LAW, AND THE ENVIRONMENT 33–35 (2002) (discussing cognitive bias where "people tend to think that events are more probable if they can recall an incident of their occurrence"); Amos Tversky & Daniel Kahneman, *Availability: A Heuristic for Judging Frequency and Probability*, 5 COG. PSYCHOL. 207, 230 (1973).

336. Gersen, *supra* note 330, at 269; Roger G. Noll & James Krier, *Some Implications of Cognitive Psychology for Risk Regulation*, 19 J. LEGAL STUD. 747, 774–75 (1990); Paul Slovic, Baruch Fischhoff & Sarah Lichtenstein, *Regulation of Risk: A Psychological Perspective*, *in* REGULATORY POLICY AND THE SOCIAL SCIENCES 241, 256–59 (Roger G. Noll ed., 1985).

337. *See* Lin, *supra* note 183, at 341–42 (discussing status quo bias); William Samuelson & Richard Zeckhauser, *Status Quo Bias in Decision Making*, 1 J. RISK & UNCERTAINTY 7 (1988).

338. *See* Cass R. Sunstein, *Paradoxes of the Regulatory State*, 57 U. CHI. L. REV. 407, 411 (1990) ("Sometimes [regulation] has imposed enormously high costs for speculative benefits; sometimes it has accomplished little or nothing; and sometimes it has aggravated the very problem it was designed to solve."); Yin, *supra* note 330, at 178 ("[T]he legislative process fails to account for the complete costs of programs enacted through permanent legislation . . . .").

predetermined mechanisms for review, revision, and renewal, industry participants can incur significant costs complying with rules that no longer make sense in a changed marketplace.[339]

For regulators, stale and sticky rules without built-in exits can be costly to enforce and even more costly to unwind.[340] Permanent rules continue until repeal, and as such, their ongoing costs, in terms of budget and impact, are not properly accounted for, given changes in the regulated space.[341] At minimum, a predetermined reassessment principle would permit policymakers to periodically examine whether rules drafted in the past still make financial and pragmatic sense for the present and the near future.[342]

For the financial system, leaving outdated regulation in place can sow the seeds for new problems and crises as industry participants gravitate towards shadowed areas cast by the old regulations.[343] Additionally, it can also lead to suboptimal allocations of capital, decreases in competition, and reductions in social welfare as regulators and industry participants incur significant costs navigating stale rules.[344]

A primary intent for this principle of predetermined reassessment is to ensure that financial regulation best reflects the current market realities and the best available information.[345] From the regulator's perspective, this principle will probably manifest in staged rulemaking processes as features like preset reviews and sunset provisions drive policymakers to incorporate

339. *See* Bruce Adams, *Sunset: A Proposal for Accountable Government*, 28 ADMIN. L. REV. 511, 519–21 (1976) (opining that sunset provisions can create more government accountability); Lewis Anthony Davis, *Review Procedures and Public Accountability in Sunset Legislation: An Analysis and Proposal for Reform*, 33 ADMIN. L. REV. 393, 407–08 (1981) (suggesting methods to design better sunset provisions); *see also* PAUL ROSE & CHRISTOPHER J. WALKER, THE IMPORTANCE OF COST-BENEFIT ANALYSIS IN FINANCIAL REGULATION (2013).

340. *See* Yin, *supra* note 330, at 180 (discussing the budget benefits of temporary legislation); Roberta Romano, *Regulating in the Dark*, *in* REGULATORY BREAKDOWN: THE CRISIS OF CONFIDENCE IN U.S. REGULATION 88–98 (Cary Coglianese ed., 2012).

341. Romano, *supra* note 340, at 88–89.

342. *See* Robert W. Hahn, *Achieving Real Regulatory Reform*, 1997 U. CHI. LEGAL F. 143, 156; Romano, *supra* note 340, at 95.

343. *See infra* Part V.D; *see also* Calomiris, *supra* note 150; McCoy et al., *supra* note 289; Andrei Shleifer & Robert W. Vishny, *Unstable Banking*, 97 J. FIN. ECON. 306, 306–07 (2010); Christine Harper and Yalman Onaran, *Pushing Banks to Unwind Their Global Bets*, BUS. WK., Dec. 17, 2012, at 45 (discussing the increased operational costs of international banks in light of new U.S. capital rules).

344. *See* Whitehead, *supra* note 226, at 1295 ("Permitting new rules to be adjusted to reflect market feedback can assist in minimizing uncertainty over the rules' benefits, as well as lower the likelihood that regulation will be ineffective or result in unanticipated costs.").

345. *See* Gersen, *supra* note 330, at 248 ("From an informational perspective, temporary legislation provides concrete advantages over its permanent cousin by specifying windows of opportunity for policymakers to incorporate a greater quantity and quality of information into legislative judgments.").

the latest information, mitigate past cognitive biases, and assuage certain political pathologies related to rulemaking.[346] From the industry's perspective, the principle of predetermined assessment will allow industry participants to better adjust to regulatory realities and help inform policymakers of regulatory mismatches. Collectively, with well-designed regulations, this principle will better facilitate regulators and industry to periodically engage in a dynamic, information-sharing regulatory process.[347]

This advocacy for a first principle of reassessment is not to suggest that the benefits of adhering to this principle are not without their drawbacks; there are shortcomings to mechanisms like sunset provisions and mandatory reviews inherent in temporary rules.[348] Rather, this commentary suggests that, on balance, by adhering to a principle of default reassessment, policymakers can better create a regulatory framework that is more dynamic, more adaptive, and more flexible just like the new financial industry that it seeks to govern.

* * *

Regulating the emerging, new financial industry will be one of the most challenging endeavors for policymakers in the coming years. It is understood that much of the difficulties of financial regulation lie in the actual drafting, passage, implementation, execution, and enforcement of new rules and regulations. The tenets proposed herein aim to serve as principles of regulatory design for policymakers as they face those difficulties, as they contemplate fresh rules and regulations for cyborg finance. Admittedly, some of the proposed principles can be perceived as competing, complementary, and crosscutting. Nevertheless, these principles are intended to serve as guideposts and not roadblocks for creating a better, workable framework for the new financial industry in the years ahead.

346. *See id*. at 266–67; Cass R. Sunstein, *Irreversible and Catastrophic*, 91 CORNELL L. REV. 841, 859–60 (2006); Whitehead, *supra* note 226, at 1273 (espousing the virtues of staged regulation).

347. *See* Gersen, *supra* note 330, at 271 ("Under these circumstances, temporary legislation should create stronger incentives for accurate information revelation because staged decision procedures ensure repeated interaction between affected interests and legislators."); Yair Listokin, *Learning Through Policy Variation*, 118 YALE L.J. 480, 524–27 (2008).

348. *See* GUIDO CALABRESI, A COMMON LAW FOR THE AGE OF STATUTES 61–62 (1982) (arguing against the utility of sunset provisions); Coffee, *supra* note 154, at 1023–26 (criticizing mandatory sunset provisions financial reform regulation); Kysar, *supra* note 330, at 1009 ("[T]emporary legislation is worse than ineffective: such legislation creates serious political-economy concerns, entrenchment problems, and planning disruptions.").

CONCLUSION

Modern finance is undergoing a fundamental transformation. A financial industry built largely on human actions and human relationships is changing into one built on artificial intelligence, mathematical models, and supercomputers. Humans and machines now inextricably reign over a new financial industry that is faster, larger, more complex, more global, more interconnected, and less human.

This Article offered an early systemic account of this complex, ongoing metamorphosis and its wide-ranging policy ramifications for financial regulation. This Article provided a normative and descriptive cartography of this changing financial landscape. It identified particular dangers, systemic risks, and current regulatory shortcomings. It then presented an original set of guiding principles for the future of financial regulation. In the end, this Article is intended to serve as an early framework for further study on how best to regulate the emerging, new financial industry.

UCLA LAW REVIEW

The New Investor

Tom C.W. Lin

ABSTRACT

A sea change is happening in finance. Machines appear to be on the rise and humans on the decline. Human endeavors have become unmanned endeavors. Human thought and human deliberation have been replaced by computerized analysis and mathematical models. Technological advances have made finance faster, larger, more global, more interconnected, and less human. Modern finance is becoming an industry in which the main players are no longer entirely human. Instead, the key players are now cyborgs: part machine, part human. Modern finance is transforming into what this Article calls cyborg finance.

This Article offers one of the first broad, descriptive, and normative examinations of this sea change and its wide-ranging effects on law, society, and finance. The Article begins by placing the rise of artificial intelligence and computerization in finance within a larger social context. Next, it explores the evolution and birth of a new investor paradigm in law precipitated by that rise. This Article then identifies and addresses regulatory dangers, challenges, and consequences tied to the increasing reliance on artificial intelligence and computers. Specifically, it warns of emerging financial threats in cyberspace, examines new systemic risks linked to speed and connectivity, studies law's capacity to govern this evolving financial landscape, and explores the growing resource asymmetries in finance. Finally, drawing on themes from the legal discourse about the choice between rules and standards, this Article closes with a defense of humans in an uncertain financial world in which machines continue to rise, and it asserts that smarter humans working with smart machines possess the key to better returns and better futures.

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INTRODUCTION

The end is near for the human investor.[1] Computers have changed everything.

In May 2010, the Dow Jones Industrial Average lost one thousand points in a matter of minutes, destroying nearly $1 trillion in market value for no apparent reason.[2] After months of investigation, the culprit turned out to be automated computer programs.[3]

One of the most important developments of the past century is the growing and pervasive presence of computers in modern life. The first computer was invented in 1941.[4] In 1946, it acquired electronic memory and software.[5] In 1950, the first commercially produced computer was built.[6] In 1952, computers predicted the presidential election.[7] By 1969, they were common in corporate America.[8] In 1983, the computer was named *Time* magazine's "Machine of the Year" in lieu of a "Person of the Year."[9] By 1991, it connected the world through the internet.[10] In 1997, the computer became world chess champion.[11] By 2003, the computer became a part of a majority of American homes.[12] And in 2011, it became

1. The human investor has long been the main character of modern financial regulation. *See, e.g.*, H.R. REP. NO. 73-1383, pt. 2, at 5 (1934) (focusing on investor protection during the enactment of the Securities Exchange Act of 1934); H.R. REP. NO. 73-85, pt. 1, at 2 (1933) (emphasizing the protection of investors as the purpose of the Securities Act of 1933); Ralph K. Winter, *On "Protecting the Ordinary Investor,"* 63 WASH. L. REV. 881, 882–83 (1988) (noting that safeguarding investors is a primary goal of securities regulation).
2. Graham Bowley, *Dow Falls 1,000, Then Rebounds, Shaking Market*, N.Y. TIMES, May 7, 2010, at A1.
3. Graham Bowley, *Lone Sale of $4.1 Billion in Contracts Led to 'Flash Crash' in May*, N.Y. TIMES, Oct. 2, 2010, at B1.
4. *See* DIANA H. HOOK & JEREMY M. NORMAN, ORIGINS OF CYBERSPACE: A LIBRARY ON THE HISTORY OF COMPUTING, NETWORKING, AND TELECOMMUNICATIONS 78 (2002).
5. *See id.* at 85–86.
6. Norman E. Fry, *Univac*, *in* HISTORICAL DICTIONARY OF THE 1940S, at 390 (James G. Ryan & Leonard Schlup eds., 2006).
7. CARL REYNOLDS & PAUL TYMANN, SCHAUM'S OUTLINE OF PRINCIPLES OF COMPUTER SCIENCE 11 (2008).
8. PAUL E. CERUZZI, A HISTORY OF MODERN COMPUTING 110 (2d ed. 2003).
9. *Time* typically chooses a "Person of the Year," but in 1983 the distinction was granted to a machine for the first time. *See* Otto Friedrich, *The Computer Moves In*, TIME, Jan. 3, 1983, at 14.
10. The World Wide Web debuted on December 25, 1990. *See* STEPHANIE SAMMARTINO MCPHERSON, USA TODAY, TIM BERNERS-LEE: INVENTOR OF THE WORLD WIDE WEB 5 (2010).
11. FENG-HSIUNG HSU, BEHIND DEEP BLUE: BUILDING THE COMPUTER THAT DEFEATED THE WORLD CHESS CHAMPION, at ix (2002).
12. *See* S. CRAIG WATKINS, THE YOUNG AND THE DIGITAL: WHAT THE MIGRATION TO SOCIAL-NETWORK SITES, GAMES, AND ANYTIME, ANYWHERE MEDIA MEANS FOR OUR FUTURE 3 (2009).

Jeopardy! champion.[13] Now, it is an inextricable, existential part of modern life and business.

Computers have changed our world in profound and prosaic ways. This change is especially consequential and pronounced in finance.[14] Computer technology has made finance faster, larger, more global, and more interconnected in form and function.[15] An industry once monopolized by humans has evolved into an industry in which machines play a larger and more influential role. Modern finance is a stage on which the main players are no longer entirely human.[16] Instead, they are cyborgs: part machine, part human. Modern finance is transforming into what this Article calls "cyborg finance," or "cy-fi." This sea change is ongoing, incomplete, and without a final judgment on its normative impact and consequences.

This Article offers one of the first broad, descriptive, and normative examinations of this transformation and its wide-ranging effects on law, society, and finance. The aim of this Article is twofold: First, it strives to capture a descriptive snapshot of the changing landscape in finance that is a result of the rise of artificial intelligence and computerization. Second, building on that picture, this Article aims to identify and address the larger normative consequences for law, society, and finance. Undoubtedly, such an attempt to capture and forecast the story of the constantly evolving modern financial landscape will be incomplete, dated, and tentative.[17] Yet, it must be told and studied, for its transformative effects have grown too large and too important to ignore.

This Article narrates this story and study in five parts. Part I sets the stage. It places the ongoing financial sea change within a larger social context in which

13. John Markoff, *Computer Wins on 'Jeopardy!': Trivial, It's Not*, N.Y. TIMES, Feb. 17, 2011, at A1.

14. *See* Andrew G. Haldane, Exec. Dir., Fin. Stability, Bank of Eng., The Race to Zero, Speech at the International Economic Association Sixteenth World Congress, Beijing, China 3 (July 8, 2011), http://www.bankofengland.co.uk/publications/speeches/2011/speech509.pdf (discussing transformational changes in financial markets over the last century).

15. As indicia of modern finance's global nature, the U.S. Supreme Court recently opined on a securities case involving Australian securities purchased abroad and litigated under federal law. *See* Morrison v. Nat'l Austl. Bank Ltd., 130 S. Ct. 2869 (2010); *see also* Stephen J. Choi & Andrew T. Guzman, *Portable Reciprocity: Rethinking the International Reach of Securities Regulation*, 71 S. CAL. L. REV. 903, 905–07 (1998) (noting that the "internationalization of capital markets continues at a dramatic pace" as a result of technology); Merritt B. Fox, *Securities Disclosure in a Globalizing Market: Who Should Regulate Whom*, 95 MICH. L. REV. 2498, 2501–03 (1997).

16. *See* Shirley J. Ho & Sushanta K. Mallick, The Impact of Information Technology on the Banking Industry: Theory and Empirics 2 (Nov. 7, 2006) (unpublished manuscript) (describing the prominent role of computers in modern banking).

17. Charles Reich concedes a similar sentiment in his commentary of the then-transforming and transformative role of government on property, wealth, and individualism. *See* Charles A. Reich, *The New Property*, 73 YALE L.J. 733, 733 (1964) ("Inevitably, such an effort must be incomplete and tentative. But it is long past time that we began looking at the transformation taking place around us.").

machines are playing greater and more critical roles. Part I describes how the ascent of machines has changed the way we live, love, work, and play. It then describes how that ascension has also transformed modern finance into cyborg finance—a faster, larger, more global, more interconnected, and less human industry.[18]

Part II introduces a protagonist. It examines how changes in finance have transformed prevailing understandings of financial regulation's main character, "the investor," and how law must better account for this metamorphosis. Part II begins with a discussion about the conceptual evolution of the investor from "the reasonable investor" to "the irrational investor" to "the new investor." Part II then presents a dossier of "the new investor," highlights characteristics that make it distinct from previous paradigms, and alludes to the hope possessed by "the new investor."

Part III injects danger into the framework. It warns of perils created and mutated by cyborg finance. Part III recounts the Flash Crash of 2010,[19] which destroyed nearly $1 trillion in market capitalization in minutes, and cautions about future crashes. Part III then highlights new financial vulnerabilities by discussing the threats of hackers, worms, viruses, spies, thieves, and other antagonists. Ultimately, it calls for greater regulatory vigilance about such threats, but it cautions against thoughtless overreactions that would inhibit the "generativity" of cy-fi.[20]

Part IV foreshadows and contends with emerging systemic issues. It explores several key emerging normative consequences. First, Part IV warns of two systemic risks borne out of the enhanced velocity and connectivity of cyborg finance that this Article has respectively termed "too fast to save" and "too linked to fail." It suggests that these two emerging, systemic risks warrant more regulatory attention. Second, Part IV comments on the ongoing race between law and finance, and it discusses the contest's larger effects as finance continues to outpace law. It identifies mismatches in jurisdiction and origination as core problems of law's lagging performance. Third, Part IV studies the impact of growing resource disparities between the regulators and the regulated, and among players within the financial industry.

18. While cyborg finance is ubiquitous throughout all facets of modern finance, it is most prominent in equity markets. Thus, this Article gives special emphasis to cyborg finance in connection with equity markets.

19. *See generally* COMMODITY FUTURES TRADING COMM'N & SEC. & EXCH. COMM'N, FINDINGS REGARDING THE MARKET EVENTS OF MAY 6, 2010, at 1 (2010), *available at* http://www.sec.gov/news/studies/2010/marketevents-report.pdf (summarizing and evaluating the events occurring on May 6, 2010) [hereinafter CFTC & SEC FINDINGS].

20. Jonathan Zittrain suggested that the internet and its related information technology contained an inherent capacity for innovation that he called "generativity." *See* Jonathan L. Zittrain, *The Generative Internet*, 119 HARV. L. REV. 1975, 1980 (2006) ("Generativity denotes a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences.").

Part V looks further into the future. It offers a defense for humans in finance and society as machines rise. It predicates this defense on the persistence of randomness and the necessity of humans in an era of ascendant machines. Part V offers testimony about the limitations of computers and artificial intelligence in life and finance. It then cross-examines modernity's choice between humans and machines as a recasting of law's choice between rules and standards.[21] Part V rests with an exposition on the essential symbiosis between smarter humans and smart machines as the key to better returns and better futures in an uncertain world.

I. THE RISE OF MACHINES

A chief attribute of the recent past, the ongoing present, and the coming future is the rise of machines and the increasing reliance on computers and artificial intelligence. In 1965, Gordon Moore, the founder of Intel, predicted that the number of components on integrated circuits would increase exponentially about every two years and costs would fall correspondingly, leading to incredible progressions in computing power and electronic processing capacity.[22] Moore's prediction turned out to be so accurate that it is now commonly known as "Moore's Law."[23] Since then, technological advances have made computing power and digital storage faster, cheaper, and smaller.[24] The average smartphone today has more computing capacity than large mainframe computers in previous eras.[25] A single iPhone today possesses more computing power than NASA did during its first lunar mis-

21. For an overview of the legal debate between rules and standards, see Colin S. Diver, *The Optimal Precision of Administrative Rules*, 93 YALE L.J. 65 (1984), Louis Kaplow, *Rules Versus Standards: An Economic Analysis*, 42 DUKE L.J. 557 (1993), Seana Valentine Shiffrin, Essay, *Inducing Moral Deliberation: On the Occasional Virtues of Fog*, 123 HARV. L. REV. 1214 (2010), Kathleen M. Sullivan, *The Supreme Court, 1991 Term—Foreword: The Justices of Rules and Standards*, 106 HARV. L. REV. 22 (1993), and Cass R. Sunstein, *Problems With Rules*, 83 CALIF. L. REV. 953 (1995).

22. Gordon E. Moore, *Cramming More Components Onto Integrated Circuits*, ELECTRONICS, Apr. 19, 1965, at 114, 114–15.

23. *See* NICHOLAS CARR, THE BIG SWITCH: REWIRING THE WORLD, FROM EDISON TO GOOGLE 58 (2009).

24. *See* NICHOLAS CARR, THE SHALLOWS: WHAT THE INTERNET IS DOING TO OUR BRAINS 83 (2011) ("[T]he price of a typical computing task has dropped by 99.9 percent since the 1960s."); ORG. FOR ECON. CO-OPERATION AND DEV. (OECD), 21ST CENTURY TECHNOLOGIES: PROMISES AND PERILS OF A DYNAMIC FUTURE 9 (1998) (stating that "[f]aster, cheaper, [and] smaller" are the key objectives of the technology sector); Chip Walter, *Kryder's Law*, SCI. AM., Aug. 2005, at 32.

25. *See, e.g.*, *How Your Nokia Smartphone Compares With PCs of the Past*, CONVERSATIONS BY NOKIA (Mar. 18, 2011), http://nokiaconnects.com/2011/03/18/how-your-nokia-smartphone-compares-with-pcs-of-the-past (describing how a smartphone contains thousands of times the memory and processing power of the average 1980s computer).

sion.[26] Such technological progress has led to an increasingly ubiquitous presence of machines in our world.[27] This ascent of machines has had a profound impact on society in general and on finance in particular.

A. In Society

The increased reliance on machines, particularly computers, has had significant social effects. A generation ago, computers were bulky, sedentary tools for data computation and word processing; not every business or home had one. Today, computers are everywhere, in every form—from large mainframes to pocket-sized smartphones, from desktops to laptops, from visible to invisible.[28] Globally, more than 350 million personal computers were sold in 2011 alone.[29] And because of high-speed connectivity and the internet, in many parts of the world, anyone with a computer or smartphone has instant access to a plethora of information, services, and entertainment.[30] Compared to bulky, obtuse computers of previous generations, today's computers are smart machines powered by artificial intelligence.[31] Computers and their progeny have changed the way we learn, think, work, play, love, and live.[32] In short, just as humans have changed computers, computers have changed humans.[33]

26. MICHIO KAKU, PHYSICS OF THE FUTURE: HOW SCIENCE WILL SHAPE HUMAN DESTINY AND OUR DAILY LIVES BY THE YEAR 2100, at 21 (2011).
27. *See* CARR, *supra* note 23, at 45–56 (tracing the creation and proliferation of computers); MAURICE ESTABROOKS, ELECTRONIC TECHNOLOGY, CORPORATE STRATEGY, AND WORLD TRANSFORMATION 2 (1995).
28. *See* DEBORAH MORLEY, UNDERSTANDING COMPUTERS IN A CHANGING SOCIETY 44 (4th ed. 2011).
29. *See* Press Release, Gartner, Inc., Gartner Says PC Shipments to Slow to 3.8 Percent Growth in 2011; Units to Increase 10.9 Percent in 2012 (Sept. 8, 2011), http://www.gartner.com/it/page.jsp?id=1786014&source=email_rt_mc.
30. *See* WILLIAM POWERS, HAMLET'S BLACKBERRY: BUILDING A GOOD LIFE IN THE DIGITAL AGE 14 (2010) ("For the last decade, we've worked hard to bring digital connectedness into every available corner of existence and, once it's there, to make it ever faster and more seamless.").
31. Steven Levy, *The AI Revolution*, WIRED, Jan. 2011, at 88 (describing the rise of artificial intelligence in modern life).
32. *See, e.g.*, STACEY L. EDGAR, MORALITY AND MACHINES: PERSPECTIVES ON COMPUTER ETHICS 1 (2003); EUGENE F. PROVENZO, JR. ET AL., COMPUTERS, CURRICULUM, AND CULTURAL CHANGE: AN INTRODUCTION FOR TEACHERS 18 (2005); SHERRY TURKLE, THE SECOND SELF: COMPUTERS AND THE HUMAN SPIRIT 287–88 (MIT Press 20th anniv. ed. 2005) (1984) ("[Computers and] the Internet changed every aspect of life in communications, economics, politics, and the arts. But [they] also changed how we saw ourselves and our relationships."); Stephen Marche, *Is Facebook Making Us Lonely?*, ATLANTIC, May 2012, at 62 ("In a world consumed by ever more novel modes of socializing, we have less and less actual society. We live in an accelerating contradiction: the more connected we become, the lonelier we are.").
33. *See* CARR, *supra* note 24, at 6–8 (discussing how the internet affects our cognitive functions and abilities); SHERRY TURKLE, ALONE TOGETHER: WHY WE EXPECT MORE FROM TECHNOLOGY

Computers have increased business productivity and enhanced personal efficiency.[34] Assembly lines of laborers have been replaced by computer-operated robots, which can often perform tasks with greater precision at lower costs.[35] Online retailers such as Amazon now use robots in their distribution centers to help fill orders at cheaper rates and higher speeds.[36] Artificial intelligence software is replacing journalists in writing news stories.[37] Digital forms that computers process in seconds have replaced reams of hand-filled documents that previously required countless hours of human labor to process.[38] Entire businesses and labor categories have shrunk or disappeared from plain view because of computerization and automation.[39] Think about the last time you used a travel agency to book a flight. Or the last time you used a phone book to look for a phone number.[40] Many of these machine-driven changes have made business activities more productive and personal activities more efficient.[41]

AND LESS FROM EACH OTHER 279–81 (2011) (discussing how technology affects human behavior).

34. *See, e.g.*, Quentin Hardy, *The Matrix of Soap*, FORBES, Aug. 22, 2011, at 32 (reporting on how one company utilizes supercomputer data analysis to manage its global businesses in real time); Daniel Lyons, *Who Needs Humans*, NEWSWEEK, July 25, 2011, at 28 (discussing how robotics has changed labor force composition).

35. *See, e.g.*, JOHN MAYNARD KEYNES, *Economic Possibilities for Our Grandchildren*, *in* ESSAYS IN PERSUASION 358, 364 (Norton Library 1963) (1931) (warning of a "new disease" of "technological unemployment," in which jobs are lost because of rapid technological progress (emphasis omitted)); David H. Autor et al., *The Skill Content of Recent Technological Change: An Empirical Exploration*, 118 Q.J. ECON. 1279 (2003) (explaining how computerization accelerates the substitution of machinery for human labor).

36. *See* Joseph Galante, *Rise of the Orange Machines*, BUS. WK., Nov. 15, 2010, at 47.

37. *See* Steven Levy, *The Rise of the Robot Reporter*, WIRED, May 2012, at 132.

38. IAN AYRES, SUPER CRUNCHERS: WHY THINKING-BY-NUMBERS IS THE NEW WAY TO BE SMART 129 (2007).

39. *See* W. Brian Arthur, *The Second Economy*, MCKINSEY Q., Oct. 2011, at 92 (discussing how technology has replaced human labor with electronic and digital processes in many areas).

40. For readers in the distant future, there was a time when individuals in this country used a large bulky book printed on low-stock paper weighing multiple pounds to locate the telephone number of businesses and individuals manually. For a history of phone books, see AMMON SHEA, THE PHONE BOOK: THE CURIOUS HISTORY OF THE BOOK THAT EVERYONE USES BUT NO ONE READS (2010).

41. This increase in productivity has arguably come at some cost to individuals and society. For individuals, it could be argued that our brains have become less adept at deep thought because of increased reliance on computers. For society, it could be argued that virtual interactions and online connections have taken the place of meaningful physical interactions and real connections. *See* CARR, *supra* note 24, at 120–26 (explaining how the internet affects our cognitive functions); JARON LANIER, YOU ARE NOT A GADGET: A MANIFESTO 1–14 (2010) (noting the social effects of computerization); POWERS, *supra* note 30, at 50–52 (explicating on the detrimental symptoms of digital technology); TURKLE, *supra* note 32, at 279–81 (discussing how computers affects interpersonal and intrapersonal behavior).

In addition to increasing business productivity and personal efficiency, the use of computers has also increased our capacity to be informed and, thus, to act with better information. Modern data analysis with supercomputers has made everyone with a smartphone a walking encyclopedia.[42] Arguments about trivia, questions about directions, and curiosities about the esoteric can readily be satisfied by a few simple taps or voice commands to one's smartphone.[43]

Beyond mere access to more information, modern machines have changed the way we evaluate and respond to information. Data aggregation, analysis, retrieval, and transmission by computers on grand scales, collectively and colloquially referred to as Big Data, are changing the way we process information, what we learn from that information, and how we behave based on that information.[44] Supercomputers are now used to predict when and where storms will strike with meaningful accuracy.[45] Computer analysis of Shakespeare's plays is modifying the way we understand the Bard.[46] Data analysis has created a new field of sports scouting, known as sabermetrics.[47] Computers sorting through mountains of data are advising candidates on how to campaign for political office.[48] Data analysis by companies like Netflix and Amazon has altered how we make purchases and select entertainment.[49] Modern machines have even changed the way people date (and find love) using data.[50]

The future holds more promises from computerized machinery in a host of different fields and functions. Big Data will change consumer habits in ways that

42. *See* AYRES, *supra* note 38, at 154 ("The ability to digitalize and store information means that any laptop with access to the Internet can now access libraries several times the size of the library of Alexandria.").
43. *See* David Pogue, *New iPhone Conceals Sheer Magic*, N.Y. TIMES, Oct. 12, 2011, at B1 (describing the speech recognition features of the iPhone 4S).
44. *See, e.g.*, NATE SILVER, THE SIGNAL AND THE NOISE: WHY SOME PREDICTIONS FAIL—BUT SOME DON'T 9–10 (2012); Andrew McAfee & Erik Brynjolfsson, *Big Data: The Management Revolution*, HARV. BUS. REV., Oct. 2012, at 60, 62–68 (discussing Big Data's impact on corporations); Ashlee Vance, *The Data Knows*, BUS. WK., Sept. 12, 2011, at 71 (reporting on the impact of data analysis on individual and societal behavior).
45. *See* Eliza Strickland, *Supercomputers Predict a Stormy Hurricane Season*, IEEE SPECTRUM, July 2011, at 11.
46. *See* Tom Post, *Bits and the Bard*, FORBES, June 27, 2011, at 46.
47. *See* GABRIEL B. COSTA ET AL., PRACTICING SABERMETRICS: PUTTING THE SCIENCE OF BASEBALL STATISTICS TO WORK 5–8 (2009).
48. *See* Julianna Goldman, *The Obama Campaign's Secret Weapon: Geeks*, BUS. WK., Dec. 19, 2011, at 39.
49. *See* AYRES, *supra* note 38, at 19–20.
50. *See* Nick Paumgarten, *Looking for Someone*, NEW YORKER, July 4, 2011, at 36, 37–38; Jenna Wortham, *With an App, Your Next Date Could Be Just Around the Corner*, N.Y. TIMES, Nov. 3, 2011, at A1.

we cannot fully foresee.[51] Robots will likely play a larger role in warfare and other military affairs.[52] Computers will probably make activities like driving unmanned efforts.[53] Google has already built a car that drives itself using artificial intelligence.[54] In sum, whereas society once viewed computers as crude machines of limited utility, society now views modern computerized machines as intelligent, indispensible tools—with many yet unrealized possibilities—that are becoming more intertwined with our very existence.[55]

B. In Finance

Over the last quarter century, computerization and artificial intelligence have revolutionized finance, and they continue to fundamentally transform finance from an industry dominated by humans to one in which humans and machines share dominion.[56] Modern finance is cyborg finance, an industry in which the key players are part human and part machine.

This transformation resulted from advances in technology and regulatory reforms over the last few decades. Beginning in the 1990s, advances in technology encouraged the Securities and Exchange Commission (SEC) to introduce reforms

51. *See generally* Natasha Singer, *You for Sale*, N.Y. TIMES, June 17, 2012, at BU1 (reporting on the development of consumer data analytics and the potential privacy and customer classification concerns that may result).

52. *See* Elizabeth Bumiller & Thom Shanker, *War Evolves With Drones, Some Tiny As Bugs*, N.Y. TIMES, June 20, 2011, at A1 (reporting on the United States's increased use of unmanned aerial drones in warfare); John Markoff, *War Machines: Recruiting Robots for Combat*, N.Y. TIMES, Nov. 28, 2010, at A1 (discussing the impact of robotics on future warfare).

53. At the same time, certain technological advances have actually made humans more likely to perform some routine tasks. *See, e.g.*, Craig Lambert, *Our Unpaid, Extra Shadow Work*, N.Y. TIMES, Oct. 30, 2011, at SR12 ("Although the automatons were supposedly going to free people by taking on life's menial, repetitive tasks, frequently, technological innovation actually offloads such jobs onto human beings.").

54. *See* John Markoff, *Look Officer, No Hands: Google Car Drives Itself*, N.Y. TIMES, Oct. 10, 2010, at A1.

55. *See, e.g.*, Claire Cain Miller & Nick Bilton, *Google's Lab of Wildest Dreams*, N.Y. TIMES, Nov. 14, 2011, at A1; Ashlee Vance, *Merely Human? So Yesterday*, N.Y. TIMES, June 13, 2011, at BU1 (reporting on futurists who envision a time when "human beings and machines will so effortlessly and elegantly merge that poor health, the ravages of old age and even death itself will all be things of the past"); David Weinberger, *The Machine That Would Predict the Future*, SCI. AM., Dec. 2011, at 52.

56. *See* Frank J. Fabozzi et al., *High-Frequency Trading: Methodologies and Market Impact*, 19 REV. FUTURES MARKETS 7, 9–10 (2011) (describing continuing changes in computerized trading in finance); Michael J. McGowan, *The Rise of Computerized High Frequency Trading: Use and Controversy*, 2010 DUKE L. & TECH. REV., no. 16, at i, iv–vii (chronicling the history of algorithmic trading); Felix Salmon & Jon Stokes, *Bull vs. Bear vs. Bot*, WIRED, Jan. 2011, at 91 ("Algorithms have become so ingrained in our financial system that the markets could not operate without them.").

like decimalization[57] and Regulation Alternative Trading System (Reg ATS)[58] to permit new trading systems and electronic communication networks for finance, which made today's Wall Street possible.[59] Electronic communication networks yielded direct market access, which allowed firms to execute trades on an exchange directly without going through an intermediary such as a salesperson or a market maker.[60] By the mid-1990s, computers took over significant functions at major financial institutions.[61] By then, computerized networks initiated and managed significant trading in many important financial markets such as stocks, bonds, currency, and commodities.[62]

Later in 2005, the SEC passed Regulation National Market System (Reg NMS)[63] to further increase competition and access to financial trading.[64] Reg NMS aimed "to bind together the fragmented electronic marketplace into a single interlinked web of trading—a true national market system."[65] These and other reg-

57. *See* STAFF OF THE SEC, REPORT TO CONGRESS ON DECIMALIZATION 4 (2012), *available at* http://www.sec.gov/news/studies/2012/decimalization-072012.pdf ("Prior to implementing decimal pricing in April 2001, the U.S. equity market used fractions as pricing increments, and had done so for hundreds of years.").

58. *See* Regulation ATS—Alternative Trading Systems, 17 C.F.R. § 242.300(a) (2012); *see also* EDWARD F. GREENE ET AL., U.S. REGULATION OF THE INTERNATIONAL SECURITIES AND DERIVATIVES MARKETS § 14.10, at 10-133 (9th ed. 2009) ("In the [Reg ATS], the SEC expanded its interpretation of an 'exchange' under the Exchange Act to include a broad range of electronic trading systems . . . .").

59. *See* SAL ARNUK & JOSEPH SALUZZI, BROKEN MARKETS: HOW HIGH FREQUENCY TRADING AND PREDATORY PRACTICES ON WALL STREET ARE DESTROYING INVESTOR CONFIDENCE AND YOUR PORTFOLIO 68–78 (2012); BRIAN R. BROWN, CHASING THE SAME SIGNALS: HOW BLACK-BOX TRADING INFLUENCES STOCK MARKETS FROM WALL STREET TO SHANGHAI 2 (2010); DAVID J. LEINWEBER, NERDS ON WALL STREET: MATH, MACHINES, AND WIRED MARKETS 31–64 (2009).

60. ARNUK & SALUZZI, *supra* note 59, 68–78.

61. *See, e.g.*, RAY KURZWEIL, THE AGE OF SPIRITUAL MACHINES: WHEN COMPUTERS EXCEED HUMAN INTELLIGENCE 70 (1999); Markku Malkamäki & Jukka Topi, *Future Challenges for Securities and Derivative Markets*, *in* 3 RESEARCH IN BANKING AND FINANCE 359, 382 (Iftekhar Hasan & William C. Hunter eds., 2003) ("At the end of the 1990s, between 30% and 40% of all U.S. securities transactions were channeled through the Internet and about 15% of all the U.S. equity trades were done on-line.").

62. KURZWEIL, *supra* note 61, at 70; *see also* William M. Bulkeley, *Computers Take On New Role as Experts in Financial Affairs*, WALL ST. J., Feb. 7, 1986, at 23.

63. 17 C.F.R. § 242.601.

64. *See* Regulation NMS, 70 Fed. Reg. 37,496, 37,621–32 (June 29, 2005) (codified as amended at 17 C.F.R. §§ 242.600–242.612); *see also* Laura Nyantung Beny, *U.S. Secondary Stock Markets: A Survey of Current Regulatory and Structural Issues and a Reform Proposal to Enhance Competition*, 2002 COLUM. BUS. L. REV. 399, 426 ("[T]he express purpose of the NMS [is] to promote efficiency and competition across secondary markets.").

65. SCOTT PATTERSON, DARK POOLS: HIGH-SPEED TRADERS, AI BANDITS, AND THE THREAT TO THE GLOBAL FINANCIAL SYSTEM 49 (2012).

ulatory reforms opened access for firms to leverage new technology in finance.[66] Coupled with technological advances in computer science and the growth of digitized information, such reforms gave birth to a new form of finance in which complex mathematical models processed by computers at warp speed played critical roles in the most important decisions concerning capital allocation and risk assessment.[67] According to some experts, today "Wall Street is essentially floating on a sea of mathematics and computer power."[68] This financial current is one that flows beyond Wall Street and America to all parts of the world.

A key feature of cy-fi is the use of incredibly powerful and fast computers to analyze and execute trading opportunities based on complex mathematical models.[69] Many have referred to computer-programmed trading collectively as "black box trading."[70] Today, almost every major financial institution and hedge fund employs black box trading in one form or another.[71]

Two prominent, interrelated forms of black box trading are algorithmic trading and high-frequency trading. Algorithmic trading utilizes preset formulas to buy, sell, and hold positions in various financial instruments.[72] Computers often exclusively execute these complex formulas without any human interference after the initial installation.[73] Computers are programmed to "automatically capture and read market data in real-time, transmit thousands of order messages per second to an exchange, and execute, cancel, or replace orders based on new information on prices or demand."[74] Technology has become so sophisticated that within mere seconds of a securities filing or news report, computers can essentially read them

66. *See, e.g.*, Melanie Rodier, *Wall Street Firms Fine-Tune Reg NMS Compliance, Look Ahead at the Future*, WALL ST. & TECH. (June 12, 2007), http://www.wallstreetandtech.com/articles/199903415.
67. For an overview of contemporary quantitative trading and its leading players, see generally SCOTT PATTERSON, THE QUANTS: HOW A NEW BREED OF MATH WHIZZES CONQUERED WALL STREET AND NEARLY DESTROYED IT (2010).
68. FIN. CRISIS INQUIRY COMM'N, THE FINANCIAL CRISIS INQUIRY REPORT 44 (2011) (quoting Interview by Fin. Crisis Inquiry Comm'n With Scott Patterson (Aug. 12, 2010)).
69. *See* PATTERSON, *supra* note 65, at 36–38 (describing the rise of powerful, high-speed computers in finance).
70. *See* BROWN, *supra* note 59, at 8 ("A 'black box' is a quantitative investment strategy in which the decisions are defined by mathematical formulas.").
71. *See id.* at 2, 11.
72. ROBERT A.G. MONKS & ALEXANDRA REED LAJOUX, CORPORATE VALUATION FOR PORTFOLIO INVESTMENT: ANALYZING ASSETS, EARNINGS, CASH FLOW, STOCK PRICE, GOVERNANCE, AND SPECIAL SITUATIONS 229 (2011).
73. *See* CFTC & SEC FINDINGS, *supra* note 19, at 2–3 (discussing automation in high-frequency trading); PATTERSON, *supra* note 65, at 128–30; David M. Serritella, *High Speed Trading Begets High Speed Regulation: SEC Response to Flash Crash, Rash*, 2010 U. ILL. J.L. TECH. & POL'Y 433, 436 ("Automation is a crucial element in HFT [high frequency trading].").
74. Fabozzi et al., *supra* note 56, at 8.

and send summaries to traders and investors.[75] Computers running algorithmic programs can process a deluge of information in real time, spot trends, and react accordingly within seconds.[76] Investment decisions that previously took dozens of people minutes or even hours to analyze and execute now take only seconds by a single computer.

Algorithmic trading and its progenies have grown so prevalent that the landmark trading floor of the New York Stock Exchange (NYSE) has become a relic of a bygone era as human traders give way to computers on the Big Board's famed floor.[77] In fact, most equity trading today takes place in shadowy, less-regulated private markets instead of lit, better-regulated exchanges like the NYSE or NASDAQ.[78] Moreover, rather than defend the virtues of transparent, better regulated exchanges for trading, the traditional exchanges have initiated steps to create robust, less transparent markets themselves and have aided computerized trading to the detriment of human trading.[79] In 2012, the SEC fined the NYSE $5 million for inappropriately sharing trading data with certain computerized traders before sharing it with all the other traders.[80] Later in December 2012, the IntercontinentalExchange, an electronic derivatives and commodities exchange, announced a takeover of the NYSE.[81] In light of these developments, it is probably safe to predict that a day will come in the near future when human traders no longer roam the NYSE's famed trading floor.

While significant volumes of algorithmic trading still occur on public exchanges, a growing volume of trades are taking place in private exchanges and dark pools, away from the purview of the public.[82] "A dark pool is an anonymous

75. *See* ARNUK & SALUZZI, *supra* note 59, at 121 ("Machine-readable news data feeds enable HFT computers to react within microseconds to news events, beating out traditional institutional and retail investors."); Helen Coster, *Search and Disrupt*, FORBES, Sept. 26, 2011, at 60 (profiling software that reads and summarizes federal securities filings in seconds).

76. *See, e.g.*, Charles Duhigg, *Stock Traders Find Speed Pays, in Milliseconds*, N.Y. TIMES, July 24, 2009, at A1 ("[Algorithmic computer programs] can spot trends before other investors can blink, changing orders and strategies within milliseconds.").

77. *See, e.g.*, 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, 866 (2008) ("Exchange trading floors are fast fading into history as the trading of stocks and derivative instruments moves to electronic communications networks (ECNs) that simply match trades by computers through algorithms.").

78. *See* Nathaniel Popper, *Public Exchanges Duel With Newcomers Over Trade Transparency*, N.Y. TIMES, June 27, 2012, at B1.

79. *Id.*

80. *In re* N.Y. Stock Exch. LLC, No. 3-15023, Exchange Act Release No. 67,857 (Sept. 14, 2012), 2012 SEC LEXIS 2921, *available at* http://www.sec.gov/litigation/admin/2012/34-67857.pdf.

81. Ben Protess & Nathaniel Popper, *Exchange Sale Reflects New Realities of Trading*, N.Y. TIMES, Dec. 21, 2012, at A1.

82. *See* Regulation of Non-public Trading Interest, 74 Fed. Reg. 61,208 (proposed Nov. 23, 2009) (to be codified at 17 C.F.R. pt. 242); Mary L. Schapiro, Chairman, U.S. Sec. & Exch. Comm'n, Statement

crossing network that allows institutions to hide their orders from the marketplace."[83] Private exchanges and dark pools are particularly attractive to many institutional investors, who prefer to move large volumes of securities without disseminating too much information to the public so as not to lose any informational advantages to competitors that may mimic their trades.[84] Unlike public exchanges, which are partially constrained by geography and physical space, private exchanges and dark pools can exist anywhere because they frequently exist in cyberspace, a frontier without similar physical and geographic limitations.[85] In 2010, more than 60 percent of trading in stocks listed on the NYSE occurred on separate computerized exchanges.[86] Partially as a result of private exchanges and dark pools, a "shadow banking" infrastructure now casts a large penumbra over the financial system.[87]

In addition to algorithmic trading, the other prominent form of black box trading is high-frequency trading.[88] High-frequency trading refers to trading that uses computerized platforms to execute a large number of trades at super speeds.[89] The velocity of high-frequency trading is measured not in minutes but in seconds and milliseconds.[90] For many institutional traders utilizing high-frequency trading, the volume and value of the trades can exceed $1 billion and one billion units

on Dark Pool Regulation Before the Commission Open Meeting (Oct. 21, 2009) (transcript available at http://www.sec.gov/news/speech/2009/spch102109mls.htm); ARNUK & SALUZZI, *supra* note 59, at 62 (describing the rise in nonpublic dark pools and alternative trading systems over the last decade); PATTERSON, *supra* note 65, at 61–62; Matthew Philips, *Where Has All the Trading Gone?*, BUS. WK., May 14, 2012, at 49 (reporting on the migration of trading from public exchanges to dark pools).

83. BROWN, *supra* note 59, at 116.

84. *See id.*

85. *See, e.g.*, David R. Johnson & David Post, *Law and Borders—The Rise of Law in Cyberspace*, 48 STAN. L. REV. 1367, 1367 (1996); Lawrence Lessig, *The Law of the Horse: What Cyberlaw Might Teach*, 113 HARV. L. REV. 501, 514–15 (1999).

86. Nelson D. Schwartz & Louise Story, *Surge of Computer Selling After Apparent Trading Glitch Sends Stocks Plunging*, N.Y. TIMES, May 7, 2010, at B7.

87. *See, e.g.*, GARY B. GORTON, SLAPPED BY THE INVISIBLE HAND: THE PANIC OF 2007, at 6–8 (2010) (noting the growing importance of the shadow banking system in modern finance); DAVID SKEEL, THE NEW FINANCIAL DEAL: UNDERSTANDING THE DODD-FRANK ACT AND ITS (UNINTENDED) CONSEQUENCES 62 (2011) (discussing deregulation, financial innovation, and the birth of shadow banking); Andrew W. Lo, *Regulatory Reform in the Wake of the Financial Crisis of 2007–2008*, 1 J. FIN. ECON. POL'Y 4, 14–18 (2009) (summarizing the reach of the shadow banking system).

88. It should be noted that algorithmic trading is not mutually exclusive from high-frequency trading, which is frequently driven by algorithmic models. *See* ARNUK & SALUZZI, *supra* note 59, at 2–3.

89. *See* IRENE ALDRIDGE, HIGH-FREQUENCY TRADING: A PRACTICAL GUIDE TO ALGORITHMIC STRATEGIES AND TRADING SYSTEMS 1 (2010); ARNUK & SALUZZI, *supra* note 59, at 2; *see also* Concept Release on Equity Market Structure, Exchange Act Release No. 34-61,358, 75 Fed. Reg. 3594, 3598 (proposed Jan. 21, 2010) (to be codified at 17 C.F.R. pt. 242).

90. Fabozzi et al., *supra* note 56, at 8.

daily.[91] Under normal circumstances, high-frequency trading can be a positive force in markets, increasing liquidity and decreasing volatility in the short term by enhancing trade volume and execution speeds.[92] During periods of high uncertainty, however, high-frequency trading can exacerbate volatility and hurt liquidity by removing significant trading positions from the markets at warp speeds.[93]

Over the last decade, high-frequency trading has grown more prevalent in finance. Between 2004 and 2010, high-frequency trading increased from about 13 percent of all foreign-exchange flows to 30 percent.[94] In the five-year period from 2005 to 2010, daily trading volume on the NYSE increased by 164 percent.[95] This increase in trading volume is attributable to the rise of high-frequency trading. By 2011, high-frequency trading "account[ed] for about 60 percent of the seven billion shares that change hands daily on United States stock markets,"[96] and for about 35 to 40 percent of European equities trading volume.[97]

Aside from being faster and less human than previous forms of trading, black box trading can be incredibly profitable. "Hedge funds on average gained 10.4 percent annualized, net of fees, from July 1, 1993, through 2010," with top funds generating even better returns employing black box trading platforms.[98] Renaissance Technologies, one of the most successful hedge funds, averaged annual returns of 35 percent (after exceptionally high fees) for nearly two decades following 1990, and "[i]n 2008, . . . [its] flagship Medallion Fund gained approximately 80 percent."[99] The success of black box trading extends beyond the boutique confines of the hedge fund world and into bulge bracket investment banks.[100] Every major investment bank in the world employs some form of black box trading with its own proprietary software.[101] In 2010, with the aid of black box trading, Bank of America and J.P.

91. *See* Eric Dash & Christine Hauser, *As Dizzying Week Ends on Wall St., Dangers Linger*, N.Y. TIMES, Aug. 13, 2011, at A1.
92. *See* FRANK PARTNOY, WAIT: THE ART AND SCIENCE OF DELAY 43 (2012).
93. *See* ARNUK & SALUZZI, *supra* note 59, at 16; PARTNOY, *supra* note 92, at 43.
94. Neil Shah, *High-Speed Traders Dive Into Forex Despite Doubts*, WALL ST. J., Apr. 25, 2011, http://online.wsj.com/article/SB10001424052748704677404576284921020282968.html.
95. Duhigg, *supra* note 76.
96. Graham Bowley, *Fast Traders, in Spotlight, Battle Rules*, N.Y. TIMES, July 18, 2011, at A1.
97. Fabozzi et al., *supra* note 56, at 8.
98. Richard Teitelbaum, *Morgan Stanley Yoga-Troubadour-Crossword-Math Pro Muller Flees*, BLOOMBERG MARKETS MAG., July 7, 2011, http://www.bloomberg.com/news/2011-07-07/morgan-stanley-s-yoga-troubadour-crossword-math-pro-flees-with-20-returns.html.
99. RISHI K. NARANG, INSIDE THE BLACK BOX: THE SIMPLE TRUTH ABOUT QUANTITATIVE TRADING 4 (2009).
100. *See* PATTERSON, *supra* note 67, at 12 (discussing how quantitative trading had "transform[ed] white-shoe bank companies into hot-rod hedge fund vehicles").
101. *See An Introduction to Financial Software Development*, SCOTTLOGIC, http://www.scottlogic.co.uk/careers/financial-software-development (last visited Nov. 24, 2012) ("All of the large financial institutions (e.g. investment banks) have their own software development teams.").

Morgan had two perfect trading quarters, which means that their trading desks were profitable every day for six months of the year.[102] Because of its lucrative potential, trading and trading-related revenues now account for a significant portion of profits and operations for many financial institutions.[103]

Beyond trading, in the age of cy-fi, computers with artificial intelligence are used for asset management and risk assessment.[104] BlackRock, the world's largest asset management firm, uses its proprietary system, Aladdin, to help clients allocate capital, measure risk, and manage risk.[105] Aladdin can analyze stocks, bonds, derivatives, and other complex financial instruments.[106] During the financial crisis of 2008, with the help of Aladdin, BlackRock aided the U.S. Treasury Department with the bailouts related to Bear Stearns, AIG, Citigroup, Fannie Mae, and Freddie Mac.[107]

In sum, increased reliance on computerization and artificial intelligence in finance has fundamentally transformed modern finance into cyborg finance, an industry that is faster, larger, more global, more interconnected, and less human than its previous iterations.[108]

II. THE EVOLUTION OF THE INVESTOR

The transformation of modern finance into cyborg finance has precipitated a conceptual evolution in prevailing legal understandings of financial regulation's main character: the investor. With the aid of computers, a new aspirational investor paradigm has emerged and holds the potential to be more informed, more diversified, more rational, and faster than previous paradigms. And law must become more cognizant of this emerging, new investor paradigm in order to remain effective.

102. *See generally* Dawn Kopecki, *BofA, JPMorgan Reprise Perfect Trading Records*, BLOOMBERG, Nov. 9, 2010, http://www.bloomberg.com/news/2010-11-09/jpmorgan-reprises-perfect-trading-record-as-goldman-posts-two-losing-days.html.

103. *See* DAVID P. STOWELL, AN INTRODUCTION TO INVESTMENT BANKS, HEDGE FUNDS, AND PRIVATE EQUITY: THE NEW PARADIGM 97–111 (2010) (discussing the prevalence of institutional financial trading).

104. *See* Erik F. Gerding, *Code, Crash, and Open Source: The Outsourcing of Financial Regulation to Risk Models and the Global Financial Crisis*, 84 WASH. L. REV. 127, 130–35 (2009).

105. *Aladdin Enterprise Investment System*, BLACKROCK, http://www2.blackrock.com/US/brs/investment-tools/aladdin (last visited Nov. 24, 2012).

106. *See* Sheelah Kolhatkar & Sree Vidya Bhaktavatsalam, *The Colossus of Wall Street*, BUS. WK., Dec. 13, 2010, at 60, 66.

107. *Id.* at 63.

108. *See* Salmon & Stokes, *supra* note 56, at 93 ("It's the machines' market now; we just trade in it.").

A. The Reasonable Investor

A bedrock concept of financial regulation is "the reasonable investor."[109] Much of state corporate law and federal securities law exist to protect this paragon of investors.[110] For example, analysis under Rule 10b-5[111] of the Securities Exchange Act of 1934, as amended, revolves around the perspective of the reasonable investor. The U.S. Supreme Court in the landmark case, *TSC Industries, Inc. v. Northway, Inc.*,[112] held that for analyzing materiality for securities fraud purposes,

> [a]n omitted fact is material if there is a substantial likelihood that a reasonable shareholder would consider it important in deciding how to vote. . . . Put another way, there must be a substantial likelihood that the disclosure of the omitted fact would have been viewed by *the reasonable investor* as having significantly altered the "total mix" of information made available.[113]

Twelve years later, in *Basic Inc. v. Levinson*,[114] the Supreme Court expressly adopted this holding for securities litigation under the antifraud provisions of Section 10, particularly Rule 10b-5,[115] which is considered one of the most important investor protection measures in financial regulation.[116]

Yet, despite the importance of the reasonable investor in financial regulation, courts have not spoken with one clear voice on its identity.[117] The reasonable inves-

109. *See, e.g.*, David A. Hoffman, *The "Duty" to Be a Rational Shareholder*, 90 MINN. L. REV. 537, 537–39 (2006) (highlighting the importance of the reasonable investor construct to federal securities law); Margaret V. Sachs, *Materiality and Social Change: The Case for Replacing "the Reasonable Investor" With "the Least Sophisticated Investor" in Inefficient Markets*, 81 TUL. L. REV. 473, 475 (2007).

110. *See, e.g.*, H.R. REP. NO. 73-1383, pt. 2, at 5 (1934) (discussing the need to protect individual investors in enacting the Securities Exchange Act of 1934); H.R. REP. NO. 73-85, pt. 1, at 2 (1933) (highlighting protection for reasonable investors as the purpose of the Securities Act of 1933).

111. 17 C.F.R. § 240.10b-5 (2012).

112. 426 U.S. 438 (1976).

113. *Id.* at 449 (emphasis added).

114. 485 U.S. 224 (1988).

115. *Id.* at 231–32.

116. *See* Julie A. Herzog, *Fraud Created the Market: An Unwise and Unwarranted Extension of Section 10(b) and Rule 10b-5*, 63 GEO. WASH. L. REV. 359, 367–70 (1995) (examining the breadth and impact of Rule 10b-5); James J. Park, *Rule 10b-5 and the Rise of the Unjust Enrichment Principle*, 60 DUKE L.J. 345, 351–52 (2011) (highlighting the historical importance of Rule 10b-5 in preventing securities fraud).

117. *See, e.g.*, Stefan J. Padfield, *Is Puffery Material to Investors? Maybe We Should Ask Them*, 10 U. PA. J. BUS. & EMP. L. 339, 365 (2008) (acknowledging the unsettled definition of the "reasonable investor").

tor, thus far, has remained anonymous, elusive, and the subject of much inquiry.[118] Legal scholars and commentators have speculated on the reasonable investor's gender,[119] temperament,[120] and sophistication,[121] among other characteristics.

Despite varying meditations on the reasonable investor, an influential paradigm has prevailed in financial regulation: the rational actor as the reasonable investor.[122] The rational actor is the *homo economicus*, the idealized, utility-maximizing person from neoclassical economic theory.[123] Additionally, regulators have generally and historically viewed the reasonable investor as a long-term investor, not a short-term trader.[124]

Rulemaking with the assumption of the rational actor as the reasonable investor is fairly straightforward since "all human behavior can be viewed as involving participants who maximize their utility from a stable set of preferences and accumulate an optimal amount of information and other inputs in a variety of markets."[125] Financial regulation is, therefore, structured to equip investors with the requisite information and tools so that "investors can protect themselves against corporate abuses and mismanagement" in relatively efficient markets.[126] As a matter of practice, this regulatory modus operandi has resulted in more disclosure by

118. *See, e.g.*, Joan MacLeod Heminway, *Female Investors and Securities Fraud: Is the Reasonable Investor a Woman?*, 15 WM. & MARY J. WOMEN & L. 291, 293–94 (2009).
119. *See id.* at 294–95.
120. *See* Peter H. Huang, *Moody Investing and the Supreme Court: Rethinking the Materiality of Information and the Reasonableness of Investors*, 13 SUP. CT. ECON. REV. 99, 100–04 (2005) (theorizing that reasonable investors invest based on attitudes and noncognitive factors beyond risk and return).
121. *Compare* Barbara Black & Jill I. Gross, *Making It Up as They Go Along: The Role of Law in Securities Arbitration*, 23 CARDOZO L. REV. 991, 1037 (2002) ("[T]oday's 'reasonable investors' are expected to possess a certain level of understanding and sophistication . . . ."), *and* Heminway, *supra* note 118, at 301–02 (advancing arguments supporting the sophisticated investor as the reasonable investor), *with* Sachs, *supra* note 109, at 475–76 (claiming that the most reasonable investors are those who are least sophisticated).
122. *See* Heminway, *supra* note 118, at 297 ("Decisional law and the related literature support the view that the reasonable investor is a rational investor . . . ."); Huang, *supra* note 120, at 111 ("[M]any courts appear to view the reasonable investor as referring to a normative idealized type of behavior, instead of a descriptive realistic depiction of actual behavior.").
123. Carlos Rodriguez-Sickert, *Homo Economicus*, *in* HANDBOOK OF ECONOMICS AND ETHICS 223, 223 (Jan Peil & Irene van Staveren eds., 2009).
124. *See, e.g.*, Regulation NMS, 70 Fed. Reg. 37,496, 37,500 (June 29, 2005) ("Indeed, the core concern for the welfare of long-term investors . . . was first expressed in the foundation documents of the Exchange Act itself.").
125. GARY S. BECKER, THE ECONOMIC APPROACH TO HUMAN BEHAVIOR 14 (1976).
126. Troy A. Paredes, *Blinded by the Light: Information Overload and Its Consequences for Securities Regulation*, 81 WASH. U. L.Q. 417, 418 (2003).

corporations,[127] increased governmental supervision,[128] and enhanced direct governance tools, like "say-on-pay," for investors.[129]

In meaningful ways, the rational actor assumption has served regulators, legislators, and investors well for many decades. Despite serious financial crises, it has predicated a regulatory framework that, while imperfect, is by many accounts the envy of the developed world,[130] producing lengthy periods of significant wealth creation and economic growth.[131] It is, in part, because of such success that the paradigm of the rational actor as the reasonable investor remains so embedded in law and finance.

B. The Irrational Investor

New research has challenged and refined the rational investor paradigm, and it has introduced an alternative paradigm, the irrational investor.[132] The rational investor paradigm, while prevalent and instructive, is not perfect.[133] An original sin of the rational investor paradigm is the assumption that real individuals are always rational like their economic kin.[134] Whereas rational actors comprehend

127. *See, e.g.*, Tom C.W. Lin, *A Behavioral Framework for Securities Risk*, 34 SEATTLE U. L. REV. 325, 336 (2011) ("In practice, this assumption has produced a regulatory framework that emphasizes more information over less information, more disclosure over better disclosure, quantity over quality.").

128. *See, e.g.*, Drake Bennett & Carter Dougherty, *She's With the Government and She's Here to Help*, BUS. WK., July 11, 2011, at 58, 60–64 (chronicling efforts to establish the Consumer Financial Protection Bureau as a sentinel for protecting investors and consumers).

129. Shareholder Approval of Executive Compensation and Golden Parachute Compensation, Exchange Act Release No. 33-9178, 76 Fed. Reg. 6010, 6013 (Feb. 2, 2011) (to be codified at 17 C.F.R. pts. 229, 240, 249) (granting shareholders a nonbinding vote on certain executive compensation matters).

130. *See* CHARLES ROXBURGH ET AL., MCKINSEY GLOBAL INST., GLOBAL CAPITAL MARKETS: ENTERING A NEW ERA 9 (2009) (charting the growth of U.S. capital markets); Bengt Holmstrom & Steven N. Kaplan, *The State of U.S. Corporate Governance: What's Right and What's Wrong?*, J. APPLIED CORP. FIN., Spring 2003, at 8, 8–11 ("Despite the alleged flaws in its governance system, the U.S. economy has performed very well, both on an absolute basis and particularly relative to other countries. U.S. productivity gains in the past decade have been exceptional, and the U.S. stock market has consistently outperformed other world indices over the last two decades . . . .").

131. *See* OFFICE OF MGMT. & BUDGET, BUDGET OF THE UNITED STATES GOVERNMENT, FISCAL YEAR 2006, at 20–21 (2005) (detailing the rise of the U.S. gross domestic product since 1940).

132. *See* David Brooks, *The Unexamined Society*, N.Y. TIMES, July 8, 2011, at A23 ("[T]oday we are in the middle of a golden age of behavioral research. Thousands of researchers are studying the way actual behavior differs from the way we assume people behave."); *see also* BEHAVIORAL LAW & ECONOMICS (Cass R. Sunstein ed., 2000).

133. A pillar of the influential field of behavioral economics is built on challenging the rational actor assumption of neoclassical economics. *See, e.g.*, Christine Jolls et al., *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471 (1998); Richard A. Posner, *Rational Choice, Behavioral Economics, and the Law*, 50 STAN. L. REV. 1551 (1998).

134. *See* David L. Faigman, *To Have and Have Not: Assessing the Value of Social Science to the Law as Science and Policy*, 38 EMORY L.J. 1005, 1047 n.151 (1989) ("[E]conomists who assume that people

and synthesize information perfectly, real individuals do not.[135] Whereas rational actors make decisions dispassionately without being influenced by irrelevant factors, real individuals often make decisions based on emotions, biases, and irrelevant stimuli.[136] Whereas rational actors live in a simple world filled with other perfectly monochromatic, rational actors, real individuals exist in a complex world filled with other flawed, colorful characters. Plainly stated, real individuals and real investors are not rational actors.

Despite their incongruence with rational actors, real investors are not entirely irrational and unpredictable. Instead, the rationality of real investors is imperfect, bounded, and in many ways, predictable.[137] Biases,[138] heuristics,[139] framing effects,[140] and other cognitive stimuli that result in suboptimal decisions affect the

are "rational" decisionmakers have articulated highly sophisticated models that purport to make predictions of great exactitude. In the real world, of course, people are not rational decisionmakers, and the economists' models suffer accordingly."); Lin, *supra* note 127, at 336–49 (highlighting differences between rational actors and real individuals).

135. *See* Jeffrey J. Rachlinksi, *Misunderstanding Ability, Misallocating Responsibility*, *in* THINKING AND SEEING: VISUAL METACOGNITION IN ADULTS AND CHILDREN 251, 252 (Daniel T. Levin ed., 2004) (comparing the reasonable person to "a kind of superhero" because of her superior cognitive abilities relative to lay people); Erwann Michel-Kerjan & Paul Slovic, *An Idea Whose Time Has Come*, *in* THE IRRATIONAL ECONOMIST: MAKING DECISIONS IN A DANGEROUS WORLD 1, 3–7 (Erwann Michel-Kerjan & Paul Slovic eds., 2010).

136. *See, e.g.*, DANIEL KAHNEMAN, THINKING, FAST AND SLOW 377–85 (2011); Paul J.H. Schoemaker, *A Two-Edged Sword: Implications of Decision Psychology for Decision Analysis*, *in* THE IRRATIONAL ECONOMIST, *supra* note 135, at 53, 57–59.

137. *See* DAN ARIELY, PREDICTABLY IRRATIONAL: THE HIDDEN FORCES THAT SHAPE OUR DECISIONS 239 (2008) ("Our irrational behaviors are neither random nor senseless—they are systematic and predictable."); Stephen J. Choi & A.C. Pritchard, *Behavioral Economics and the SEC*, 56 STAN. L. REV. 1, 2 (2003) ("These [cognitive] biases are not merely isolated quirks, rather, they are consistent, deep-rooted, and systematic behavioral patterns."); Jolls et al., *supra* note 133, at 1475 ("Behavioral economics does not suggest that behavior is random or impossible to predict; rather it suggests, with economics, that behavior is systematic and can be modeled.").

138. *See* Margit E. Oswald & Stefan Grosjean, *Confirmation Bias*, *in* COGNITIVE ILLUSIONS: A HANDBOOK ON FALLACIES AND BIASES IN THINKING, JUDGEMENT AND MEMORY 79 (Rüdiger F. Pohl ed., 2004) (explaining the confirmation bias); Lin, *supra* note 127, at 340–44 (surveying various cognitive biases); William Samuelson & Richard Zeckhauser, *Status Quo Bias in Decision Making*, 1 J. RISK & UNCERTAINTY 7, 7–10 (1988) (discussing the status quo bias); Amos Tversky & Daniel Kahneman, *Loss Aversion in Riskless Choice: A Reference-Dependent Model*, 106 Q.J. ECON. 1039, 1040–42 (1991) (studying the loss aversion bias).

139. *See, e.g.*, ROY F. BAUMEISTER & BRAD J. BUSHMAN, SOCIAL PSYCHOLOGY AND HUMAN NATURE 161 (2008) ("Mental shortcuts, [or] heuristics, provide quick estimates (though sometimes inaccurate ones) for decisions about uncertain events." (emphasis omitted)); Abhijit V. Banerjee, *A Simple Model of Herd Behavior*, 107 Q.J. ECON. 797, 798–800 (1992) (discussing the heuristics of herd behavior); Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, 185 SCIENCE 1124, 1128–29 (1974) (discussing the anchoring heuristic).

140. *See* Amos Tversky & Daniel Kahneman, *The Framing of Decisions and the Psychology of Choice*, 211 SCIENCE 453, 454–57 (1981) (describing the concept of "framing").

rationality of real investors. Real investors, for instance, generally possess unhealthy surpluses of confidence,[141] optimism,[142] and loss aversion.[143]

Given the cognitive limitations of real investors as compared with the limitless cognition of mythical, rational investors, a serious chasm exists between the regulatory world and the real world. Financial regulations crafted primarily for one illusive population of rational investors actually govern a significantly distinct population of real investors.

This mismatch between the reasonable investor and the real investor has exhibited itself in prosaic and profound ways. During the dot-com boom of the late 1990s, investors failed to read and heed the warning of securities filings and invested in companies based solely on names that suggested technology or internet affiliations.[144] For example, in 1999, Computer Literacy Inc. changed its name to fatbrain.com, and its stock subsequently shot up 33 percent in one day.[145] More recently, in the years preceding the financial crisis of 2008, overly optimistic investors purchased homes that they could not afford based on assumptions that were not reasonable, like perpetually rising housing prices.[146] Similarly, banks made loans that they should not have made, and individuals signed mortgages that they did not understand; and they collectively caused the housing market to collapse.[147]

In the aftermath of the financial crisis, many—including some prominent free-market apologists—have questioned the utility of the rational actor–investor

141. *See* Robert J. Shiller, *Measuring Bubble Expectations and Investor Confidence*, 1 J. PSYCHOL. & FIN. MARKETS 49, 50–52 (2000) (studying the impact of investor overconfidence on stock markets).

142. *See* David A. Armor & Shelley E. Taylor, *When Predictions Fail: The Dilemma of Unrealistic Optimism*, *in* HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT 334, 334 (Thomas Gilovich et al. eds., 2002) (addressing the cognitive bias of overoptimism); Shiller, *supra* note 141, at 50–52.

143. *See* Choi & Pritchard, *supra* note 137, at 13; Hoffman, *supra* note 109, at 553.

144. *See* JASON ZWEIG, YOUR MONEY AND YOUR BRAIN: HOW THE NEW SCIENCE OF NEUROECONOMICS CAN HELP MAKE YOU RICH 8 (2007) ("During 1998 and 1999, one group of stocks outperformed the rest of the technology industry by a scorching 63 percentage points—merely by changing their official corporate names to include *.com*, *.net*, *or Internet*.").

145. *Id.*

146. *See, e.g.*, Oren Bar-Gill, *The Law, Economics and Psychology of Subprime Mortgage Contracts*, 94 CORNELL L. REV. 1073, 1081–82 (2009) (speculating on the irrationality of lenders, borrowers, and homeowners in the years prior to the financial crisis).

147. *See* STAFF OF S. PERMANENT SUBCOMM. ON INVESTIGATIONS, 112TH CONG., WALL STREET AND THE FINANCIAL CRISIS: ANATOMY OF A FINANCIAL COLLAPSE 48–51 (2011) [hereinafter LEVIN-COBURN REPORT] (reporting on bad lending process that led to the financial crisis); Gerald H. Lander et al., *Subprime Mortgage Tremors: An International Issue*, 15 INT'L ADVANCES ECON. RES. 1, 4 (2009) ("Numerous borrowers say they didn't understand the loan structure and the escalating payments; in many cases, they couldn't afford them."); Tom C.W. Lin, *Too Big to Fail, Too Blind to See*, 80 MISS. L.J. 355, 367–71 (2010) (critiquing the rational actor model in connection with the financial crisis of 2008).

paradigm.[148] Acknowledgment of the incongruence between economics's rational actor and reality's real individuals has increased, and it is evidenced, in part, by the growing prominence of behavioral law and economics.[149] Nonetheless, while efforts have been made to craft financial regulations for the irrational investor,[150] most of the regulatory framework continues to exist for the mythical, rational investor.[151]

C. The New Investor

The resilience of the rational investor paradigm in the face of new evidence is both a triumph of ignorance over knowledge as well as a triumph of hope over reality. While new studies continue to highlight the fallacies of equating real investors to their rational kin, new science and technology also continue to narrow the gulf between the irrational investor and the rational investor.[152] The narrowing of this gulf is giving birth to "the new investor," an aspirational paradigm with positive attributes distinct from previous conceptions of investors.

First, the new investor is better informed than the irrational investor, or at least has better access to better information. Advances in information technology have given modern investors more investment information through more mediums. Investors today can receive high-quality, user-friendly investment information through television, radio, satellite radio, websites, social media tools, smartphone applications, and other fora, customized to each investor's interests regardless of their wealth or connections.[153] Information technology advances have moved the new investor beyond the insular, segmented information exchanges

148. *See, e.g.*, *The Financial Crisis and the Role of Federal Regulators: Hearing Before the H. Comm. on Oversight and Gov't Reform*, 110th Cong. 46 (2008) (statement of Alan Greenspan, Former Chairman of the Fed. Reserve Board) (acknowledging that he "found a flaw in the [neoclassical] model that . . . defines how the world works"); Richard A. Posner, *How I Became a Keynesian*, NEW REPUBLIC, Sept. 23, 2009, at 34.

149. *See, e.g.*, Richard A. Posner, *The Rise and Fall of Administrative Law*, 72 CHI.-KENT L. REV. 953, 958 (1997); Guhan Subramanian, *Fixing Freezeouts*, 115 YALE L.J. 2, 37 n.149 (2005); Brooks, *supra* note 132 (noting the proliferation of behavioral research).

150. *See, e.g.*, Ron Lieber, *Consumer Watchdog Is All Ears for Ideas*, N.Y. TIMES, July 16, 2011, at B1.

151. *See, e.g.*, Basic Inc. v. Levinson, 485 U.S. 224, 231–32 (1987).

152. *See, e.g.*, RAY KURZWEIL, THE SINGULARITY IS NEAR: WHEN HUMANS TRANSCEND BIOLOGY 1–5 (2005) (discussing the ability of humans to expand their limitations through science and technology).

153. *See* Patricia Sánchez Abril, *The Evolution of Business Celebrity in American Law and Society*, 48 AM. BUS. L.J. 177, 178 (2011) ("Over the past half-century, digital communications, globalization, mass-market media and advertising, and a heightened public interest in business matters have conspired to shine a brighter spotlight on business leaders as stars."); Tom C.W. Lin, *Undressing the CEO: Disclosing Private, Material Matters of Public Company Executives*, 11 U. PA. J. BUS. L. 383, 389–92 (2009) (discussing the increase in media for business information).

of its predecessors, toward a more egalitarian form of information exchange. Today, any individual with online access can find and review every public company's filings with the SEC.

Second, the new investor is faster than its predecessors and continues to accelerate with technological progress.[154] Over the last century, financial technology evolved from couriers, to ponies, to tickers, to telegrams, to telephones, to computers, and most recently to supercomputers.[155] As a result, the new investor is capable of investing and trading faster than any of its predecessors and can do so from nearly any place on the globe.[156] This enhanced velocity has shortened the timeline of finance from days to hours, to minutes, to seconds, to nanoseconds.[157] The accelerated velocity means not only faster trade executions but also faster investment turnovers. "At the end of World War II, the average holding period for a stock was four years. By 2000, it was eight months. By 2008, it was two months. And by 2011 it was *twenty-two seconds* . . . ."[158]

Third, compared to previous paradigms, the new investor is more capable of better investment diversification. If investment diversification is a hallmark of sound investing,[159] the new investor is better equipped than its predecessors are in this regard. The new investor can invest in bonds, stocks, and commodities like its predecessors. Unlike its predecessors, however, the new investor can also readily invest in more exotic investments like foreign currencies, exchange-traded funds, options, and swaps.[160] Access to such diverse assets, in theory, allows the new investor to spread its risks across various types of investments.

154. *See* KEN AULETTA, GOOGLED: THE END OF THE WORLD AS WE KNOW IT 15 (2009) ("It took telephones seventy-one years to penetrate 50 percent of American homes, electricity fifty-two years, and TV three decades. The Internet reached more than 50 percent of Americans in a mere decade[, and] . . . Facebook built up a community of two hundred million users in just five years.").

155. *See* LABOR STATISTICS BUREAU, CAREER GUIDE TO INDUSTRIES 2008–2009, at 188 (2008) ("The securities industry is continuously changing because of improvements in technology . . . .").

156. *See* Haldane, *supra* note 14, at 5 (discussing how modern financiers continue to break new frontiers in execution speed for their investments and trades).

157. *See* Graham Bowley, *The New Speed of Money*, N.Y. TIMES, Jan. 2, 2011, at BU1 (reporting on the astounding velocity of modern finance).

158. PATTERSON, *supra* note 65, at 46.

159. *See* IAN AYRES & BARRY NALEBUFF, LIFECYCLE INVESTING: A NEW, SAFE, AND AUDACIOUS WAY TO IMPROVE THE PERFORMANCE OF YOUR RETIREMENT PORTFOLIO 1–3 (2010) (analyzing the importance of asset and time diversification in investing); GARY BELSKY & THOMAS GILOVICH, WHY SMART PEOPLE MAKE BIG MONEY MISTAKES—AND HOW TO CORRECT THEM: LESSONS FROM THE NEW SCIENCE OF BEHAVIORAL ECONOMICS 250–51 (2010) (highlighting the benefits of diversification in investments). *But see* GERALD M. LOEB, THE BATTLE FOR INVESTMENT SURVIVAL 103–04 (John Wiley & Sons 2007) (1935) (espousing the virtues of concentrated investments over diversified investments).

160. *See, e.g.*, Houman B. Shadab, *Fending for Themselves: Creating a U.S. Hedge Fund Market for Retail Investors*, 11 N.Y.U. J. LEGIS. & PUB. POL'Y 251, 277 (2008) ("Finally, with the development of

Fourth, relative to the irrational investor, the new investor is less emotional and more rational. The new investor is more self-aware of its personal and psychological pitfalls, and more capable of tempering its emotional and irrational impulses.[161] Recent studies in behavioral finance and psychology have made the new investor more mindful of its cognitive vulnerabilities.[162] Such awareness, in turn, has led to the creation of new investment tools to help the new investor allocate its assets more rationally.[163] For example, the new investor frequently trades using computer models and mathematical algorithms, which are more impervious to the irrational cognitive whims of market players.[164] Dispassionate computerized analysis mitigates the arbitrariness of fear and greed that often motivate investors.[165] Computers running "statistical regressions don't have egos or feelings,"[166] and they are not prone to overconfidence.[167] While these tools dominate the upper echelons of finance,[168] they also exist outside high finance. Free and inexpensive tools allow pedestrian investors to better evaluate the risk and diversity of their investments. For instance, online brokers such as Charles Schwab and E-Trade have user-friendly tools that help investors assess the risks and balance of their

sophisticated at-home trading tools and publicly registered exchange traded funds (ETFs), retail investors can implement hedge fund trading strategies on their own, at low cost.").

161. *See generally* RICHARD H. THALER & CASS R. SUNSTEIN, NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH, AND HAPPINESS (2009) (discussing many circumstances in which individuals and institutions can create choice architectures that better protect them from their cognitive limitations); Cass R. Sunstein & Richard H. Thaler, *Libertarian Paternalism Is Not an Oxymoron*, 70 U. CHI. L. REV. 1159 (2003) (finding that individuals are slow to join 401(k) plans that offer more choices because they are prone to procrastination).

162. *See* Posner, *supra* note 149, at 958 (alluding to the proliferation of behavioral economics scholarship); Subramanian, *supra* note 149, at 37 n.149; *see also* KAHNEMAN, *supra* note 136, at 377–97.

163. *See* BELSKY & GILOVICH, *supra* note 159, at 207–11 (advising on various methods to improve financial decisions based on the science of behavioral economics); Donald C. Langevoort, *Selling Hope, Selling Risk: Some Lessons for Law From Behavioral Economics About Stockbrokers and Sophisticated Customers*, 84 CALIF. L. REV. 627, 635 (1996); Lin, *supra* note 127, at 356–63 (discussing various ways to improve federal securities disclosures based on insights from behavioral economics); Troy A. Paredes, *On the Decision to Regulate Hedge Funds: The SEC's Regulatory Philosophy, Style, and Mission*, 2006 U. ILL. L. REV. 975, 1026 (espousing default rules to enhance financial regulation); David H. Freedman, *The Perfected Self*, ATLANTIC, June 2012, at 42.

164. MONKS & LAJOUX, *supra* note 72, at 229 ("The goal of algorithmic trading is to take the human factor out of trading as much as possible to avoid the irrational aspects of fear (economic panics) and greed (irrational exuberance).").

165. NARANG, *supra* note 99, at xii.

166. AYRES, *supra* note 38, at 115.

167. *See, e.g.*, Tom C.W. Lin, *The Corporate Governance of Iconic Executives*, 87 NOTRE DAME L. REV. 351, 373–76 (2011) (describing the perils of overconfidence in business decisions).

168. *See* Joe Nocera, *Risk Management*, N.Y. TIMES MAG., Jan. 4, 2009, at 24 (discussing the wide use of the Value at Risk model by investment banks to manage risk).

portfolios.[169] In the future, advances in transcranial magnetic stimulation technology may permit the brain to be reprogrammed to make better financial decisions.[170] While new awareness and corresponding developments help make the new investor more rational, they do not make it completely impervious to all of its cognitive quirks and limitations. Investors will continue to make mistakes,[171] but they now have better tools to correct and prevent them.[172]

Fifth, compared to the other models, the new investor is more humble about its capabilities and knowledge. While the new investor possesses more knowledge and investing capabilities relative to its predecessors, the new investor is also more mindful of its limitations, the limitations of models, and the limitations of technology.[173] The new investor is more aware of the role of randomness, serendipity, and uncertainty in life and finance.[174] The new investor has a vast library of data and information but also has a vast antilibrary[175]: a collection of known unknowns and unknown unknowns; a repository of unlearned knowledge.[176] The antilibrary tempers the new investor's confidence in its capabilities and knowledge as it relates to financial markets.

In sum, the aspirational new investor is a modest cyborg.[177] When famed finance professor Benjamin Graham published his landmark book, *The Intelligent*

169. *See* ANN C. LOGUE, DAY TRADING FOR DUMMIES 195 (2d ed. 2011) (describing the numerous investment tools and services available to clients of Charles Schwab); E-trade, *E-trade Baby Girlfriend Super Bowl Commercial 2010*, YOUTUBE (Feb. 7, 2010), http://www.youtube.com/watch?v=tbLTl7egwlU.

170. *See* Sharon Begley With Jean Chatzky, *Stop! You Can't Afford It*, NEWSWEEK, Nov. 7 & 14, 2011, at 50.

171. *See, e.g.*, BELSKY & GILOVICH, *supra* note 159, at 151–53 (acknowledging that awareness of one's cognitive limitations does not necessarily mean that one will perfectly correct them).

172. Cass R. Sunstein, Essay, *Empirically Informed Regulation*, 78 U. CHI. L. REV. 1349, 1410–11 (2011) (discussing the use of empirical findings about human behavior in crafting better regulations).

173. *See, e.g.*, EMANUEL DERMAN & PAUL WILMOTT, THE FINANCIAL MODELERS' MANIFESTO 1 (2009), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1324878 ("Our experience in the financial arena has taught us to be very humble in applying mathematics to markets, and to be extremely wary of ambitious theories, which are in the end trying to model human behavior. We like simplicity, but we like to remember that it is our models that are simple, not the world.").

174. *See, e.g.*, LEONARD MLODINOW, THE DRUNKARD'S WALK: HOW RANDOMNESS RULES OUR LIVES 216–18 (2008) (expounding on the role of randomness in life and markets).

175. NASSIM NICHOLAS TALEB, THE BLACK SWAN: THE IMPACT OF THE HIGHLY IMPROBABLE 1 (2d ed. 2010) (introducing the term "antilibrary" as a collection of knowledge that one does not yet possess).

176. The terms "known unknowns" and "unknown unknowns" were popularized by former Secretary of Defense Donald Rumsfeld. *See* Donald H. Rumsfeld, Sec'y of Def., Remarks at Department of Defense News Briefing (Feb. 12, 2002), *available at* http://www.defense.gov/Transcripts/Transcript.aspx?TranscriptID=2636.

177. *See* Donna J. Haraway, *A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century*, *in* READINGS IN THE PHILOSOPHY OF TECHNOLOGY 161, 161 (David M. Kaplan ed., 2004) ("A cyborg is a cybernetic organism, a hybrid of machine and organism, a creature

Investor, in 1973, it is unlikely that he envisioned his title character would be a cyborg, but modernity has made it so.[178] The new investor is in many ways Graham's intelligent investor modernized, and it is neither wholly human nor wholly machine. Instead, it is the hybrid offspring of both human and machine. In fact, Sherry Turkle, a leading sociologist, and others have declared that, "We are all cyborgs now."[179] And because we are all cyborgs, we all hold the promise and potential of becoming a better investor—of becoming the new investor.

* * *

New science and technology have precipitated a conceptual evolution of the investor from the reasonable investor to the irrational investor to the new investor. While the reasonable investor model remains statically and theoretically dominant, regulators need to become more mindful of the dynamism and realism of the new investor model if they hope to remain relevant.

III. CLEAR, PRESENT, AND FUTURE DANGERS

The new investor offers the promise of smarter, faster, and better results, but this paradigm also poses new challenges and dangers from within and without. The enhanced speed and interconnectedness of cyborg finance makes it more endogenously vulnerable to volatile crashes, and the heavy reliance on machines makes the system more exogenously vulnerable to cyber perils.

A. The Flash Crash and Future Crashes

On May 6, 2010, the perils of cyborg finance became clear. On that day, the world witnessed a crash and recovery of spectacular volatility and velocity in the U.S.

of social reality as well as a creature of fiction."); Peter Norberg, *Trading Trust: Post-aristocratic Finance in the City of Stockholm* 11 (SSE/EFI Working Paper in Bus. Admin. No. 2009:8, 2009), *available at* http://swoba.hhs.se/hastba/papers/hastba2009_008.pdf ("Fused with algorithms, hybrid cyborg investors occupied with trading online take the place of simple human beings.").

178. *See* BENJAMIN GRAHAM, THE INTELLIGENT INVESTOR: A BOOK OF PRACTICAL COUNSEL (4th rev. ed. 1973) (providing a guide to becoming an intelligent investor—one that is thoughtful, rational, and value driven).

179. *See* TURKLE, *supra* note 32, at 152; *see also* David J. Hess, *On Low-Tech Cyborgs*, *in* THE CYBORG HANDBOOK 371, 373 (Chris Hables Gray ed., 1995) ("[A]lmost everyone in urban societies could be seen as a low-tech cyborg, because they spend large parts of the day connected to machines such as cars, telephones, computers, and, of course, televisions."); Amber Case, *We Are All Cyborgs Now*, TED.COM (Jan. 2011), http://www.ted.com/talks/amber_case_we_are_all_cyborgs_now.html.

stock market.[180] In less than thirty minutes, approximately $1 trillion in market value vanished.[181] The events of that day are now known simply as the Flash Crash.[182]

The Flash Crash occurred on a day when the markets opened with concerns about an ongoing European debt crisis.[183] At approximately 2:32 p.m., with an automated computer program, a Kansas mutual fund company initiated a trade to sell $4.1 billion of E-Mini S&P futures contracts.[184] The sale was executed via a high-speed computerized algorithm that was programmed to execute the trade "without regard to price or time."[185] The program completed the sale in merely twenty minutes.[186] A sale of this value would normally take several hours or days to complete in years past.[187]

The execution of this trade led to corresponding trades in the futures and equity markets. Seconds after the completion of the $4.1 billion sale, other black box programs began selling large blocks of S&P futures, accounting for over 33 percent of the total trading volume.[188] Between 2:41 p.m. and 2:44 p.m., S&P futures dropped by approximately 3 percent. By 2:42 p.m., the Dow Jones Industrial Average (Dow) had declined 3.9 percent to 10,445.85. At 2:45:28 p.m., the Chicago Mercantile Exchange's curbs were triggered, pausing the sale of S&P futures for a few seconds to slow the freefall in price.[189] When trading resumed at 2:45:33 p.m., the S&P futures gradually began to stabilize and recover.[190] The Dow, however, continued to decline, dropping to 9872.57, or a 9.16 percent drop from the previous day's close, before recovering nearly all of the decline by 3:00 p.m.[191] During the Dow's precipitous drop, the share prices of blue-chip stocks like Proctor & Gamble and 3M experienced losses exceeding 18 percent, wiping out billions of dollars in shareholder wealth in a few minutes.[192] "Peak to trough, Accenture shares fell by over 99%, from $40 to $0.01. At precisely the same time, shares in Sotheby's rose three thousand–fold, from $34 to $99,999.99."[193] At the end of the

180. CFTC & SEC FINDINGS, *supra* note 19, at 9.
181. Haldane, *supra* note 14, at 2.
182. Bowley, *supra* note 3.
183. CFTC & SEC FINDINGS, *supra* note 19, at 1.
184. *Id.* at 2; Bowley, *supra* note 3.
185. Bowley, *supra* note 3.
186. CFTC & SEC FINDINGS, *supra* note 19, at 2.
187. *See id.*
188. *Id.* at 3.
189. *See id.* at 4.
190. *Id.*
191. *Id.*
192. *Id.* at 84–85.
193. Haldane, *supra* note 14, at 2.

trading day, "major futures and equities indices 'recovered' to close at losses of about 3% from the prior day."[194]

Following the Flash Crash, the SEC and the Commodity Futures Trading Commission (CFTC) commenced inquiries on the events of that day and took steps to mitigate the damage from similar episodes in the future. Unsurprisingly, the inquiry showed that the volatility and declines of the Dow during the Flash Crash mirrored volatility and declines of the S&P 500 futures.[195] The inquiry, however, did not blame the Flash Crash entirely on black box traders but rather acknowledged that such traders played a critical role in eroding liquidity and exacerbating volatility.[196]

In response to the Flash Crash, the SEC shortly thereafter implemented a new circuit breaker program to pause trading for five minutes once a security has experienced a 10 percent price change over the preceding five minutes.[197] The purpose of circuit breakers is to serve as speed bumps during periods of extreme volatility that may induce more volatility and destabilization in the marketplace. The SEC approved this circuit breaker on June 10, 2010, for the S&P 500.[198] On September 10, 2010, the SEC expanded the circuit breaker to include the Russell 1000 Index and certain exchange traded funds.[199] The SEC also proposed a "consolidated audit trail" rule to make it easier for regulators to monitor and track the happenings of the complex securities execution system.[200] The SEC and the CFTC also planned further studies and actions on black box trading.[201]

While no other crash matching the magnitude of the Flash Crash has occurred since May 6, 2010, there have been several minicrashes and disruptions.[202] On September 27, 2010, Progress Energy's stock plunged almost 90 percent, fall-

194. CFTC & SEC FINDINGS, *supra* note 19, at 1.
195. *Id* at 3.
196. *See id.* at 6.
197. *Id.* at 7.
198. *Id.*
199. *Id.*
200. *See* Consolidated Audit Trail, 75 Fed. Reg. 32,556 (proposed June 8, 2010) (to be codified at 17 C.F.R. pt. 242).
201. *See* CFTC & SEC FINDINGS, *supra* note 19, at 6–8. In September 2011, the SEC proposed additional rules to protect against crashes related to high-frequency trading. Notice of Filing of Proposed Rule Change to Update Rule 6121 (Trading Halts Due to Extraordinary Market Volatility) and Amend Rule 6440 (Trading and Quotation Halt in OTC Equity Securities), 76 Fed. Reg. 61,429 (proposed Sept. 28, 2011).
202. *See* Graham Bowley, *The Flash Crash, in Miniature*, N.Y. TIMES, Nov. 9, 2010, at B1 ("The crashes continue even as Washington regulators investigate the structure of modern markets and as a report traced the main trigger of May's big crash to a poorly timed trade by a mutual fund in Kansas."); Edward E. Kaufman, Jr. & Carl M. Levin, *Preventing the Next Flash Crash*, N.Y. TIMES, May 6, 2011, at A27 (discussing minicrashes since the Flash Crash).

ing from $44.57 per share to $4.57 per share in a matter of minutes.[203] The circuit breakers instituted by the SEC were set off, but the plunge occurred so quickly that the stock price continued to fall on the NASDAQ.[204] After numerous trades were voided, it was determined that the faulty trades were a mistake; an errant execution of a computer algorithm was to blame for the loss and recovery of millions of dollars in market capitalization.[205] Several months later, on May 13, 2011, the stock of Enstar, a natural gas company, fell from $100 to $0 and then bounced back to $100; Focus Morningstar Health Card Index opened at $25.32 then fell to $0.06, before recovering, due in large part to black box trading.[206] Then in March 2012, the initial public offering of BATS Global Markets, an electronic stock exchange pioneer, had to be withdrawn after major technical difficulties caused serious volatility and confusion in its first hours of trading.[207] Later in 2012, the markets again experienced instability caused by computerized trading with Facebook's initial public offering in May and a rogue computer program related to Knight Trading in August.[208]

While no other major crash has occurred since the Flash Crash, experts and regulators fear that it is only a matter of time before the "Big One."[209] And in the interim, smaller market disruptions have grown and will likely continue to grow more prevalent as cy-fi advances and proliferates.[210]

B. Cybercrimes and Cyberthreats

In the age of cyborg finance, financial institutions have to guard against new and emerging threats relating to cyberspace and intellectual property.[211] Computer

203. Bowley, *supra* note 202.
204. *Id.*
205. *Id.*
206. Matt Krantz, *Mini Flash Crashes Worry Traders*, USA TODAY, May 16, 2011, http://www.usatoday.com/money/markets/2011-05-16-mini-flash-crashes-market-worry_n.htm.
207. *See* Michael J. de la Merced, *BATS Chief on Friday's Troubles*: *'My Stomach Sank*,' N.Y. TIMES DEALBOOK (Mar. 26, 2012, 12:11 AM), http://dealbook.nytimes.com/2012/03/26/bats-chief-on-fridays-meltdown-my-stomach-sank; *see also* Nathaniel Popper, *BATS Flaw Not So Rare, Data Shows*, N.Y. TIMES, Mar. 29, 2012, at B1 (citing the erratic actions of BATS's trading platform).
208. *See* Nathaniel Popper, *Runaway Trades Spread Turmoil Across Wall St.*, N.Y. TIMES, Aug. 2, 2012, at A1.
209. *See* Bowley, *supra* note 202 (citing experts' speculations about another big crash); Kaufman & Levin, *supra* note 202 ("[A]lgorithmic trading has caused mini-Flash Crashes since, and surveys suggest that most investors and analysts believe it's only a matter of time before the Big One.").
210. *See* Popper, *supra* note 207.
211. *See* David Barboza & Kevin Drew, *Security Firm Sees Global Cyberspying*, N.Y. TIMES, Aug. 4, 2011, at A11 ("Cybersecurity is now a major international concern, with hackers gaining access to sensitive corporate and military secrets, including intellectual property."); Michael Joseph Gross, *Exclusive: Operation Shady RAT—Unprecedented Cyber-espionage Campaign and Intellectual-Property Bonanza*,

codes and platforms are some of the most valuable and the most vulnerable assets of many firms, particularly financial firms.[212] With cy-fi, safeguarding trade secrets, intellectual property, and the integrity of proprietary systems is the key to sustainable success for many financial institutions and financial systems.[213] Serious crimes and threats against financial institutions now often involve computers as the weapon of choice, intellectual property as their targeted bounty, and cyberspace as their default setting.[214] In 2008, the Conficker worm, a malicious software program with unknown origins, "infected 1.5 million computers in 195 countries."[215] In 2009, a former Goldman Sachs computer programmer was arrested and initially sentenced to more than eight years in prison for stealing computer codes used in Goldman Sachs's algorithmic trading platforms.[216] In 2011, hackers affiliated with WikiLeaks threatened to release sensitive information relating to Bank of America, sending its shares down significantly.[217] In 2012, the U.S. Department of Labor enhanced the security of its economic data in response to hacking threats aimed at benefitting high-speed traders.[218] That same year, the world also witnessed two large coordinated attacks, one against global financial institutions of every class and type, called "Operation High Roller," and another one specifically targeting American banks; some of these attacks have been attributed to Iran.[219] By some

VANITY FAIR, Aug. 2, 2011, http://www.vanityfair.com/culture/features/2011/09/operation-shady-rat-201109 (discussing the increase in cyberattacks on many prominent governmental agencies and corporations like "Sony, Fox, the British National Health Service, and the Web sites of PBS, the U.S. Senate, and the C.I.A., among others").

212. *See* Alex Berenson, *Arrest Over Software Illuminates a Secret of Wall St.*, N.Y. TIMES, Aug. 24, 2009, at A1 (discussing the importance of computer programs to financial institutions).

213. *See* BROWN, *supra* note 59, at 49 (discussing the urgent need for black box firms to safeguard successful strategies for as long as possible); *see* Deborah Radcliff, *Three Industries, Three Security Needs*, COMPUTERWORLD, Nov. 29, 1999, at 38 ("Now that banks are moving to Internet-based transactions, they must also ensure the security of their Web servers and the information they store, along with providing secure transport of customer information over the Internet.").

214. *Cf.* Michael Joseph Gross, *Enter the Cyber-dragon*, VANITY FAIR, Sept. 2011, http://www.vanityfair.com/culture/features/2011/09/chinese-hacking-201109 ("Hackers from many countries have been exfiltrating—that is, stealing—intellectual property from American corporations and the U.S. government on a massive scale, and Chinese hackers are among the main culprits.").

215. MARK BOWDEN, WORM: THE FIRST DIGITAL WORLD WAR 116 (2011).

216. *See* Ahmed Azam, *Ex-programmer Is Sentenced to 8 Years for Stealing Code From Goldman*, N.Y. TIMES, Mar. 19, 2011, at B2.

217. *See* Nelson D. Schwartz, *Facing Threat From WikiLeaks, a Bank Plays Defense*, N.Y. TIMES, Jan. 3, 2011, at B1.

218. *See* John H. Cushman, Jr., *Guarding the Numbers*, N.Y. TIMES, July 17, 2012, at B1.

219. *See* DAVE MARCUS & RYAN SHERSTOBITOFF, MCAFEE & GUARDIAN ANALYTICS, DISSECTING OPERATION HIGH ROLLER 3 (2012), *available at* http://www.mcafee.com/us/resources/reports/rp-operation-high-roller.pdf; Nicole Perlroth, *Attacks on 6 Banks Frustrate Customers*, N.Y. TIMES, Oct. 1, 2012, at B1; Nicole Perlroth & Quentin Hardy, *Bank Hacks Were Work of Iranians, Officials Say*, N.Y. TIMES, Jan. 9, 2013, at B1.

accounts, cybercrime costs the United States an estimated $400 billion annually.[220] Because of the borderless and anonymous nature of cyberspace, cyberattacks are difficult to trace ex post and difficult to prevent ex ante.[221]

All industries are susceptible to cybercrimes and cyberthreats, but the modern financial industry is particularly vulnerable because of its heavy reliance on computerized systems to store information, analyze data, and allocate capital.[222] The modern financial industry is essentially a high-tech industry in which computer codes and computer networks are at the heart of its very existence. This vulnerability is magnified by the fact that once established, many of these systems are self-executing and devoid of human control. Attackers could trigger a crash by injecting the system with bad data and fake trades.[223] The impact of such a cyberattack on the financial system would be economically crippling and confidence shattering.[224]

In the age of cy-fi, firms and governments have to safeguard their interests from an expanding cast of elusive antagonists including their employees, competitors, rogue hackers, and even other nation-states.[225] A recent study indicated that cyberattacks—that may have been state sponsored—were specifically targeting American corporations.[226] Given the importance of the American financial industry, cyberattacks on our financial institutions make much strategic sense for those who seek to harm American interests.

220. Sean S. Costigan, *Terrorists and the Internet: Crashing or Cashing In?*, *in* TERRORNOMICS 113, 117 (Sean S. Costigan & David Gold eds., 2007).

221. *See, e.g.*, BOWDEN, *supra* note 215, at 48–52 (describing challenges in creating a cybersecurity defense system); Gross, *supra* note 214 ("Because virtual attacks can be routed through computer servers anywhere in the world, it is almost impossible to attribute any hack with total certainty.").

222. *See* Michael Riley & Ashlee Vance, *The Code War*, BUS. WK., July 25, 2011, at 51, 52.

223. *See id.* at 56 ("Computer-security specialists warn that the automated, high-frequency trading systems now prevalent on Wall Street would be prime targets in a cyber war. Attackers could cause a panic by injecting the systems with streams of bad data and fake trades."); FIN. STABILITY OVERSIGHT COUNCIL, 2012 ANNUAL REPORT 136–37 (2012) (acknowledging the emerging threat of cyberattacks on automated trading programs).

224. *See* JOE KLEIN, THE NATURAL: THE MISUNDERSTOOD PRESIDENCY OF BILL CLINTON 190 (2002) ("[Following September 11, 2001,] the Treasuries Secretaries Robert Rubin and Lawrence Summers opposed cyber-warfare on grounds that it may threaten the stability of the international financial system.").

225. *See* BOWDEN, *supra* note 215, at 48 ("Today the most serious computer predators are funded by rich criminal syndicates and even nation-states, and their goals are far more ambitious."); INTELLIGENCE & NAT'L SEC. ALLIANCE (INSA), CYBER INTELLIGENCE: SETTING THE LANDSCAPE FOR AN EMERGING DISCIPLINE 7–9 (2011); PATTERSON, *supra* note 67, at 116 (discussing a hedge fund's fears of potential misappropriation of trade secrets by former employees); *cf.* SEC v. Dorozhko, 574 F.3d 42, 44–51 (2d Cir. 2009) (involving hackers who traded on illicitly acquired material, nonpublic information).

226. *See* DMITRI ALPEROVITCH, MCAFEE, REVEALED: OPERATION SHADY RAT 7–9 (2011) (providing a complete list of the targeted countries), *available at* http://www.mcafee.com/us/resources/white-papers/wp-operation-shady-rat.pdf; Barboza & Drew, *supra* note 211.

While it may appear far-fetched to believe that the prominent theater of future warfare is cyberspace,[227] reality is not too far off.[228] In 2007, during a dispute with Russia, Estonia experienced a massive cyberattack on its cyberinfrastructure, which some attributed to Russia, making it difficult for Estonians to engage in any online activities.[229] A few years later in 2011, it was widely believed that coordinated cyberattacks by Israel and the United States caused a serious blow to Iran's nuclear weapons program.[230] The initial weapon of choice in a 2011 attack was Stuxnet, a computer virus superworm, deemed by some as "the most sophisticated cyberweapon ever deployed."[231] A year later, it was reported that another computer super virus called the Flame—which some again attributed to the United States and Israel—was "afflicting computers in Iran and the Middle East."[232] That same year, the U.S. Secretary of Defense, Leon Panetta, warned that the United States was facing a potential "cyber–Pearl Harbor."[233] Furthermore, experts suspect that China has long engaged in cyberwarfare and cyberespionage against American interests and businesses for many years.[234]

In response to the emerging threat of cyberwarfare, the federal government has taken notice. In 2011, recognizing the burgeoning importance of cybersecurity to commerce, the SEC for the first time issued disclosure guidance relating to cybersecurity as a business risk that could materially affect firms.[235] That same year, the White House and the Department of Defense published a number of

227. *See, e.g.*, Thomas Rid, *Think Again: Cyberwar*, FOREIGN POL'Y, Mar.–Apr. 2012, at 80, 80 ("Cyberwar is still more hype than hazard.").

228. *See* RICHARD A. CLARKE & ROBERT A. KNAKE, CYBER WAR: THE NEXT THREAT TO NATIONAL SECURITY AND WHAT TO DO ABOUT IT, at x–xii, 69–71 (2010); Andrea Stone, *Cyberspace Is the Next Battlefield: U.S., Foreign Forces Prepare for Conflict Unlike Any Before*, USA TODAY, June 19, 2001, at 1A (reporting on military measures in connection with an anticipated rise in "informational warfare"); Misha Glenny, *A Weapon We Can't Control*, N.Y. TIMES, June 25, 2012, at A19 (commenting on the unforeseeable and unintended dangers of cyberweapons).

229. *See* Mark Landler & John Markoff, *After Computer Siege in Estonia, War Fears Turn to Cyberspace*, N.Y. TIMES, May 29, 2007, at A1.

230. *See* William J. Broad et al., *Israeli Tests Called Crucial in Iran Nuclear Setback*, N.Y. TIMES, Jan. 16, 2011, at A1.

231. *Id.*

232. Andrew E. Kramer & Nicole Perlroth, *Expert Issues a Cyberwar Warning*, N.Y. TIMES, June 3, 2012, at B1.

233. Elisabeth Bumiller & Thom Shanker, *Panetta Warns of Dire Threat of Cyberattack*, N.Y. TIMES, Oct. 12, 2012, at A1.

234. *See* Barboza & Drew, *supra* note 211 ("Many security experts say the Chinese government has built up a sophisticated cyberwarfare unit and that the government might be partnering with professional hackers."); Michael Riley & Ashlee Vance, *Inside the Chinese Boom in Corporate Espionage*, BUS. WK., Mar. 19, 2012, at 78–84.

235. *CF Disclosure Guidance: Topic No. 2: Cybersecurity*, SEC.GOV (Oct. 13, 2011), http://sec.gov/divisions/corpfin/guidance/cfguidance-topic2.htm.

white papers,[236] including the latter's first strategic statement for cyberspace.[237] Additionally, the Pentagon has aggressively accelerated its cyberwarfare programs in recent years.[238] As of 2012, the Air Force alone spends approximately $4 billion annually on its cyberprograms.[239]

While the perils posed by cybercrimes and cyberthreats are many, serious, and real,[240] they should not be overblown, nor should they lead to rash overreactions.[241] Attempts at cybersecurity should not inhibit the "generativity" of information technology and finance.[242] Cybersecurity prevention and protection efforts are undoubtedly difficult,[243] but they must also be sensible, thoughtful, and not obstruct the promise and progress of cyborg finance.[244] This will, undoubtedly, be a difficult endeavor, given the amorphous and evolving nature of cyberspace, its technologies, and its threats. However, it is an endeavor that must be pursued vigorously because, ultimately, technological advances in finance may hold more promise than threat in the future.

IV. EMERGING IMPLICATIONS AND CONSEQUENCES

The transformation of modern finance into cyborg finance contains numerous implications and consequences. Some have emerged, others are emerging, and many remain unknown. That said, three meaningful, budding, and underappreciated outgrowths of this ongoing financial transformation relate to (1) systemic risks involving increased financial speed and connectivity, (2) law's capacity

236. *See, e.g.*, THE WHITE HOUSE, INTERNATIONAL STRATEGY FOR CYBERSPACE: PROSPERITY, SECURITY, AND OPENNESS IN A NETWORKED WORLD (2011); DEP'T OF DEF., CYBERSPACE POLICY REPORT: A REPORT TO CONGRESS PURSUANT TO THE NATIONAL DEFENSE AUTHORIZATION ACT FOR FISCAL YEAR 2011, SECTION 934 (2011).

237. DEP'T OF DEF., STRATEGY FOR OPERATING IN CYBERSPACE (2011).

238. Julian E. Barnes, *Pentagon Digs in on Cyberwar Front*, WALL ST. J., July 6, 2012, at A4.

239. *Id.*

240. *See, e.g.*, NAT'L RESEARCH COUNCIL & NAT'L ACAD. OF ENG'G, TOWARD A SAFER AND MORE SECURE CYBERSPACE 49–50 (Seymour E. Goodman & Herbert S. Lin eds., 2007) (warning against the possibility of a "digital Pearl Harbor").

241. *See, e.g.*, Paul Ohm, *The Myth of the Superuser: Fear, Risk, and Harm Online*, 41 U.C. DAVIS L. REV. 1327, 1348–62 (2008) (discussing the dangers of overreacting to online threats).

242. *See* Zittrain, *supra* note 20, at 1980–81; *see also* Richard A. Booth, *The Uncertain Case for Regulating Program Trading*, 1994 COLUM. BUS. L. REV. 1, 54–55 (arguing against regulations that would stifle the benefits of program trading during its nascent period).

243. *See* Derek E. Bambauer, *Conundrum*, 96 MINN. L. REV. 584, 598–603 (2011) (describing the various challenges of cybersecurity efforts).

244. *See* LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD 8–16 (2001) (arguing that misguided regulations can limit the potential of new technology); Zittrain, *supra* note 20, at 1997–2000.

to adapt itself to this transformation, and (3) critical resource asymmetries within the financial industry spurred by this transformation.

A. Of Speed and Links

Modern finance has produced great opportunities for wealth creation and societal progress by providing capital and financing for the new developments of businesses and governments, but it has also produced profound challenges for economic stability and social welfare in the form of new systemic risks.[245] Regulators have paid much attention to the systemic risk of "too big to fail" in recent years, and rightfully so.[246] "Too big to fail" describes a deleterious systemic risk of modern finance in which financial institutions grow too large and too important to the economy for them to falter, such that the government has to rescue these private businesses with public funds.[247] As modern finance transforms into cyborg finance, two new deleterious systemic risks have arisen: one related to velocity, which this Article terms "too fast to save," and the other related to connectivity, which this Article terms "too linked to fail."

1. Too Fast to Save

Cyborg finance operates at velocities previously unattainable and poses perils previously unimaginable.[248] Billions of dollars move across borders and oceans through cables and spectra at the speed of milliseconds.[249] Mere seconds are too

245. *See, e.g.*, Amir E. Khandani et al., *Systemic Risk and the Refinancing Ratchet Effect* 38 (MIT Sloan Sch. of Mgmt. Research Paper No. 4750-09, 2009) ("[S]ystemic risk . . . arises when large financial losses affect important economic entities that are unprepared for and unable to withstand such losses, causing a cascade of failures and widespread loss of confidence.").

246. *See, e.g.*, LEVIN-COBURN REPORT, *supra* note 147, at 15–17.

247. *See, e.g.*, *id.* (reporting on the rise and dangers of too-big-to-fail U.S. financial institutions); ANDREW ROSS SORKIN, TOO BIG TO FAIL: THE INSIDE STORY OF HOW WALL STREET AND WASHINGTON FOUGHT TO SAVE THE FINANCIAL SYSTEM FROM CRISIS—AND THEMSELVES 538–39 (2009) (opining on the difficulties in solving the problem presented by "too big to fail" institutions); Brendan Greeley, *The $120 Billion Not-Bailout Bailout*, BUS. WK., July 9, 2012, at 11, 11 ("Five banks—JPMorgan, Bank of America, Citigroup, Wells Fargo, and Goldman Sachs—held more than $8.5 trillion in assets at the end of 2011, equal to 56 percent of the U.S. economy, according to the Federal Reserve.").

248. *See, e.g.*, Concept Release on Equity Market Structure, Exchange Act Release No. 34–61,358, 75 Fed. Reg. 3594, 3605 (proposed Jan. 21, 2010) (to be codified at 17 C.F.R. pt. 242) (noting the emphasis on accelerating velocities in modern equity markets); Duhigg, *supra* note 76.

249. *See* Fabozzi et al., *supra* note 56, at 8.

slow, and cy-fi does not intend to slow down.[250] In 2012, work began on a "$300 million transatlantic fiber-optic line called Project Express" aimed at reducing trade execution times by a mere five milliseconds.[251] The new frontiers of financial speed are nanoseconds (billionths of a second) and picoseconds (trillionths of a second).[252] Such velocities can create problems of "too fast to save" relating to the underlying components of cyborg finance: computers and humans.

In terms of computers, the accelerated speed of transactions in and of itself can increase the error rate and the utilization of bad data by automated computer programs before remedial measures can be taken.[253] Popular author Tom Clancy described a nightmare scenario in his novel *Debt of Honor*, in which falsified data are intentionally injected into the securities markets causing global financial chaos as automated programs instantaneously reacted to the bad information before it could be detected.[254] While that nightmare scenario, to the best of our knowledge, has not yet materialized, smaller malfeasances may have already occurred.[255] During the financial crisis of 2008, many blamed short sellers for injecting misinformation into the market to create profitable positions for themselves by driving down the price of financial stocks with false rumors during a time of distress.[256] The problems surrounding automated programs reacting to bad data likely will persist and grow as reliance on black box programs increases in finance.

Beyond computers, humans can also trigger serious problems that are "too fast to save." Today, a single rogue trader or a well-intentioned but misinformed trader can now cause catastrophic damage to a financial institution or the entire sys-

250. *See, e.g.*, Bowley, *supra* note 157 ("Almost each week, it seems, one exchange or another claims a new record: Nasdaq, for example, says its time for an average order 'round trip' is 98 microseconds—a mind-numbing speed equal to 98 millionths of a second.").

251. Matthew Philips, *Trading at the Speed of Light*, BUS. WK., Apr. 2, 2012, at 46.

252. *See* David Schneider, *Trading at the Speed of Light*, IEEE SPECTRUM, Oct. 2011, at 11–12; A.D. Wissner-Gross & C.E. Freer, *Relativistic Statistical Arbitrage*, 82 PHYSICAL REV. E 56, 104-1 (2010) (studying arbitrage opportunities as trading approaches the speed of light); Haldane, *supra* note 14, at 5.

253. *See* THOMAS NEAL FALKENBERRY, HIGH FREQUENCY DATA FILTERING: A REVIEW OF THE ISSUES ASSOCIATED WITH MAINTAINING AND CLEANING A HIGH FREQUENCY FINANCIAL DATABASE (2002), *available at* http://www.tickdata.com/pdf/Tick_Data_Filtering_White_Paper.pdf; Fabozzi et al., *supra* note 56, at 11.

254. *See* TOM CLANCY, DEBT OF HONOR 294–312 (1994). While this scenario may appear far-fetched, in the same novel Mr. Clancy also envisioned enemies of America intentionally crashing jets into strategically important buildings, which became a reality on September 11, 2001. *See id.* at 760–64.

255. *See* Bowley, *supra* note 3.

256. *See, e.g.*, HOWARD DAVIES, THE FINANCIAL CRISIS: WHO IS TO BLAME? 171 (2010) ("[T]hose firms which suffered very sharp falls in their stock prices and, in some cases, went out of business identified short-selling as a powerful contributor to their problems."); SORKIN, *supra* note 247, at 14–15, 81–82, 201; SEBASTIAN P. WERNER, SHORT SELLING ACTIVITIES AND CONVERTIBLE BOND ARBITRAGE: EMPIRICAL EVIDENCE FROM THE NEW YORK STOCK EXCHANGE 13 (2010) ("Short sellers had been largely blamed for the tumble in stock prices of financial institutions . . . .").

tem with just a few clicks before anyone can intervene. In 2008, a trader at the French investment bank Societe Generale nearly destroyed the storied firm with $69 billion in unauthorized positions.[257] The unwinding of those trades resulted in a $7 billion loss.[258] In 2011, another trader at the Swiss investment bank UBS caused losses of $2.3 billion.[259] While such trades and bad acts could have occurred in the analog ages of finance, they would likely have taken much longer to execute and required more clearance by more individuals prior to execution. Today, many checks and balances have been sacrificed for velocity and efficiency because of cy-fi's insistence on speed. This insistence has made it more difficult to catch and prevent such bad acts and bad actors.

While some argue that certain modern financial products are "unsafe at any rate,"[260] the speed at which many transactions are being executed suggests that some products are simply unsafe at high speeds.[261] The emphasis on speed in cyborg finance has led to more automated trading platforms, more reactive executions, less reflective deliberation, and less opportunity for safeguarding:

> For the first time in financial history, machines can execute trades far faster than humans can intervene. That gap is set to widen. In some respects the 2010 Flash Crash and the 1987 stock market crash have common genes—algorithmic amplification of stress. But they differ in one critical respect. Regulatory intervention could feasibly have forestalled the 1987 crash. By the time of the Flash Crash, regulators might have blinked—literally, blinked—and missed their chance.[262]

Following the Flash Crash, the national exchanges proposed rules for more stringent circuit breakers in the event of accelerated market decreases.[263] These enhanced circuit breakers were intended to serve as speed bumps for a market in descent. While they may prove to be helpful, they nonetheless do not fully address the problems posed by "too fast to save," as trading in less regulated dark pools and electronic markets without circuit breakers will continue to grow,[264] and hyperspeed trades with detrimental consequences may not timely trigger the proposed breakers.

257. Nicola Clark, *Rogue Trader at Société Générale Gets 3 Years*, N.Y. TIMES, Oct. 6, 2010, at B1.
258. *Id.*
259. *See* Julia Werdigier, *Revealing Details of Rogue Trades, UBS Raises Loss Estimate to $2.3 Billion*, N.Y. TIMES, Sept. 19, 2011, at B3.
260. Elizabeth Warren, *Unsafe at Any Rate*, DEMOCRACY J., Summer 2007, at 8.
261. Frank Partnoy, *Don't Blink: Snap Decisions and Securities Regulation*, 77 BROOK. L. REV. 151, 155 (2011) (espousing the virtues of slower speeds in financial markets).
262. Haldane, *supra* note 14, at 15.
263. *See, e.g.*, Notice of Filing of Proposed Rule Change to Update Rule 6121 and Amend Rule 6440, Exchange Act Release No. 34-65,430, 76 Fed. Reg. 61,429 (Oct. 4, 2011).
264. It should likely not be shocking to industry insiders and learned observers if in the near future dark pools and electronic markets become the dominant space of trading for all investors.

The future speed of finance, undoubtedly, will become faster, and too fast to save will be one of the greatest regulatory challenges for regulators and policymakers in the coming years.

2. Too Linked to Fail

Modern finance exists as an expansive, interconnected network that crosses institutions, industries, states, and products—creating a systemic problem that this Article terms "too linked to fail." In the age of cy-fi, commercial banks, investment banks, hedge funds, mutual funds, pension funds, private equity firms, nation-states, wealthy traders, and a host of other players and institutions are all bounded together as part of this growing financial web of mutuality. And within the mesh of that financial web are financial products that have also grown more linked to one another.

The connectedness of cyborg finance has enhanced the mobility of capital and dispersed certain risks.[265] Despite its many positive externalities, however, cyborg finance's connectedness has also created new challenges and magnified old ones.[266] Whereas in eras past the failure of one financial institution, one sovereign treasury, or one financial product was largely and better contained by geography, cyborg finance has obliterated all borders and boundaries. The financial problems of one nation-state can now affect all nation-states like never before.[267] The demise of one financial institution can now affect many financial institutions.[268] The mistake of one trader can now cause catastrophic consequences for entire market segments. The volatility of one financial product can now ripple across many

265. *See, e.g.*, Jamie Morgan, *How Reality Ate Itself: Orthodoxy, Economy and Trust*, *in* REAL WORLD ECONOMICS: A POST-AUTISTIC ECONOMICS READER 105, 107 (Edward Fullbrook ed., 2006) (discussing policy commentary on opportunities for financial risk dispersion as a result of new technology).

266. *See* Serritella, *supra* note 73, at 437 (noting the potential perils resulting from "the interconnectivity of financial markets and their participants, as well as increased interconnections between securities and their derivatives").

267. *See, e.g.*, Robert W. Kolb, *Introduction*, *in* FINANCIAL CONTAGION: THE VIRAL THREAT TO THE WEALTH OF NATIONS, at xiii (Robert W. Kolb ed., 2011) ("Similarly, financial distress in one nation can affect another . . . .").

268. ROBERT W. KOLB, LESSONS FROM THE FINANCIAL CRISIS: CAUSES, CONSEQUENCES, AND OUR ECONOMIC FUTURE 128 (2010) ("The failure of just one large financial institution might lead to the failure of one or more other institutions that would then spread to yet more financial institutions in a contagion that was feared might end in the collapse of the entire financial system.").

financial products.[269] This may be the case not only for too-big-to-fail firms, which have received most of the regulatory attention,[270] but also for smaller firms, financial intermediaries, and financial products that are simply "too linked to fail" because their failure may unravel other institutions that are bound to it as part of the modern financial network. In 1998, Long-Term Capital Management, a hedge fund located in Greenwich, Connecticut, with less than two hundred employees caused serious panic on Wall Street when several of its positions turned sour as a result of the financial crises in Asia and Russia.[271] To prevent significant losses for several investment banks and to stem wider panic on Wall Street, the Federal Reserve orchestrated a $3.6 billion industry-led bailout for Long-Term Capital Management.[272]

More than a decade later, investors continue to witness the mutating problems of "too linked to fail" with greater magnitude as financial problems and financial products of individual institutions and sovereign states, oceans away, affect the U.S. financial system, and vice versa. The demise of Bear Stearns and the bankruptcy of Lehman Brothers in 2008[273] sent destructive waves through the global financial system.[274] The potential failure in 2008 of credit default swaps conceived by an American International Group (AIG) subsidiary in London and bought by all the major investment banks was at the crux of the financial crisis.[275] In 2011 and 2012, problems relating to the sovereign debt of Greece, Italy, and Spain created significant economic stresses for America, China, Europe, and much of the developed world.[276] In 1944, President Franklin D. Roosevelt made the following statement that rings truer today than it did then: "Economic diseases are highly

269. *See* Kathryn Judge, *Fragmentation Nodes: A Study in Financial Innovation, Complexity, and Systemic Risk*, 64 STAN. L. REV. 657, 659 (2012) (arguing that new financial products born of the shadow banking system create new sources of systemic risk).

270. *See, e.g.*, Authority to Designate Financial Market Utilities as Systemically Important, 76 Fed. Reg. 44,763, 44,765 (July 27, 2011) (codified at 12 C.F.R. pt. 1320 (2012)) (correlating systemic importance largely based on monetary value).

271. *See* ROGER LOWENSTEIN, WHEN GENIUS FAILED: THE RISE AND FALL OF LONG-TERM CAPITAL MANAGEMENT, at xviii–xx (2000).

272. *See* FRANK PARTNOY, INFECTIOUS GREED: HOW DECEIT AND RISK CORRUPTED THE FINANCIAL MARKETS 261 (2003).

273. *See* Andrew Ross Sorkin, *Lehman Files for Bankruptcy; Merrill Is Sold*, N.Y. TIMES, Sept. 15, 2008, at A1.

274. *See* Bryan Burrough, *Bringing Down Bear Stearns*, VANITY FAIR, Aug. 2008, http://www.vanityfair.com/politics/features/2008/08/bear_stearns200808.

275. SORKIN, *supra* note 247, at 394–400.

276. *See* Clive Cook, *Who Lost the Euro*, BUS. WK., May 28, 2012, at 9, 10–12; Peter Coy, *Greece: Why the Beast Is Back*, BUS. WK., May 30, 2011, at 10, 10–11; Carol Matlack & Jeff Black, *Exit the Euro Zone? Think Before You Leap*, BUS. WK., Sept. 19, 2011, at 15.

communicable. It follows, therefore, that the economic health of every country is a proper matter of concern to all its neighbors, near and distant."[277]

Like a vast alignment of dominoes of all shapes and sizes, the demise of one institution or one instrument can send ripples through all and cause many to falter and many to fall.[278] These effects are compounded by a factor of many multiples when players engage in similar strategies and algorithms.[279] This mass mimicry can lead to a "crowded trade" phenomenon in which a few trades lead to a cascade of trades as spillover effects and feedback loops effectuated by automated programs that permeate the financial system.[280] Because of the growing number of linked participants and linked products within the modern financial network, these ripples could become more frequent, thereby leading to increased volatility in the marketplace.[281]

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The combination of enhanced velocity and connectivity in cyborg finance poses profound dangers for investors and society as more financial actors and actions become too fast to save and too linked to fail. Many experts have predicted that as computerized trading expands deeper into foreign markets the next financial crash could be quicker and more pervasive than any previously witnessed.[282] Harnessing the power of cy-fi's speed and linkage while managing its risks will be a critical challenge for financial regulators in the coming years.[283]

277. HANS KELSEN, COLLECTIVE SECURITY UNDER INTERNATIONAL LAW 257 (Lawbook Exchange Ltd. 2001) (1954) (quoting Franklin D. Roosevelt, Address to the Monetary and Fin. Conference, Washington, D.C. (June 29, 1944)).

278. Bernard S. Donefer, *Algos Gone Wild: Risk in the World of Automated Trading Strategies*, J. TRADING, Spring 2010, at 31.

279. *See* Concept Release on Equity Market Structure, Exchange Act Release No. 34-61,358, 75 Fed. Reg. 3594, 3611 (proposed Jan. 21, 2010) (to be codified at 17 C.F.R. pt. 242) ("[M]any proprietary firms potentially could engage in similar or connected trading strategies that, if such strategies generated significant losses at the same time, could cause many proprietary firms to become financially distressed and lead to large fluctuations in market prices.").

280. *See* BROWN, *supra* note 59, at 7.

281. *See* PATTERSON, *supra* note 65, at 9 (discussing the financial dangers of "a vicious self-reinforcing feedback loop"); Louise Story & Graham Bowley, *Market Swings Are Becoming New Standard*, N.Y. TIMES, Sept. 12, 2011, at A1.

282. *See, e.g.*, Kaufman & Levin, *supra* note 202; Jim McTague, *Next Danger: "Splash Crash,"* BARRON'S (May 21, 2011), http://online.barrons.com/article/SB50001424052970203869804576327391603772726.html (reporting on the possibility of a global "widespread and catastrophic" crash across asset classes and markets caused by high-speed trading computers).

283. Jason Zweig, *Could Computers Protect the Market From Computers*, WALL ST. J., May 26, 2012, at B1.

B. Of Laws and Rules

Law constantly plays tortoise to finance's hare. Technological and market innovations in finance often bound ahead of laws and regulations.[284] Developments in finance over the last three decades exemplify this Aesopian dynamic as financial innovation outpaced the rules and laws designed to govern financial markets.[285] In some instances, innovations were designed to skirt existing regulations and regulators.[286] In other instances, the reactive, yet tedious slog of rulemaking was simply no match for the swiftness of financial and technological innovation.[287] And in some instances, regulations inadvertently sowed the seeds of financial risk and peril.[288] The computerization of finance over the last few decades has enhanced the specter of law's inadequacy over financial innovation, which can be traced to matters of jurisdiction and origination, among others.[289]

On matters of jurisdiction, law is bounded by sovereign and regulatory borders,[290] but cyborg finance knows no borders.[291] Technology has made the in-

284. *See* INSA, *supra* note 225, at 6 ("National and international laws, regulations, and enforcement are still struggling to catch up to cyber activities worldwide."); Lyria Bennett Moses, *Recurring Dilemmas: The Law's Race to Keep Up With Technological Change*, 2007 U. ILL. J.L. TECH. & POL'Y 239, 239–41.

285. *See* Stephen J. Choi & Andrew T. Guzman, *National Laws, International Money: Regulation in a Global Capital Market*, 65 FORDHAM L. REV. 1855, 1856–57 (1997) (discussing how globalization has increased the burden of capital market regulators to maintain adequate disclosure, antifraud, and antimanipulation rules); Charles K. Whitehead, *Reframing Financial Regulation*, 90 B.U. L. REV. 1, 2–5 (2010) (noting the lack of regulatory innovation in response to financial innovation); Tara Bhupathi, Note, *Technology's Latest Market Manipulator? High Frequency Trading: The Strategies, Tools, Risks, and Responses*, 11 N.C. J.L. & TECH. 377, 377–78 (2010) ("Rapid technological advances have . . . caus[ed] the legal world to either choose to judicially adapt old laws and policies to the new digital situations or to legislatively create new doctrines to deal with unforeseen challenges.").

286. *See, e.g.*, GILLIAN TETT, FOOL'S GOLD: HOW THE BOLD DREAM OF A SMALL TRIBE AT J.P. MORGAN WAS CORRUPTED BY WALL STREET GREED AND UNLEASHED A CATASTROPHE 39–47 (2009) (discussing how the derivatives markets grew by working around existing regulations); Charles W. Calomiris, *Financial Innovation, Regulation, and Reform*, 29 CATO J. 65, 65 (2009) (explaining how financial innovation is often born out of "sidestepping regulatory restrictions").

287. *See, e.g.*, Claudio Gonzalez-Vega, *Nonbank Institutions in Financial Sector Reform*, *in* SEQUENCING?: FINANCIAL STRATEGIES FOR DEVELOPING COUNTRIES 127, 133 (Alison Harwood & Bruce L.R. Smith eds., 1997) (discussing how swift financial innovation is frequently met with slow regulation).

288. *See, e.g.*, Calomiris, *supra* note 286, at 67–68 ("Risk-taking was driven by government policies; government's *actions* were the root problem, not government *inaction*.").

289. *See, e.g.*, Moses, *supra* note 284, at 239–40 (chronicling incidents in which new technology generated new legal questions).

290. *See* Morrison, 130 S. Ct. at 2885 ("Like the United States, foreign countries regulate their domestic securities exchanges and securities transactions occurring within their territorial jurisdiction.").

291. *See* JACK GOLDSMITH & TIM WU, WHO CONTROLS THE INTERNET?: ILLUSIONS OF A BORDERLESS WORLD, at vii–viii (2006); Johnson & Post, *supra* note 85, at 1367 (discussing the need for new legal conceptions of jurisdiction with the emergence of the internet); Lawrence Lessig, *The Path of Cyberlaw*, 104 YALE L.J. 1743, 1743–45 (1995). *Contra* Allan R. Stein, *The*

vestment market a global market with little regard for the jurisdiction of countries and regulators.[292] In the age of cy-fi, boundaries matter little to financiers but matter greatly to regulators.[293] This territorial dissonance between regulators and the regulated has a large impact on financial governance. Because of this territorial dissonance, financial players are in some cases governed by a multiplicity of uncoordinated regulators spanning seas and states with rules that sometimes overlap and conflict.[294] In other cases, financial players simply operate in a regulatory penumbra with little or no governance.[295]

This jurisdictionally based patchwork of regulations and regulators allows financial players to engage in dangerous games of regulatory arbitrage within and across countries.[296] Various regulators with complex sets of rules, for example, govern investment banking operations in the United States and the United Kingdom.[297] Credit-default-swap operations, on the other hand, existed with little to no meaningful government regulation and oversight for many years.[298] In the lead up to

Unexceptional Problem of Jurisdiction in Cyberspace, 32 INT'L LAW. 1167, 1191 (1998) (arguing that jurisdictional issues relating to cyberspace are "not uniquely problematic").

292. *See* BROWN, *supra* note 59, at 149 ("Advancements in electronic trading technology have rapidly accelerated the globalization of equity markets.").

293. *See* EEOC v. Arabian Am. Oil Co., 499 U.S. 244, 248 (1991) ("It is a longstanding principle of American law 'that legislation of Congress, unless a contrary intent appears, is meant to apply only within the territorial jurisdiction of the United States.'" (quoting Foley Bros., Inc. v. Filardo, 336 U.S. 281, 285 (1949))).

294. *See Morrison*, 130 S. Ct. at 2885 ("And the [financial] regulation of other countries often differs from ours as to what constitutes fraud, what disclosures must be made, what damages are recoverable, what discovery is available in litigation, what individual actions may be joined in a single suit, what attorney's fees are recoverable, and many other matters.").

295. *See, e.g.*, ALEXANDER DAVIDSON, HOW THE GLOBAL FINANCIAL MARKETS REALLY WORK: THE DEFINITIVE GUIDE TO UNDERSTANDING INTERNATIONAL INVESTMENT AND MONEY FLOWS 17–19 (2009) (discussing shadow banking and the less regulated areas of finance); Robert A. Eisenbeis, *Agency Problems and Goal Conflicts in Achieving Financial Stability: The Case of the EMU*, *in* THE STRUCTURE OF FINANCIAL REGULATION 232, 235 (David G. Mayes & Geoffrey E. Wood eds., 2007) (discussing conflicting state and federal financial regulation); James J. Park, *The Competing Paradigms of Securities Regulation*, 57 DUKE L.J. 625, 665 (2007) (discussing how regulatory competition creates regulatory-gamesmanship opportunities for industry players).

296. *See* Victor Fleischer, *Regulatory Arbitrage*, 89 TEX. L. REV. 227, 229 (2010) ("Regulatory arbitrage exploits the gap between the economic substance of a transaction and its legal or regulatory treatment, taking advantage of the legal system's intrinsically limited ability to attach formal labels that track the economics of transactions with sufficient precision."); Frank Partnoy, *Financial Derivatives and the Costs of Regulatory Arbitrage*, 22 J. CORP. L. 211, 227 (1997) ("Regulatory arbitrage consists of those financial transactions designed specifically to reduce costs or capture profit opportunities created by differential regulations or laws.").

297. *See* Jack Ewing, *Global Rules for Banks Draw Near*, N.Y. TIMES, Sept. 11, 2010, at B1 (discussing the complexities in creating banking rules and standards across different sovereignties).

298. *See* James E. Kelly, *Transparency and Bank Supervision*, 73 ALB. L. REV. 421, 424 (2010) (highlighting regulatory gaps relating to "hedge funds; derivatives markets; off balance sheet entities; the credit ratings agencies; firms' disclosure of risk, valuation, . . . compensation policies; [and] securitized and structured products"); Interview by Michael Kirk With Brooksley Born, CFTC Chair 1996–1999

the financial crisis in 2008, credit default swaps, a crucial financial product used by all major investment banks, were largely unregulated because the industry created and situated itself within a regulatory gap.[299]

As financial players continue to innovate with little regard for sovereign and regulatory borders, lawmakers and regulators must continue to examine whether the current jurisdictionally based apparatus is adequate or whether a new paradigm is necessary.[300] This recommendation for more thoughtful examination is not an endorsement of a supercoordinated global regulator that obliterates borders and sovereignties because friction-free coordinated governance also contains serious risks.[301] Rather, this recommendation is a call for thinking anew about harmonizing financial regulation that moves beyond traditional spaces bounded by anachronistic barriers of jurisdiction.

On matters of origination, law operates in a structure built on precedent and rootedness,[302] but cyborg finance operates in a structure built on novelty and change.[303] Because of this dichotomy, new financial problems and grievances in cyfi often lack elegant legal and regulatory solutions and remedies. Financial regulations often do not organically innovate; instead, they are the children of busts, scares, and scandals (and they become orphans in boom times).[304] The Great

(Aug. 28, 2009) (PBS television broadcast Oct. 20, 2009), *available at* http://www.pbs.org/wgbh/pages/frontline/warning/interviews/born.html (discussing the lack of attention paid to credit default swaps and other derivatives prior to the financial crisis).

299. Kelly, *supra* note 298; Frank Partnoy & David A. Skeel, Jr., *The Promise and Perils of Credit Derivatives*, 75 U. CIN. L. REV. 1019, 1046–47 (2007); Whitehead, *supra* note 285, at 34.

300. *See, e.g.*, Choi & Guzman, *supra* note 15, at 904–08; Fox, *supra* note 15, at 2501–03; Orin S. Kerr, *Applying the Fourth Amendment to the Internet: A General Approach*, 62 STAN. L. REV. 1005, 1007–10 (2010); John Seo, *Everything Will Be Too Big to Fail*, FOREIGN POL'Y, Sept./Oct. 2011, at 74, 75 (discussing the need for global regulations to prevent financial catastrophes in the future); Bart Chilton, Comm'r, Commodities Futures Trading Comm'n, Speech to Goldman Sachs Global Commodity Conference: Stopping Stammering: Overcoming Obstacles in Financial Regulatory Reform (Mar. 28, 2011), *available at* http://www.cftc.gov/pressroom/speechestestimony/opachilton-43.html (calling for more international harmonization in regulating derivatives).

301. *See* Charles K. Whitehead, *Destructive Coordination*, 96 CORNELL L. REV. 323, 326 (2011) ("By promoting coordination, regulations and standards can erode key presumptions underlying financial risk management, reducing its effectiveness and magnifying the systemic impact of a downturn in the financial markets.").

302. *See* Frederick G. Kempin, Jr., *Precedent and Stare Decisis: The Critical Years, 1800 to 1850*, 3 AM. J. LEGAL HIST. 28, 28 (1959) ("The modern doctrine of stare decisis as applied in the United States is a general policy of all courts to adhere to the ratio decidendi of prior cases decided by the highest court in a given jurisdiction . . . .").

303. Lawrence Lessig presciently noted in the infancy of cyberspace that this new space contained changing features that reject old modes of governance. *See* Lawrence Lessig, *Foreword*, 52 STAN. L. REV. 987, 990–95 (2000).

304. *See* Stuart Banner, *What Causes New Securities Regulation? 300 Years of Evidence*, 75 WASH. U. L.Q. 849, 850 (1997) ("[M]ost of the major instances of new securities regulation in the past three hundred years of English and American history have come right after crashes."); Joseph A. Grundfest,

Depression gave birth to the Securities Act of 1933, the Securities Exchange Act of 1934, and the formation of the SEC.[305] The Enron and WorldCom scandals led to the adoption of the Sarbanes-Oxley Act.[306] The financial crisis of 2008 spurred the Dodd-Frank Wall Street Reform and Consumer Protection Act.[307] Following the Flash Crash in 2010, regulators rushed to create new rules to address problems relating to black box trading.[308] In 2011, following years without meaningful regulation,[309] the SEC finally adopted rules to regulate hedge funds, albeit in a limited manner, after their perceived role in the recent financial crisis.[310]

As finance continues to innovate, old policies, old laws, and old regulatory frameworks will grow more inadequate to govern and protect new investors in the age of cy-fi.[311] New questions and challenges will arise: Should regulators place speed limits and fees on high-frequency trading?[312] How should current disclosure requirements adapt to new markets of dark pools driven by Big Data and deep secrecy?[313] How will laws concerning insider trading and securities fraud account for computerized trading platforms dictated by artificial intelligence?[314] Does ar-

Punctuated Equilibria in the Evolution of United States Securities Regulation, 8 STAN. J.L. BUS. & FIN. 1, 1 (2003) ("[E]very dramatic change in the structure of our securities laws has been provoked by a perceived failure in the capital markets that stimulated a regulatory response."). For critiques of recent crisis-driven financial regulation, see Stephen M. Bainbridge, *Dodd-Frank: Quack Federal Corporate Governance Round II*, 95 MINN. L. REV. 1779 (2011); Roberta Romano, *The Sarbanes-Oxley Act and the Making of Quack Corporate Governance*, 114 YALE L.J. 1521 (2005).

305. *See* JACK E. KIGER ET AL., ACCOUNTING PRINCIPLES 409 (1st rev. ed. 1984).

306. *See* Larry E. Ribstein, *Bubble Laws*, 40 HOUS. L. REV. 77, 83, 86 (2004).

307. SKEEL, *supra* note 87, at 43–57.

308. *See* Speech by Troy A. Paredes, Comm'r, SEC: Remarks at the Symposium on Hedge Fund Regulation and Current Developments (June 8, 2011), http://www.sec.gov/news/speech/2011/spch060811tap.htm (remarking on new regulatory proposals following the Flash Crash).

309. *See* Whitehead, *supra* note 285, at 5 ("Although hedge funds grew by 260% between 1999 and 2004 to become a one trillion dollar business, they were largely exempt from regulation under the federal securities and investment advisory laws.").

310. *See* Edward Wyatt, *Rule Allows U.S. a Close Look at Big Hedge Funds*, N.Y. TIMES, Oct. 27, 2011, at B1; Press Release, SEC, SEC Approves Confidential Private Fund Risk Reporting (Oct. 26, 2011), http://sec.gov/news/press/2011/2011-226.htm.

311. Regulating cy-fi may require a pathbreaking governing model. During the infancy of the internet, Lawrence Lessig suggested that cyberspace required cyberlaw, a distinct legal field in which technology itself would serve as a governing apparatus in addition to laws and rules. *See* LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE 19–20 (1999).

312. *See* Nathanial Popper, *As U.S. Discusses Limits on High-Speed Trading Other Nations Act*, N.Y. TIMES, Sept. 27, 2012, at B1; Haldane, *supra* note 14, at 3, 18–19.

313. *See, e.g.*, Henry T.C. Hu, *Too Complex to Depict? Innovation, "Pure Information," and the SEC Disclosure Paradigm*, 90 TEX. L. REV. 1601, 1611–12 (2012) (calling for a new "pure information" model of regulated disclosures); Tom C.W. Lin, *Executive Trade Secrets*, 87 NOTRE DAME L. REV. 911, 919–22 (2012) (describing the current disclosure obligations of public firms).

314. *See, e.g.*, Lawrence B. Solum, *Legal Personhood for Artificial Intelligences*, 70 N.C. L. REV. 1231, 1231–34 (1992) (forecasting legal challenges presented by the emergence of artificial intelligence).

tificial intelligence constitute legal personhood?[315] How will the mens rea element of financial crimes apply when machines act with no mental state?[316] Should financial fiduciary duties evolve to match the evolution of financial operations?[317] What role should financial regulators play in protecting the financial system from cyberthreats?[318] Should securities regulation, which has traditionally focused on protecting long-term investors, expand to protect short-term investors as well?[319] These and other questions will continue to force law to rethink and reimagine its content and purpose in the face of financial innovation.[320]

In Aesop's fable, the tortoise eventually catches up to the hare. In the race between law and finance, the race continues with finance far ahead. In the fable, when the hare was ahead, there were no real consequences. With finance ahead of law, societies have suffered through financial crises costing investors and nation-states trillions of dollars and through psychological crises of confidence with immeasurable economic costs.[321] Law needs to better situate itself at the intersection

315. *See, e.g.*, Ralph D. Clifford, *Intellectual Property in the Era of the Creative Computer Program: Will the True Creator Please Stand Up?*, 71 TUL. L. REV. 1675, 1686 n.73 (1997) (predicting the legal challenges posed by "autonomous and self-aware artificial intelligence"); Solum, *supra* note 314, at 1262 (arguing that artificial intelligence cannot constitute legal personhood).

316. *See, e.g.*, Gabriel Hallevy, *"I, Robot—I, Criminal"—When Science Fiction Becomes Reality: Legal Liability of AI Robots Committing Criminal Offenses*, 22 SYRACUSE SCI. & TECH. L. REP. 1, 9 (2010) (questioning the criminal liability of artificial-intelligence robots); Solum, *supra* note 314, at 1267 (suggesting that machines with artificial intelligence cannot possess intentionality); *cf.* Gary Fields & John R. Emshwiller, *As Federal Crime List Grows, Threshold of Guilt Declines*, WALL ST. J., Sept. 27, 2011, http://online.wsj.com/article/SB10001424053111904060604576570801651620000.html (opining on the decline of mens rea in federal crimes).

317. *See* Andrea M. Matwyshyn, *Imagining the Intangible*, 34 DEL. J. CORP. L. 965, 967 (2009) (proposing new corporate fiduciary duties for an information-driven marketplace).

318. *See, e.g.*, INSA, *supra* note 225, at 3–4 (proposing a public–private partnership to address cyberthreats); *Cyber Crime*, FBI.GOV, http://www.fbi.gov/about-us/investigate/cyber (last visited Nov. 26, 2012).

319. *See* Regulation NMS, 70 Fed. Reg. 37,496, 37,500 (June 29, 2005) ("[W]hen the interests of long-term investors and short-term traders conflict . . . , the Commission believes that its clear responsibility is to uphold the interests of long-term investors. Indeed, the core concern for the welfare of long-term investors . . . was first expressed in the foundation documents of the Exchange Act itself.").

320. Some policymakers, scholars, and commentators have already begun to contemplate such questions, and the author also plans to address in greater detail these inquiries in future scholarship as these questions evolve and ripen with the maturation of cyborg finance. *See* FIN. STABILITY OVERSIGHT COUNCIL, *supra* note 224, at 136–37 (acknowledging the regulatory challenges posed by the expansive and growing electronic trading infrastructure); Choi & Guzman, *supra* note 15, at 904–08; John C. Coffee, Jr. & Hillary A. Sale, *Redesigning the SEC: Does the Treasury Have a Better Idea?*, 95 VA. L. REV. 707, 707–17 (2009); Fox, *supra* note 15, at 2501–03; Whitehead, *supra* note 285, at 6 (advocating for more flexible financial regulations that break away from outdated "fixed categories, intermediaries, business models, or functions").

321. *See, e.g.*, ARNUK & SALUZZI, *supra* note 59, at 1–6 (describing the loss of investor confidence associated with the rise of computerized trading); MICHAEL LEWIS, BOOMERANG: TRAVELS IN THE NEW THIRD WORLD 1–3, 41–45, 83–87, 133–38 (2011) (discussing the catastrophic impact of the 2008 financial crisis on various nations across the world, particularly Germany, Greece, Iceland, Ireland, and the United States).

of technology and finance in order to remain relevant and effective. As a new investor emerges, old rules must be reexamined and reimagined for a new financial landscape.[322] Just as technology and finance adapt and evolve, law "in its eternal youth" ultimately must do the same.[323]

C. Of Resources and Asymmetries

Cyborg finance's reliance on capital-intensive, advanced information technology is creating huge resource asymmetries between government regulators and the regulated industry, and within the industry itself. Both of these asymmetries could have profound effects on finance, law, and beyond.

1. Between Regulators and the Industry

The information technology that is at the heart of cy-fi often requires huge expenditures, and regulating cy-fi also requires huge expenditures as the industry expands, diversifies, and grows more complicated. While competition for profit drives financial firms to invest and innovate in information technology, investments in government regulators lack similar driving forces and are often plagued by political constraints.[324] Financial engineers and analysts can make millions of dollars in the cyborg finance era.[325] Regulators, alternatively, earn a fraction of that income.[326] Financial firms invest billions of dollars in their operations while finan-

322. *See* Aryeh S. Friedman, *Law and the Innovative Process: Preliminary Reflections*, 1986 COLUM. BUS. L. REV. 1, 2 (theorizing on the impact of technological breakthroughs on legal norms); Moses, *supra* note 284, at 265 ("Rules are devised in a particular technological context, with explicit and implicit assumptions as to what is possible. . . . Technological change may render existing rules obsolete or less useful for different reasons . . . .").

323. *See* O.W. Holmes, *The Path of the Law*, 10 HARV. L. REV. 457, 474–75 (1897) (highlighting the necessity of law to adapt itself to novel technology); Samuel D. Warren & Louis D. Brandeis, *The Right to Privacy*, 4 HARV. L. REV. 193, 193 (1890) ("Political, social, and economic changes entail the recognition of new rights, and the common law, in its eternal youth, grows to meet the demands of society.").

324. Jesse Eisinger, *Greater Power Over Wall Street, Left Unexamined*, N.Y. TIMES DEALBOOK (May 4, 2011, 3:12 PM), http://dealbook.nytimes.com/2011/05/04/more-power-over-wall-street-but-little-chance-to-discuss-it ("And monetary policy can be in conflict with banking regulation.").

325. *See, e.g.*, U.S. GOV'T ACCOUNTABILITY OFFICE, GAO–11–654, SECURITIES AND EXCHANGE COMMISSION: EXISTING POST-EMPLOYMENT CONTROLS COULD BE FURTHER STRENGTHENED (2011) (studying the revolving door between the SEC and the private sector); JAMES Q. WILSON ET AL., AMERICAN GOVERNMENT: INSTITUTIONS & POLICIES 279 (2010) ("Every year, hundreds of people leave important jobs in the federal government to take more lucrative positions in private industry.").

326. While this has traditionally been the case, the compensation gap between those in the industry and those regulating the industry has grown exponentially in the last few decades. Admittedly, there exist better compensated financial regulators and monitors, namely private industry and intra-

cial regulators face limited budgets that continue to stagnate or shrink relative to their growing mandates and the dynamic, complex marketplace.[327] As a result, a large gulf exists between the resources of the industry and its regulators.

This resource asymmetry between the regulators and the regulated has made it extremely difficult for regulators to police key players in cy-fi actively and meaningfully in the face of intense industry lobbying and innovation.[328] Resource asymmetry between the regulators and the regulated has created significant compensation disparities that make it difficult for government regulators to attract and retain talented individuals.[329] Additionally, cy-fi's high speed and high connectivity has also increased its complexity, which has rendered it more challenging for regulators to timely monitor and investigate misdeeds with scarce resources.[330] Thus, instead of vigilant prevention, regulators are constrained to limited prosecution.[331] The end result is a financial marketplace in which significant sectors are largely regulated on paper but not in practice, and are prone to cause serious shocks

institution regulators like stock exchange officials, in-house attorneys, risk officers, and compliance directors. Nevertheless, the commentary herein focuses on external, government regulators, who serve as arguably the most prominent and consequential regulators of the financial industry. *See supra* note 325.

327. *See* James B. Stewart, *As a Watchdog Starves, Wall Street Is Tossed a Bone*, N.Y. TIMES, July 15, 2011, at A1 (discussing successful political efforts to reduce the budgets of financial regulators like the SEC); *Oversight of the U.S. Securities and Exchange Commission's Operations, Activities, Challenges, and FY 2012 Budget Request: Hearing Before the Subcomm. on Capital Mkts. and Gov't-Sponsored Enters. of the H. Comm. on Fin. Servs.*, 112th Cong. 49 (2011) (prepared statement of the SEC), *available at* http://www.sec.gov/news/testimony/2011/ts031011directors.htm ("Over the past decade, the SEC has faced significant challenges in maintaining a staffing level and budget sufficient to carry out its core mission. The SEC experienced three years of frozen or reduced budgets . . . that forced a reduction of 10 percent of the agency's staff. Similarly, the agency's investments in new or enhanced IT systems declined about 50 percent . . . .").

328. Admittedly, technological advances have improved the regulator's effectiveness in some respects, but, on balance, it has diluted the regulator's effectiveness as resource disparities allow industry players to outmaneuver regulators. *See* HENRY KAUFMAN, ON MONEY AND MARKETS: A WALL STREET MEMOIR 229 (2000) ("[R]egulatory responses to new financial methods and instruments tend to be desultory. . . . Regulators fail[] to grasp the technical complexities of these new tools, instruments, and techniques, or to comprehend their broader significance for the financial system."); Michael Corkery, *SEC Chairman Admits: We're Outgunned by Market Supercomputer*, WALL ST. J. DEAL J. BLOG (May 11, 2010, 2:38 PM), http://blogs.wsj.com/deals/2010/05/11/sec-chairman-admits-were-outgunned-by-market-supercomputers.

329. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, *supra* note 325; Edward Wyatt, *Study Questions Risk of S.E.C. Revolving Door*, N.Y. TIMES, Aug. 6, 2012, at B2.

330. *See* Fabozzi et al., *supra* note 56, at 30 (describing the regulatory challenges of high-speed finance); Nathaniel Popper & Ben Protess, *To Regulate High-Speed Traders, S.E.C. Turns to One of Them*, N.Y. TIMES, Oct. 8, 2012, at B1.

331. Despite limited and asymmetric resources, the SEC had a series of high profile victories in 2011 and 2012 against large investment banks, hedge funds, and other better-resourced participants in the financial industry. *See* Devin Leonard, *Outmanned, Outgunned, and on a Roll*, BUS. WK., Apr. 23, 2012, at 60.

to the system.[332] Prior to the fallout of the financial crisis, credit default swaps and derivatives were largely unregulated by the federal securities and commodities regulators despite their paramount importance and relevance to the financial markets.[333] Many have pointed to the credit default swap and derivatives markets in the first decade of the millennium as prime examples of this dynamic in which intense lobbying and innovation by the resource-rich, politically connected industry players allow them to outmaneuver resource-scarce, politically constrained regulators.[334]

The resources between the regulators and the regulated need not be equal, but at the same time, the disparity in resources cannot be so large that it renders regulators impotent and unable to achieve their mandates. As previously noted, law often plays tortoise to finance's hare. However, that comparison may need to be amended: Law often plays tortoise to finance's supersonic, mechanical hare. Cyborg finance may have become too fast for old, government centered regulatory schemes, especially given the resource disparities.[335] As finance continues to innovate, regulators must ask and answer some difficult questions of themselves: Do we need a new funding model for regulators in the age of cy-fi?[336] Do we need a fundamental change in financial regulation that breaks away from old modes of top-down, government oriented regulation?[337] How these questions are answered will have profound effects on finance, law, and society.[338]

332. Serritella, *supra* note 73, at 437.

333. *See* 7 U.S.C. § 16(e)(2) (2006); Partnoy & Skeel, *supra* note 299, at 1046–47; Whitehead, *supra* note 285, at 34.

334. *See* Fabozzi et al., *supra* note 56, at 30 (describing the regulatory challenges of high-speed finance); *Frontline: The Warning* (PBS television broadcast Oct. 20, 2009), *available at* http://www.pbs.org/wgbh/pages/frontline/warning/view.

335. *See, e.g.*, Serritella, *supra* note 73, at 439–43 (critiquing the SEC's initial regulatory response to the Flash Crash as "rash"); *see also* Rodier, *supra* note 66.

336. *See, e.g.*, Arthur Levitt, Jr., *Don't Gut the S.E.C.*, N.Y. TIMES, Aug. 8, 2011, at A19 (discussing the funding and political constraints on the SEC); Richard Rubin, *House Panel Endorses Budget Cuts at IRS, Consumer Bureau*, BLOOMBERG (June 16, 2011, 12:12 PM), http://www.bloomberg.com/news/2011-06-16/house-panel-endorses-budget-cuts-at-irs-consumer-bureau-1-.html ("[Because of budget cuts], the SEC wo[n]'t be able to carry out the new responsibilities it received in the Dodd-Frank law.").

337. *See* Saule T. Omarova, *Wall Street as Community of Fate: Toward Financial Industry Self-Regulation*, 159 U. PA. L. REV. 411, 427 (2011) (advocating for more financial self-regulation as a form of new governance); *see also* Orly Lobel, *The Renew Deal: The Fall of Regulation and the Rise of Governance in Contemporary Legal Thought*, 89 MINN. L. REV. 342, 343–44 (2004) (describing a new governance model based on decentralization, localization, and collaboration).

338. This Article raises these inquiries herein to draw attention to some of the difficult fundamental issues that should be considered by policymakers in ongoing and future efforts to craft meaningful regulations for cyborg finance. The author plans to address in greater depth these inquiries in future scholarship.

2. Within the Industry

Cyborg finance has created resource asymmetries, not just between the regulators and the regulated but also among industry players. Whereas the asymmetry between the regulators and the regulated has created a competitive gap in the current regulatory framework, the asymmetry within the industry has bred more competition within the industry on one level but has also created barriers to competition on another level.[339]

On one level, cy-fi has made more investing more efficient and more inexpensive for more investors.[340] Whereas in eras past, stockbrokers, money managers, and investment advisors were necessary for many investors, today they are not. Technology has made it possible for new players like online brokerages and online banks to compete using fewer resources than traditional players. This has meant additional market access and savings for retail investors. For instance, when the NASDAQ instituted the Small Order Execution System (SOES), made possible by new technology, it opened up access to NASDAQ execution for smaller investors who historically did not have direct access to the major stock exchanges.[341] As a result of SOES, "[a]nyone with a few thousand dollars could rent a desk and trading terminal that provided a trading platform equivalent to most of the trading floors on Wall Street."[342]

Nonetheless, on another level, the resource asymmetries within the industry have also created new barriers to competition that have fundamentally changed the financial industry.[343] The increasing dependence on advanced information technology has led to competition for scarce talent and resources that are often captured by the most successful and most moneyed[344]:

339. *See* Duhigg, *supra* note 76 (describing the "technological arms race" on Wall Street) (quoting Joseph M. Mecane, NYSE Euronext).

340. *See* Salmon & Stokes, *supra* note 56 ("For individual investors, trading with algorithms has been a boon: Today, they can buy and sell stocks much faster, cheaper, and easier than ever before."); LARRY TABB, TABB GRP., LLC, WRITTEN TESTIMONY TO THE U.S. SENATE COMMITTEE ON BANKING, HOUSING, AND URBAN AFFAIRS 2 (Sept. 20, 2012) (discussing how electronic trading creates greater efficiency and lower costs for investors).

341. BROWN, *supra* note 59, at 29.

342. *Id.*

343. *See* Elimination of Flash Order Exception From Rule 602 of Regulation NMS, Exchange Act Release No. 34-60,684, 74 Fed. Reg. 48,630, 48,633 (proposed Sept. 18, 2009) (to be codified at 17 C.F.R. 242.602), *available at* http://www.sec.gov/rules/proposed/2009/34-60684.pdf (discussing the dangers of "two-tiered market[s]" in finance due to resource asymmetries); Jane K. Winn, *Catalytic Impact of Information Technology on the New International Financial Architecture*, 34 INT'L LAW. 137 (2000).

344. *See* PATTERSON, *supra* note 65, at 230 ("The new hierarchy would be all about who owned the most powerful computers, the fastest links between markets, the most sophisticated algorithms—and the inside knowledge of how the market's plumbing was put together.").

> The most successful black-box firms all have one thing in common: state-of-the-art execution platforms. Their technology allows them to participate in market rallies, to hedge risk in real time, and to capitalize on short-term price discrepancies. Without their technologies prowess, they couldn't stay one step ahead of their peers in the marketplace.[345]

Not every firm can afford the best programs, the brightest analysts, and the fastest computers. In 2010, it was estimated that high-frequency transactions in the U.S. equity markets were initiated by just 2 percent of the 20,000 trading firms in the United States—that is to say, by some 400 firms.[346] Many of these firms are hedge funds or trading desks of large investment entities with abundant resources like Goldman Sachs and BlackRock.[347]

Additionally, because speed is an essential ingredient for success in cy-fi, better-resourced institutions often possess a significant competitive advantage. Firms with more resources, for example, are able to rent expensive real estate at or near trading centers so as to reduce the amount of latency in their trade executions by fractions of seconds, a process known as colocation.[348] Latency refers to the time between an order submission and the receipt of an acknowledgement of the order.[349] "It is estimated that for each 100 miles the server is located away from the matching engine, 1 millisecond of delay is added to the transmittal and execution time."[350] By reducing latency, firms with more resources can consistently execute trades faster than their competitors, even if all market players receive actionable information at the same time. As a result of such disparities, the industry is fragmenting, and industry participants with fewer resources simply will not be able to compete and may choose to withdraw from the marketplace.[351]

The fact that some financial players have more resources than others is neither new nor revolutionary. That said, some of the resource disparities in cy-fi may be differences not only in degree but in kind—differences that have arguably unparalleled impact on the very function and integrity of the financial system. Whether

345. BROWN, *supra* note 59, at 43.

346. CAROL L. CLARK, FIN. MKTS. GRP., CHI. FED LETTER NO. 272, CONTROLLING RISK IN A LIGHTNING-SPEED TRADING ENVIRONMENT (2010), *available at* http://qa.chicagofed.org/digital_assets/publications/chicago_fed_letter/2010/cflmarch2010_272.pdf.

347. Fabozzi et al., *supra* note 56, at 8–9.

348. *See* Concept Release on Equity Market Structure, Exchange Act Release No. 34-61,358, 75 Fed. Reg. 3594, 3610 (proposed Jan. 21, 2010) (to be codified at 17 C.F.R. pt. 242); BROWN, *supra* note 59, at 63.

349. *See* BROWN, *supra* note 59, at 64.

350. Fabozzi et al., *supra* note 56, at 10.

351. *See id.* at 29; Matthew Baron et al., The Trading Profits of High Frequency Traders (Nov. 2012) (unpublished manuscript), *available at* http://conference.nber.org/confer//2012/MMf12/Baron_Brogaard_Kirilenko.pdf (finding that high-frequency traders profit at the expense of ordinary investors).

these disparities of resources within the financial industry are unfair is subject to legitimate debate, but they must be acknowledged and addressed if society values a sustainable, successful, and competitive financial industry.[352]

V. A DEFENSE OF OUR FUTURE

Cyborg finance and technological advances in artificial intelligence do not necessitate the fall of humans in society and finance. The algorithmically supercharged machines that attempt to distill order from chaos and wisdom from data need humans more than ever. In a world in which machines seek to tame the savages of randomness with elegant models, humans are nonetheless needed to create those models and harvest their true value. Rather than restrain human advancement, technological progress holds the promise of accelerated human progress—in finance and beyond.

A. On Certainty and Randomness

The speed, precision, accuracy, and convenience of computerized, data-driven analysis has led many in finance and elsewhere to adore such analysis with its elegant models as the antidote to the hostilities of randomness and uncertainty, of human action and human folly.[353] There exists a certain enchantment with the magic of technology and artificial intelligence in finance. As the noted science fiction writer Arthur C. Clarke wrote, "Any sufficiently advanced technology is indistinguishable from magic."[354] Magical or not, such adoration is misplaced; elegant models do not generate truth, nor do they eliminate randomness from an uncertain world.[355]

Financial engineers frequently operate by Leonardo da Vinci's adage that "simplicity is the ultimate sophistication"[356] as they try to impose the methodologies of physics on finance. Rough edges in data are smoothed away by assumptions and generalizations for the sake of elegance and convenience. Sometimes, when improperly acknowledged, these assumptions and generalizations can render a

352. *See* Fabozzi et al., *supra* note 56, at 28–29 (debating the market benefits of algorithmic trading).
353. *See* EMANUEL DERMAN, MODELS BEHAVING BADLY: WHY CONFUSING ILLUSION WITH REALITY CAN LEAD TO DISASTER, ON WALL STREET AND IN LIFE 143–87 (2011).
354. ARTHUR C. CLARKE, PROFILES OF THE FUTURE 21 n.1 (rev. ed. 1973).
355. *See* Paul Krugman, *How Did Economists Get It So Wrong?*, N.Y. TIMES MAG., Sept. 6, 2009, at 36 ("[E]conomists, as a group, mistook beauty, clad in impressive-looking mathematics, for truth.").
356. TAL BEN-SHAHAR, HAPPIER: LEARN THE SECRETS TO DAILY JOY AND LASTING FULFILLMENT, at xi (2007) (quoting Leonardo da Vinci).

model dangerously false.[357] In an effort to transpose the rules of the physical world onto the financial world, some financial engineers mistook elegance for truth and uncertainty for risk. Risk can be measured in terms of probabilities, but uncertainty is immeasurable.[358] Finance is not physics despite decades of attempts to transplant the analytical tenets of the physical world to the financial world.[359] Forecasting the movements of atoms is easy relative to predicting the actions of humans.[360] After losing a large sum of his investments during the South Sea Bubble in 1720, Isaac Newtown noted, "I can calculate the motion of heavenly bodies but not the madness of people."[361]

Despite the proliferation of data, there exists no dataset so large and no algorithm so refined that it generates consistent, flawless forecasts in an uncertain world.[362] Likewise, no model can perfectly predict and solve all our problems, financial or otherwise.[363] Humans can be random, and the world can be unpredictable; therefore, life cannot be perfectly modeled.[364] Data of past events help forecast future outcomes but not perfectly predict them. When properly calibrated, computer models can be incredibly powerful and instructive tools for decisionmakers in finance and beyond. Even when properly calibrated, however, they are not failsafe because randomness remains.[365] For instance, while models can have high predictive value, they cannot properly account for rare, high-impact events—so-called black swans—which exhibit the following characteristics:

> First, it is an *outlier*, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Second, it carries an extreme impact (unlike the bird). Third, in spite of

357. *See* PAUL SAMUELSON, FOUNDATIONS OF ECONOMIC ANALYSIS 4 (1947) (criticizing faulty economic models based on oversimplified assumptions that "[t]ake a little bad psychology, add a dash of bad philosophy and ethics, and liberal quantities of bad logic").

358. Frank Knight, a leader of the highly influential Chicago school of economics, made this distinction a central thesis of his landmark book, *Risk, Uncertainty, and Profit*. *See* FRANK H. KNIGHT, RISK, UNCERTAINTY, AND PROFIT (1921).

359. *See* Andrew W. Lo & Mark T. Mueller, *Warning: Physics Envy May Be Hazardous to Your Wealth!*, 8 J. INV. MGMT., no. 2, 2010, at 13, 15; JAMES OWEN WEATHERALL, THE PHYSICS OF WALL STREET: A BRIEF HISTORY OF PREDICTING THE UNPREDICTABLE 105–29 (2013) (chronicling the rise of physics in finance).

360. Lo & Mueller, *supra* note 359, at 17.

361. PATTERSON, *supra* note 67, at 12 (internal quotation marks omitted).

362. *See* Mark Whitehouse, *Economists' Grail: A Post-crash Model*, WALL ST. J., Nov. 30, 2010, at A1 (reporting on the fallacies of financial models in light of the financial crisis of 2008).

363. *Cf.* WEATHERALL, *supra* note 359, at 36–39.

364. *See* Lo & Mueller, *supra* note 359, at 21.

365. *Id.* at 14.

> its outlier status, human nature makes us concoct explanations for its occurrence *after* the fact, making it explainable and predictable.[366]

The inability to account perfectly for randomness and black swan events coupled with irrational faith in computer analysis can lead to catastrophic outcomes.[367] The financial crisis of 2008 occurred partially because many financial models failed to properly account for a potential (and eventual) steep and steady decline in the U.S. housing market.[368] During the crisis, investment banks and hedge funds suffered catastrophic losses by investing based on their computer models.[369] Most of the prevailing models at that time did not forecast the precipitous and sustained fall of the American housing market.[370] Thus, humans should not wholly surrender their rationality and free will to imperfect but elegant mathematical models, which can be misused and abused.[371] Following the crisis, Warren Buffett famously warned, "Beware of geeks bearing formulas."[372]

Where does this realization leave investors in the age of cy-fi? The answer: in a better place, if we acknowledge randomness, uncertainty, and our inability to perfectly tame them.[373] More mindful of the strengths and limitations of our tools and of ourselves, we can develop enhanced frameworks for making better and more sophisticated financial decisions.[374]

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366. TALEB, *supra* note 175, at xxii.
367. *See* Scott Patterson & Tom Lauricella, *Did a Big Bet Help Trigger 'Black Swan' Stock Swoon?*, WALL ST. J., May 10, 2010, at C2 (describing the Flash Crash as a black swan event caused by computerized trading).
368. *See, e.g.*, ANTHONY SAUNDERS & LINDA ALLEN, CREDIT RISK MANAGEMENT IN AND OUT OF THE FINANCIAL CRISES: NEW APPROACHES TO VALUE AT RISK AND OTHER PARADIGMS 31 (2010); Amir E. Khandani & Andrew W. Lo, *What Happened to the Quants in August 2007?*, 5 J. INV. MGMT., no. 4, 2007, at 5, 5–9; Krugman, *supra* note 355 ("There was nothing in the prevailing models suggesting the possibility of the kind of collapse that happened last year.").
369. *See, e.g.*, Khandani & Lo, *supra* note 368; Nocera, *supra* note 168 (chronicling the overreliance on the Value at Risk model prior to the 2008 financial crisis).
370. *See* Krugman, *supra* note 355; Nocera, *supra* note 168 (discussing how a prevailing risk management model, Value at Risk, failed during the financial crisis).
371. *See, e.g.*, Paul Wilmott, *The Use, Misuse and Abuse of Mathematics in Finance*, 358 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON A 63, 63 (2000).
372. Letter From Warren Buffett, Chairman, Berkshire Hathaway, Inc., to Shareholders 15 (Feb. 27, 2009), *available at* http://www.berkshirehathaway.com/letters/2008ltr.pdf.
373. *See, e.g.*, Krugman, *supra* note 355 ("[E]conomists need to abandon the neat but wrong solution . . . that everyone is rational and markets work perfectly. The vision that emerges as the profession rethinks its foundations may not be all that clear; it certainly won't be neat; but we can hope that it will have the virtue of being at least partly right.").
374. *See* TOBIAS ADRIAN & MARKUS K. BRUNNERMEIER, FED. RESERVE BANK OF N.Y., STAFF REPORT NO. 348, COVAR 1–6 (2011), *available at* http://www.ny.frb.org/research/staff_ reports/sr348.pdf (proposing a new tool for measuring systemic risk in financial markets); Andrew Lo, *The Adaptive Markets Hypothesis: Market Efficiency From an Evolutionary Perspective*, 30 J. PORTFOLIO MGMT. 15, 15–17 (2004) (proposing an alternative model of markets that accounts for uncertainty better than the neoclassical model's based on rational actors and efficient markets); *see also* ABHIJIT

B. On Machines and Humans

As computers play larger and more pivotal roles in law, finance, and society, it naturally raises the question: What is the role of humans in a world dominated by computers?[375]

Computers are cognitively and physically superior to humans in many ways. Computers do not suffer from irrational or emotional whims. Computers possess nearly perfect memory and recall. Computers process large amounts of data faster and more accurately than humans. Computers do not tire from work or require rest the way humans do. As a result, businesses are relying more and more on computers.[376]

The advantages of computers over the human brain—of artificial intelligence over human intelligence—extend beyond the mechanical and rote to the subjective and judgmental.[377] Computers aid movie studios in selecting scripts at a fraction of the cost and at many times the speed and box office success of humans.[378] Computers are used to read and grade student essays.[379] Computers have bested legal experts in predicting Supreme Court decisions.[380] Computers are superior to humans in conducting certain types of legal document review.[381] Today, we even use computers to spot lies.[382] Oliver Wendell Holmes may have been partly right when he wrote decades ago that "[f]or the rational study of the law the black-letter man may be the man of the present, but the man of the future is the man of statistics and the

V. BANERJEE & ESTHER DUFLO, POOR ECONOMICS: A RADICAL RETHINKING OF THE WAY TO FIGHT GLOBAL POVERTY 1–16 (2011) (discussing successful applications of behavioral economics to solve the challenges in development work with the poor).

375. *See, e.g.*, John O. McGinnis, *Accelerating AI*, 104 NW. U. L. REV. COLLOQUY 366, 366 (2010) (noting the anxiety induced by improvements in artificial intelligence); Lyons, *supra* note 34, at 28 (discussing the permanent displacement of human workers by robots and computers).

376. Andrea M. Matwyshyn, *Corporate Cyborgs and Technology Risks*, 11 MINN. J.L. SCI. & TECH. 573, 573 (2010).

377. *See, e.g.*, RICHARD NISBETT & LEE ROSS, HUMAN INFERENCE: STRATEGIES AND SHORTCOMINGS OF SOCIAL JUDGMENT 141 (1980) ("Human judges make less accurate predictions than formulas do, whether they have more information than is fed into the formula or precisely the same amount of information.").

378. *See* Malcolm Gladwell, *The Formula*, NEW YORKER, Oct. 16, 2006, at 138 (reporting on Epagogix, a company that uses software to predict the potential success of movies based on narrative elements in screenplays).

379. *See* CARR, *supra* note 24, at 223 ("[In 2009,] Edexcel, the largest educational testing firm in England, had announced it was introducing 'artificial intelligence-based, automated marking of exam essays.'").

380. *See* Theodore W. Ruger et al., *The Supreme Court Forecasting Project: Legal and Political Science Approaches to Predicting Supreme Court Decisionmaking*, 104 COLUM. L. REV. 1150, 1150 (2004).

381. *See* Joe Dysart, *A New View of Review: Predictive Coding Vows to Cut E-discovery Drudgery*, A.B.A. J., Oct. 1, 2011, at 26 (discussing how computers using predictive coding software are at least as efficient as humans at reviewing legal documents).

382. *See* Anne Eisenberg, *Software That Listens for Lies*, N.Y. TIMES, Dec. 4, 2011, at BU5.

master of economics."[383] Holmes was only partly right because the man of statistics today is not a man but a machine (or perhaps a cyborg).

In the face of strong and growing evidence of the cognitive superiority of computers over humans, it is perhaps easy to relegate humanity to a secondary role in the operations of finance and society.[384] However easy, that instinct would be misplaced and wrong.[385]

In a world driven by data and machines, humans are needed more than ever. Humans are needed to make the preliminary decisions on experimentation and analysis.[386] Humans are needed to attest to the veracity and utility of the data. Humans are needed to imagine and create the algorithms, strategies, and programs for the machines.[387] Humans are needed to analyze and apply the experimental findings of the machines.[388] Humans are needed to establish the rules and regulations that govern all these interactions. In short, humans are needed to interact with the other humans and the world that they inhabit. Machines still cannot do all that we can do.[389] The numbers do not contain all the answers. "Torture numbers, and they'll confess to anything."[390] Even quantitative traders who rely heavily on machines do not dispute the necessity of humans in a world full of machines:

> The first thing that should be made clear is that people, not machines, are responsible for most of the interesting aspects of quantitative trading. . . . Despite this talk of automation and systematization, *people* conduct the research and decide what the strategies will be, *people* select the universe of securities for the system to trade, and *people* choose what

383. Holmes, *supra* note 323, at 469.
384. *See* LANIER, *supra* note 41, at 24–30 (lamenting the self-subordination of humans to technology).
385. This instinct is not unique to modernity, as people of previous eras have expressed similar trepidations about new technology and the demise of humanity. *See* RICHARD HOLMES, THE AGE OF WONDER: HOW THE ROMANTIC GENERATION DISCOVERED THE BEAUTY AND TERROR OF SCIENCE 94 (2008).
386. AYRES, *supra* note 38, at 124.
387. *See* NARANG, *supra* note 99, at xi; Steve Lohr, *Google Schools Its Algorithm*, N.Y. TIMES, Mar. 6, 2011, at WK 4 ("Computers are only as smart as their algorithms—man-made software recipes for calculation[.]").
388. Shvetank Shah et al., *Good Data Won't Guarantee Good Decisions*, HARV. BUS. REV., Apr. 2012, at 23.
389. *See* BRIAN CHRISTIAN, THE MOST HUMAN HUMAN: WHAT TALKING WITH COMPUTERS TEACHES US ABOUT WHAT IT MEANS TO BE ALIVE 5–10 (2011) (discussing the limitations of computers to have meaningful communications with humans); CHRISTOPHER STEINER, AUTOMATE THIS: HOW ALGORITHMS CAME TO RULE OUR WORLD 5–6 (2012) (opining on the need for humans to manage processes run by algorithms); John Markoff, *How Many Computers to Identify a Cat? 16,000*, N.Y. TIMES, June 26, 2012, at B1 (reporting on efforts to create artificial intelligence that can simulate human visual recognition).
390. NARANG, *supra* note 99, at 149 (quoting Gregg Easterbrook).

> data to procure and how to clean those data for use in a systematic context, among a great many other things.[391]

Human ingenuity is needed to create an infrastructure of checks and balances to manage technology meaningfully.[392] Artificial intelligence, despite its advances, still lacks the awareness, judgment, and sophistication of human intelligence.[393] Human ingenuity in persuasion, culture, spirit, and emotion—in the matters that are difficult to capture with data but nonetheless important—are all key ingredients that must be accounted for in any successful enterprise, financial or otherwise.[394]

The discourse in finance surrounding the choice between machines and humans echoes the discourse in law surrounding the choice between legal rules and legal standards.[395] Like machines, legal rules often are appreciated for their clarity, precision, and accuracy,[396] but they are criticized for their rigidity and occasional obtuseness.[397] Like humans, legal standards are "often valued for their flexibility and their susceptibility to nuanced, context-sensitive interpretation,"[398] but they are criticized for their uncertainty and amorphousness.[399]

The emergence of cyborg finance has reduced many financial decisions to an elegant set of rules and mathematical models in which human intervention is

391. *Id.* at xi.

392. *See, e.g.*, Nat Durlach et al., *Source Separation, Localization, and Comprehension in Humans, Machines, and Human–Machine Systems*, *in* SPEECH SEPARATION BY HUMANS AND MACHINES 221, 225 (Pierre Divenyi ed., 2005) (explaining how humans are needed to monitor and correct errors in machine-driven processes); Matwyshyn, *supra* note 376, at 579 ("[Corporations] sometimes neglect to build the internal management infrastructure necessary to use new technologies responsibly . . . ignoring or unwittingly assuming significant technology risks that can meaningfully damage corporate assets and goodwill.").

393. *See* STEPHEN BAKER, FINAL JEOPARDY: MAN VS. MACHINE AND THE QUEST TO KNOW EVERYTHING 148–69 (2011) (discussing the limitations of artificial intelligence).

394. *See* AYRES, *supra* note 38, at 117 (discussing the role of human expertise in a data-driven world); NEIL POSTMAN, TECHNOPOLY: THE SURRENDER OF CULTURE TO TECHNOLOGY 71–72 (1993) (criticizing the surrender of humanity to technology); Steven Schwartz et al., *Clinical Expert Systems Versus Linear Models: Do We Really Have to Choose*, 34 BEHAV. SCI. 305, 305–10 (1989); *see also* DANIEL GOLEMAN, EMOTIONAL INTELLIGENCE 60–72 (1995) (explicating on the importance of emotional intelligence in human interactions); Ronald H. Humphrey, *The Right Way to Lead With Emotional Labor*, *in* AFFECT AND EMOTION: NEW DIRECTIONS IN MANAGEMENT THEORY AND RESEARCH 1, 12 (Ronald H. Humphrey ed., 2008) (noting the value of employing emotions in leadership roles).

395. *See* sources cited *supra* note 21.

396. Shiffrin, *supra* note 21, at 1214 ("Legal *rules* are usually celebrated for their clarity and certainty.").

397. *See* Sullivan, *supra* note 21, at 26; Sunstein, *supra* note 21, at 991–92.

398. Shiffrin, *supra* note 21, at 1214.

399. *See, e.g.*, Russell B. Korobkin, *Behavioral Analysis and Legal Form: Rules vs. Standards Revisited*, 79 OR. L. REV. 23, 37–38 (2000); Antonin Scalia, *The Rule of Law as a Law of Rules*, 56 U. CHI. L. REV. 1175, 1178–79 (1989).

unnecessary and often unwelcomed. But those models are not the end of history[400] for humans because markets populated by humans do not behave perfectly in accordance with elegant rules and mathematical models.[401] Beyond machines and rules, humans and standards are needed for progress. Standards, because of their uncertain nature, induce and require human deliberation and judgment.[402] And such deliberation "promotes moral health and development,"[403] which increases the likelihood of sound financial decisions as reflective thought balances reflexive action.[404] Advances in technology must be matched with advances in "technologies of the self" for there to be meaningful progress.[405] The clarity, precision, and accuracy of legal rules and machines must be balanced with the nuance, flexibility, and empathy of legal standards and humans. Thus, that is why law needs both standards and rules[406] and why finance needs both machines and humans.

The choice of humans versus machines is a false one because every human is a cyborg now. We are all part human and part machine. The competition of the future is not a competition of humans against machines[407] but a competition among humans with machines.[408] The future of cyborg finance is not about what

400. Francis Fukuyama coined the term "the end of history" to describe the "end point of mankind's ideological evolution" following the triumph of Western democracy at the end of the Cold War. *See* FRANCIS FUKUYAMA, THE END OF HISTORY AND THE LAST MAN, at xi (2006). Given the incredible capacity of machines in finance, it may be easy to think that we, humans, are nearing our own "end of history" moment in finance, but such thoughts of our demise are greatly exaggerated.

401. *See* JEROME FRANK, LAW AND THE MODERN MIND 129 (2009) ("The acts of human beings are not identical mathematical entities; the individual cannot be eliminated as, in algebraic equations, equal quantities on the two sides can be cancelled.").

402. *See* Shiffrin, *supra* note 21, at 1222.

403. *Id.* at 1224.

404. *Cf.* Yuval Feldman & Alon Harel, *Social Norms, Self-Interest and Ambiguity of Legal Norms: An Experimental Analysis of the Rule vs. Standard Dilemma*, 4 REV. L. & ECON. 81, 81 (2008) (suggesting that legal standards and rules each balance one another to create more optimal decisions). *But cf.* Loran F. Nordgren & Ap Dijksterhuis, *The Devil Is in the Deliberation*, 36 J. CONSUMER RES. 39, 39–46 (2009) (finding that deliberation can lead to inconsistent and suboptimal choices).

405. *See* Michael Foucault, *Technologies of the Self*, *in* TECHNOLOGIES OF THE SELF: A SEMINAR WITH MICHAEL FOUCAULT 16–20 (Luther H. Martin et al. eds., 1988) (referring to methods of self-improvement as "technologies of the self").

406. *See* FRANK, *supra* note 401, at 129 ("The law is not a machine and the judges not machine-tenders. There never was and there never will be a body of fixed and predetermined rules alike for all.").

407. Popular culture's often suggests that the critical battles of the future are ones between machines and humans. *See, e.g.*, DANIEL H. WILSON, ROBOPOCALYPSE: A NOVEL (2011); TRANSFORMERS: DARK OF THE MOON (Paramount Pictures 2011); TERMINATOR 2: JUDGMENT DAY (Carolco Pictures 1991). Despite these popular suggestions, the true contests of the future will likely be human battles with the aid of machines.

408. *See* Nikhil Hutheesing, *Better Trading Through Science*, BLOOMBERG (Aug. 31, 2011, 11:50 AM), http://www.bloomberg.com/news/2011-08-31/better-trading-through-science.html ("Perhaps one day investors and traders will have a biometric contraption connected to their computers. It could scan the prefrontal cortex of the brain, determine testosterone levels and measure sweaty palms in microseconds before warning you not to make a trade.").

machines can do *to* humans but about what humans can do *with* machines. "Every technology is an expression of human will. Through our tools, we seek to expand our power and control over our circumstances—over nature, over time and distance, over one another."[409] This is true in law, in society, and in finance. Ultimately, the sensible use of smart machines by smarter humans will hold the key to better returns and better futures for investors, and it should be a key objective of financial regulators in the coming years.[410]

CONCLUSION

A sea change is happening in finance. Human endeavors have become unmanned endeavors. Computer analysis and mathematical models have replaced human thought and human deliberation. This Article has been an examination of this ongoing sea change—an examination of the pervasive ascension of machines and its wide-ranging effects on law, society, and finance. It has revealed and addressed regulatory and systemic dangers, challenges, and consequences tied to the increasing reliance on computerization and artificial intelligence in finance. And with that revelation, this Article has forecasted this ongoing transformation's impact on the future of laws and humans as traditional finance transforms into cyborg finance.

This Article began with an ominous claim about the fall of human investors as machines rise, but it ends on a more hopeful note. In the final analysis, the critical contests of the future—in law, society, and finance—are not ones between humans and machines but ones among humans *with* machines. Machines will aid new investors in their financial decisions, but despite all the advanced technology, financial tragedies and triumphs will remain the responsibility of humans.[411] Smart computers, smart programs, and smart algorithms still do not stand a chance against stupid human policies. In the wake of the financial crisis of 2008, a blue-ribbon commission was formed to study the crisis. One of its key conclusions was that "[t]he crisis was the result of human action and inaction, not of Mother Nature or computer models gone haywire."[412] The greatest ally and the greatest enemy of

409. CARR, *supra* note 24, at 44.

410. *See, e.g.*, Jenny Strasburg, *Computer Trading Takes Human Turn*, WALL ST. J., May 22, 2012, at C1 (reporting on new efforts to better combine human financial analysis with computerized trading models).

411. *See* NARANG, *supra* note 99, at xi (stating that quantitative finance "is thoroughly dependent on human decision making"); *see also* CARR, *supra* note 24, at 3 ("We are too prone to make technological instruments the scapegoats for the sins of those who wield them. The products of modern science are not in themselves good or bad; it is the way they are used that determines their value." (quoting David Sarnoff, Speech at the Univ. of Notre Dame (1955)) (internal quotation marks omitted)).

412. FIN. CRISIS INQUIRY COMM'N, *supra* note 68, at xvii.

our financial system and our society is not a machine or a network of machines; it is us. The telos of technology is not to render us useless but to aid us in our progress and evolution.[413] This is the very nature and "perfection of man."[414] Just as the spear, the wheel, and the printing press aided our predecessors in the past,[415] the computer, its memory, its speed, and its programs will aid us in the future. And so we must build new constructs—legal, financial, and others—to harness the potential of this transformative technology while taming its hostilities. In the end, this is the challenge, the promise, and the hope of the new investor.

413. *See, e.g.*, TURKLE, *supra* note 33, at 16–17 (describing how technology has become like a "phantom limb" for humans); Lisa Guernsey, *At Airport Gate, a Cyborg Unplugged*, N.Y. TIMES, Mar. 14, 2002, at G4 (reporting on wearable computer systems that enhance memory, vision, and awareness); Rob Walker, *You Tunes*, N.Y. TIMES MAG., Nov. 27, 2011, at 32 (discussing a software application intended to improve the user's musicality).

414. SAM KEEN, IN THE ABSENCE OF GOD: DWELLING IN THE PRESENCE OF THE SACRED 41 (2010) ("This is the very perfection of man, to find out his own imperfections." (quoting St. Augustine)).

415. *See* JARED DIAMOND, GUNS, GERMS, AND STEEL: THE FATES OF HUMAN SOCIETIES 257 (1999) (outlining how technology has fueled human evolution and progress); ROGER LEWIN, HUMAN EVOLUTION 10 (2005) (explaining how tool use aided human evolution, brain expansion, and social development among early humans).