# Corporate Technologies and the Tech Nirvana Fallacy

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## Abstract

This article analyzes the impact of technology, in particular distributed ledgers/blockchains, smart contracts, Big Data analytics and AI/machine learning (collectively referred to as "Corporate Technologies", or "CorpTech") on the future of corporate boards. We take on an argument often found in the finance, law and tech literature that we dub the "Tech Nirvana Fallacy": the prediction that technology will dominate corporate governance and even replace the board of directors, based on a comparison of perfect machines with failure-prone humans. Contrary to the Tech Nirvana Fallacy, we claim that CorpTech's impact, while significant, will merely scratch the surface of the perennial problem of corporate governance, namely conflicts of interest among the relevant corporate stakeholders, and chiefly between controllers (managers or controlling shareholders) and shareholders. Even where algorithms are well programmed and effectively replace human judgment, intra-corporate conflicts of interest do not vanish in a tech-dominated corporate environment. The key question, then, becomes: "Is the human being that selects or controls the firm's CorpTech conflicted?" This article analyzes the tech manifestation of the agency problems within corporations and addresses possible market, governance, and regulatory solutions.

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Keywords: Algorithms, Artificial Intelligence, Blockchain, Board of Directors, Compliance, Corporate Governance, CorpTech, Distributed Ledgers, RegTech, Risk Management, Smart Contracts

JEL Classifications: D23, G38, K22, L22, M15, O16

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# CORPORATE TECHNOLOGIES AND THE TECH NIRVANA FALLACY

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**ABSTRACT** – *This article analyzes the impact of technology, in particular distributed ledgers/blockchains, smart contracts, Big Data analytics and AI/machine learning (collectively referred to as "Corporate Technologies", or "CorpTech") on the future of corporate boards. We take on an argument often found in the finance, law and tech literature that we dub the "Tech Nirvana Fallacy": the prediction that technology will dominate corporate governance and even replace the board of directors, based on a comparison of perfect machines with failure-prone humans.*

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## INTRODUCTION

In one of the largest financial scandals to date, at least US$4 billion was found last year to have disappeared from the Malaysian state development fund 1MDB.[1] In the run-up to this misappropriation of funds, Goldman Sachs bankers circumvented its internal controls and bribed various officials in Malaysia and Abu Dhabi, in exchange for the fees from the underwriting of 1MDB bonds.[2] U.S. Prosecutors, demanding the most severe sanction available for such conduct, recommended that the parent company, Goldman Sachs Group Inc., be required to plead guilty to a crime to settle the 1MDB case.[3] The Goldman/1MDB case is the latest reminder of how, almost 90 years after Berle & Means's seminal book *The Modern Corporation and Private Property*,[4] the mechanisms to ensure that agents within corporations perform their tasks and duties in line with the long-term interests of their shareholders, rather than pursuing their immediate self-interest are far from fail-proof.[5]

If laws, best practices, ethical standards and market pressures have so far been unable to tackle this core corporate governance challenge, perhaps technology can. Would algorithms and machines, with their more powerful, disinterested, and unbiased information-processing capacity, be better at monitoring corporate agents?

Breath-taking advancements in information technology (IT) are characterizing the 21st century, from Big Data,[6] artificial intelligence (AI) and

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1 *See* Press Release, U.S. Dep't of Justice, U.S. Attorney's Office, Eastern District of New York: Malaysian Financier Low Taek Jho, Also Known As "Jho Low," and Former Banker Ng Chong Hwa, Also Known As "Roger Ng," Indicted for Conspiring to Launder Billions of Dollars in Illegal Proceeds and to Pay Hundreds of Millions of Dollars in Bribes - Former Banker Tim Leissner Pleaded Guilty to Conspiring to Launder Money and to Violate the Foreign Corrupt Practices Act Related to 1MDB (Nov. 1, 2018), https://www.justice.gov/opa/pr/malaysian-financier-low-taek-jho-also-known-jho-low-and-former-banker-ng-chong-hwa-also-known.

2 *Ibid*.

3 *See* Sridhar Natarajan, U.S. Prosecutors Recommend Goldman Guilty Plea for 1MDB, FT Says (24 Apr. 2019), https://www.bloomberg.com/news/articles/2019-04-24/u-s-prosecutors-recommend-goldman-guilty-plea-for-1mdb-ft-says.

4 ADOLF A. BERLE & GARDINER MEANS, THE MODERN CORPORATION AND PRIVATE PROPERTY (1932).

5 *See also* Michael C. Jensen & William H. Meckling, *Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure*, 3 J. FIN. ECON. 305, 308 (1976) (arguing that moral hazard is a firm's main determinant of agency costs).

6 *See* Solon Barocas & Andrew D. Selbst, *Big Data's Disparate Impact* 104 CAL. L. REV. 671 (2016) (highlighting data dependency and the risk that algorithms simply reflect existing biases in society); Julie E. Cohen, *What Privacy Is For*, 126 Harv. L. Rev. 1904, 1918 (2013) (arguing that Big Data is an euphemism that conceals efforts to repackage

machine learning[7] to distributed ledger technology, blockchain,[8] and smart contracts.[9] In the context of financial services and their regulation, where the

pervasive surveillance as innovation and asking to balance data processing and privacy priorities); Stacy-Ann Elvy, *Paying for Privacy and the Personal Data Economy*, 117 COLUM. L. REV. 1369, 1400-28 (2017) (developing a typology of data-business models and highlighting similarities and tensions between a commercial data market and consumers' privacy interests); Mckenzie L. Kuhn, *147 Million Social Security Numbers for Sale: Developing Data Protection Legislation After Mass Cybersecurity Breaches*, 104 IOWA L. REV. 417, 421-435 (2018) (arguing in favor of adopting federal data protections laws); Dirk A. Zetzsche, Ross P. Buckley, Douglas W. Arner & Janos N. Barberis, *From FinTech to TechFin: The Regulatory Challenges of Data-Driven Finance*, 14 N.Y.U. J. L. & BUS. 393, 435-443 (2018) (arguing in favor of data-specific adjustments to financial regulations).

[7] *See* Anthony J. Casey & Anthony Niblett, *The Death of Rules and Standards*, 92 IND. L.J. 1401, 1410-12 (2017) (arguing that technology will facilitate the emergence of individualized micro-directives in between rules and standards); Anthony J. Casey & Anthony Niblett, *Self-driving contracts*, 43 J. CORP. L. 1, 13-26 (2017) (arguing that technology will lead to subject-specific, self-completing contract law); Anthony J. Casey & Anthony Niblett, *A Framework for the New Personalization of Law*, U. CHI. L. REV. (forthcoming 2019) (developing preconditions for AI-based reconfiguration of the law); Joshua P. Davis, *Artificial Wisdom? A Potential Limit on AII in Law (and Elsewhere)* 3, Working Paper (2019) (on file with authors) (discussing AI as legal application and highlighting limits of AI when handling human values); Daniel M. Katz, *Quantitative Legal Prediction−or How I Learned to Stop Worrying and Start Preparing for the Data Driven Future of the Legal Services Industry*, 62 EMORY L.J. 909 (2013) (highlighting the opportunities of data-driven quantitative predictions for the legal profession); Paul Ohm & David Lehr, *Playing with the Data: What Legal Scholars Should Learn About Machine Learning*, 51 UC DAVIS L. REV. 653, 658-661, 669-701 (2017) (defining machine learning and detailing the data secletion process underlying AI); Harry Surden, *Machine Learning and Law*, 89 U. WASH. L. REV. 87,102–10 (2014) (discussing progress on AI research and how it may affect the practice of the law).

[8] *See* PRIMAVERA DE FILIPPI & AARON WRIGHT, BLOCKCHAIN AND THE LAW – THE RULE OF CODE (2018) (acknowledging the opportunities of blockchain technologies and arguing that the law needs to catch up, because blockchain could undermine the capacity of governmental authorities to supervise commercial activities and vital government-provided services); Usha Rodrigues, *Law and the Blockchain*, 104 IOWA L. REV. 679, 708-27 (2019) (analyzing default rules from corporate, partnership and contract law that could fill the gaps in smart contracts); Dirk A. Zetzsche, Ross P. Buckley & Douglas W. Arner, *The Distributed Liability of Distributed Ledgers: Legal Risks of Blockchain*, 2018 U. ILL. L. REV. 1361, 1382-1402 (arguing that distributed ledger and blockchain is far from an unregulated space since existing doctrines of contract, corporate and partnership law do apply and could establish a blockchain participant's liability).

[9] *See e.g.* Trevor I. Kiviat, Note, *Beyond Bitcoin: Issues in Regulating Blockchain Transactions*, 65 DUKE L.J. 569, 605–07 (2015) (discussing a smart contract to trade futures); Jeremy M. Sklaroff, *Smart Contracts and the Cost of Inflexibility*, 166 U. PA. L. REV. 263 (2017) (arguing that human-based contracting is flexible due to inherent incompleteness while machine-based contracting creates new inefficiencies from automation, decentralization and anonymity); Kevin Werbach & Nicolas Cornell, *Contracts Ex Machina*, 67 DUKE L.J. 313, 367-81 (2017) (arguing that smart contracts, while offering novel

discussion circles around the FinTech and RegTech labels, many of these technologies have been understood, respectively, to disrupt existing business models and to enhance compliance with financial regulation and its enforcement.[10]

The discussion in the field of corporate governance is at a relatively early stage. So far, academia has mainly speculated as to the possible use of new technologies, such as AI or distributed ledgers, to improve discrete corporate practices, such as shareholder identification,[11] shareholder proposals, proxy fights,[12] electronic voting, virtual shareholder meetings,[13] and digitalized compliance and risk management.[14] Attention has also been

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possibilities and potential for changing the commercial world, will not displace contract law due to technical limitations and doctrinal concerns).

10 On FinTech *see e.g.* Douglas W. Arner, Janos Barberis & and Ross P. Buckley, *The Evolution of FinTech: A New Post-Crisis Paradigm?*, 47 GEO. J. INT'L L. 1271 (2017) (describing the disruptive effect of financial technologies); Chris Brummer, *Disruptive Technology and Securities Regulation*, 84 FORDHAM L. REV. 977 (2015) (arguing that securities regulation must be adapted to FinTech); Kathryn Judge, *Investor-Driven Financial Innovation*, 8 HARV. BUS. L. REV. 291 (2018) (arguing that FinTech shall be used to avoid suboptimal regulation-inspired over-demand for some asset classes). For an early discussion of the technologies now dubbed as RegTech *see* Kenneth A. Bamberger, *Technologies of Compliance: Risk and Regulation in a Digital Age*, 88 TEX. L. REV. 669 (2010) (discussing the digitalization of compliance and risk management); on RegTech *see generally* Lawrence G. Baxter, *Adaptive Financial Regulation and RegTech: A Concept Article on Realistic Protection for Victims of Bank Failures*, 66 DUKE L.J. 567, 572 (2016) (arguing that technology assists banking regulators in updating regulation and keeping up with evolving markets); Douglas W. Arner, Janos Barberis & Ross P. Buckley, *FinTech, RegTech and the Reconceptualization of Financial Regulation*, 37 NW. J. INT'L L. & BUS. 371 (2017) (arguing that regulatory technologies will fundamentally change financial services).

11 *See e.g.* George S. Geis, *Traceable Shares and Corporate Law*, 113 NW. U.L. REV. 227, 238-53 (2018). *See also* Delaware State Senate, 149th General Assembly, Senate Bill No. 69: An act to Amend Title 8 of the Delaware Code Relating to the General Corporation Law (explicitly allowing for the use of the blockchain to maintain corporate share registries).

12 *See* Geis, *supra* note 11, at 272-73.

13 *See* Michael D. Goldman & Eileen M. Filliben, Corporate Governance: Current Trends and Likely Developments for the Twenty-First Century, 25 DEL. J. OF CORP. L., 683, 689 & 695 (2000); Dirk A. Zetzsche, *Shareholder passivity, cross-border voting and the shareholders rights directive*, 8 J. CORP. L. STUD. 289, *passim* (2008) (discussing virtual shareholder meetings as a remedy to shareholder passivity in a cross-border setting); Christoph Van der Elst & Anne Lafarre, *Blockchain and the 21st century annual general meeting*, 14 EUR. COMP. L. 167, *passim* (2017) (arguing that Blockchain and distributed ledger technology could reduce procedural inefficiencies of shareholder meetings); Anne Lafarre & Christoph Van der Elst, *Blockchain Technology for Corporate Governance and Shareholder Activism* (European Corporate Governance Institute (ECGI) - Law Working Paper No. 390/2018); Carla Reyes, Nizan G. Packin & Benjamin Edwards, *Distributed Governance*, 59 WM. & MARY L. REV. ONLINE 1 (2016).

14 *See* Bamberger, *supra* note 10, at 669, 722-738 (discussing the governance

focused on an arguably fringe phenomenon, algorithmic entities, or "self-driving corporations," whereby humans relinquish control over the corporation to an algorithm.[15] Still, others have focused on discrete legal questions arising from the use of AI to assist, if not replace, boards in their decision-making functions,[16] and on the related question of whether algorithms may themselves (and should be allowed to) serve as board members.[17]

Some scholars though have speculated as to how new technologies will reshape corporate governance more broadly. Given the hype around such new technologies, these scholars, whom we refer to as "tech proponents," share the view that technology will fundamentally change existing corporate governance paradigms and may even eradicate long-standing corporate

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implications of digitalized compliance and risk management).

[15] *See* Shawn J. Bayern, *Of Bitcoins, Independently Wealthy Software, and the Zero-Member LLC*, 108 NW. U.L. REV. 1485, 1495-1500 (2014) (discussing the integration of algorithmic entities into the legal system by treating them, for many purposes, as humans); Shawn J. Bayern, *The Implications of Modern Business-Entity Law for the Regulation of Autonomous Systems*, 19 STAN. TECH. L. REV. 93 (2015); Lynn M. LoPucki, *Algorithmic Entities*, 95 WASH. U.L. REV. 887 (2018); Shawn J. Bayern, Thomas Burri, Thomas D. Grant, Daniel Markus Häusermann, Florian Möslein, Richard Williams, *Company Law and Autonomous Systems: A Blueprint for Lawyers, Entrepreneurs, and Regulators*, 9 HASTINGS SCI. & TECH. L.J. 135 (2017). *See also* John Armour & Horst Eidenmüller, Self-driving corporations 24-33 (2019) (unpublished manuscript, on file with the authors) (developing a conceptual framework for self-driving corporations and highlighting regulatory challenges).

[16] Max Bankewitz, Carl Åberg & Christine Teuchert, *Digitalization and Boards of Directors: A New Era of Corporate Governance?*, 5 BUS. & MGMT. RES. 58 (2016) (predicting that under the influence of digitalization boards will become virtual networks of people with diminished needs to monitor management and that shared leadership approaches will prevail); Florian Möslein, ROBOTS IN THE BOARDROOM: ARTIFICIAL INTELLIGENCE AND CORPORATE LAW, in RESEARCH HANDBOOK ON THE LAW OF ARTIFICIAL INTELLIGENCE 649, 668 (Woodrow Barfield & Ugo Pagallo eds., 2019) (arguing that the corporate law regime on boards of directors needs to be adapted in response to AI and predicting a dynamic development of both law and technology in this field).

[17] Sergio Gramitto Ricci, *The technology and Archeology of Corporate Law*, at 32-41, Cornell Law School Research Paper No. 18-40 (2018), http://ssrn.com/abstract=3232816 (comparing the employment of artificial intelligence to the use of slaves in Roman times and arguing that the Roman law for slaves may offer a role model for the legal treatment of how to address artificial intelligence's lack of legal capacity and authority in board matters); Martin Petrin, Corporate Management in the Age of AI 34-35 (UCL Working Paper No. 3/2019) (predicting the advent of AI directors). This is of course part of the broader debate on humans' race against the machines. *See generally* ANDREW MCAFEE & ERIK BRYNJOLFSSON, RACE AGAINST THE MACHINE (2011) (detailing the replacement of human labor by computers); Carl B. Frey & Michael A. Osborne, *The Future of Employment: How Susceptible Are Jobs to Computerisation?*, 114 TECHNOLOGICAL FORECASTING & SOC. CHANGE 254 (2017) (making predictions about the same).

governance problems.[18] From their perspective, technology is the solution to the ultimate challenge in corporate governance, namely how to deal with (human) corporate agents' inherent weaknesses, including their dogged self-interestedness and pervasive biases.[19] Multiple corporate scandals—from the Enron and WorldCom debacles of the early 2000s, which shaped the corporate governance debate of the early 2000s[20] and prompted the enactment of Sarbanes-Oxley Act in 2002,[21] to the benchmark manipulation scandal of the early 2010s,[22] up until Goldman Sachs/1MDB[23]—and even the most

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18 *See infra*, part II.

19 *See e.g.*, with specific reference to the corporate board setting, Antony Page, *Unconscious Bias and the Limits of Director Independence*, 2009 U. ILL. L. REV. 238, 248-83.

20 In the Enron and WorldCom cases executives had not only misled those firms' board of directors and audit committee on high-risk accounting practices, but also successfully pressured their audit firm (soon-to-be defunct Arthur Andersen) to ignore the issues. *See e.g.* John C. Coffee Jr., *What Caused Enron - A Capsule Social and Economic History of the 1990s*, 89 CORNELL L. REV. 269, especially at 302 (2004); CURTIS J. MILHAUPT & KATHARINA PISTOR, LAW AND CAPITALISM: WHAT CORPORATE CRISIS REVEAL ABOUT LEGAL SYSTEMS AND ECONOMIC DEVELOPMENT AROUND THE WORLD 47-67 (2008) (discussing the Enron scandal); J. Aguirre, *The Enron Decision: Closing the Fraud-Free Zone on Errant Gatekeepers?*, 28 DEL. J. CORP. L. 447 (2003); Douglas Branson, *Enron - When All Systems Fail: Creative Destruction or Roadmap to Corporate Governance Reform?*. 48 VILL. L. REV. 989 (2003). In their misdeeds these executives were supported by their legal counsel, *see* Susan P. Koniak, *When the Hurlyburly's Done: The Bar's Struggle with the SEC*, 103 COLUM. L. REV. 1236, 1248 (2003); id., *Corporate Fraud: See, Lawyers*, 26 HARV. J.L. & PUB. POL'Y 195, 196–97 (2003); Roger C. Cramton, *Enron and the Corporate Lawyer: A Primer on Legal and Ethical Issues*, 58 BUS. LAW. 143, 173 (2002).

21 Sarbanes-Oxley Act of 2002, Pub. L. No. 107-204, 116 Stat. 745 (codified in scattered sections of 11, 15, 18, 28, and 29 U.S.C.). *See e.g.* Roberta Romano, *The Sarbanes-Oxley Act and the Making of Quack Corporate Governance*, 114 YALE L.J. 1521 (2005) (critically discussing the Act); Robert A. Prentice & David B. Spence, *Sarbanes-Oxley as Quack Corporate Governance: How Wise Is the Received Wisdom?*, 95 GEO. L.J. 1843 (2007) (responding to Romano's critique).

22 Traders at major investment banks, among them Bank of America Corp., Citigroup Inc. and UBS, were in direct contact with each other discussing the direction in which several indices should be manipulated, among them the world's most important index for credit hedging, the London Interbank Exchange Rate ("Libor"). It is estimated that the Libor manipulation cost US municipalities alone at least $6bn. *See e.g.* INT'L ORG. OF SEC. COMM'NS, FINANCIAL BENCHMARKS: CONSULTATION REPORT 48 (2013), https://www.iosco.org/library/pubdocs/pdf/IOSCOPD399.pdf (describing the Libor manipulation); *see also* Gina-Gail S. Fletcher, *Benchmark Regulation*, 102 IOWA L. REV. 1929, 1947-1961 (2017) (describing the manipulation in interest rate, foreign exchange rate and crude oil indexes).

23 *See supra* note 1 and accompanying text.

severe financial crisis in the last century[24] bear testimony of the disastrous consequences that the wrong corporate governance arrangements can have on society. If automated solutions become available to finally keep corporate agents on a tight leash without unduly constraining their ability to create value, then we might be on the verge of a new era in which corporate governance scandals become a thing of the past.

Tempting as it may be to set up perfect machines against failure-prone humans (what we call the Tech Nirvana fallacy[25]), a better understanding of both the available technology and the enduring role of humans in its design and deployment justifies a more sober assessment of technology's impact on corporate governance.

This article spells out the limitations of the new technologies as applied to corporate governance, based on the current state of technology, its predictable trajectory and the inherent features of corporate governance itself. It argues that the conflicts of interest and information asymmetries that have

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[24] In the run-up to the Global Financial Crisis, inappropriately incentivized investment bankers issued subprime "toxic" securitized mortgage assets, and rating agencies analysts were prone to issuing over-optimistic ratings thereon, which finally found their way into banks' and institutional investors' portfolios around the globe. *See e.g.* ROBERT J. SHILLER, THE SUBPRIME SOLUTION: HOW TODAY'S GLOBAL FINANCIAL CRISIS HAPPENED, AND WHAT TO DO ABOUT IT (2008) (providing an account of the crisis); *see also* Brooksley Born, *Foreword: Deregulation: A Major Cause of the Financial Crisis*, 5 HARV. L. & POL'Y REV. 231, 233 (2011) (arguing that deficient regulation prompted the crisis); Joseph William Singer, *Foreclosure and the Failures of Formality, or Subprime Mortgage Conundrums and How to Fix Them*, 46 CONN. L. REV. 499, 507-30 (2013) (discussing property law issues that accelerated the crisis). Some commentators and international organizations attribute the global financial crisis of 2007 partially or primarily to weaknesses in corporate governance arrangements and humans' skewed incentives. *See e.g.*, OECD, CORPORATE GOVERNANCE AND THE FINANCIAL CRISIS: KEY FINDING AND MAIN MESSAGES 41 (2009) ("The financial crisis has also pointed in a large number of cases to boards of financial companies that were ineffective and certainly not capable of objective, independent judgment."); Brian R. Cheffins, *The Corporate Governance Movement, Banks and the Financial Crisis*, 16 THEORETICAL INQUIRIES L. 1, 31-41 (2015) (observing that the persistence of imperial CEOs at U.S. banks "plausibly contributed to the onset of the financial crisis"); Douglas W. Diamond & Raghuram G. Rajan, *The Credit Crisis: Conjectures about Causes and Remedies*, 99 AM. ECON. REV. 606, 607-08 (2009) (identifying flawed incentives at the banks' top as one of the causes of the crisis).

[25] The nirvana fallacy refers to the misconception, common among legal scholars, of comparing the real world, with its market imperfections, with a failproof, perfectly regulated one. *See e.g.* Daniel R. Fischel, *The Corporate Governance Movement*, 35 VAND. L. REV. 1259, 1272 (1982). The fallacy, but not the term "nirvana fallacy" itself, was first highlighted by the economist Harold Demsetz (Harold Demsetz, *Information and Efficiency: Another Viewpoint*, 12 J.L. & ECON. 1, 1, 2 (1969) (introducing the "nirvana approach," described as above, as being susceptible to three common fallacies: the grass is always greener fallacy, the fallacy of the free lunch and the people could be different fallacy).

always characterized corporate governance are bound to seep into the code of software products.

Scholarly predictions on technology's impact on corporate governance are prone to suffering from two deficiencies: a super-optimistic view on the future development of the yet-deficient technology—the Tech Nirvana fallacy; and/or the (less common in this context, but still ever-tempting) nothing-new-under-the-sun refrain. We take a more nuanced view here: we argue that boards will continue to perform their core monitoring and mediation functions, will show that the scenario of automated monitoring and mediation replacing boards must be ruled out for the predictable future,[26] even where the tech testing standard is human parity rather than perfection,[27] and dismiss as similarly unrealistic the idea that shareholders may disintermediate boards and monitor management directly themselves. Yet, we acknowledge that IT governance is taking center stage within the boardroom, which prompts us to reflect on whether and how corporate law and corporate governance practices should be adapted in response to the new technologies.

This article proceeds as follows. Part I provides the technical context of our analysis by briefly describing the technologies that may disrupt boards' functions in the near future. Specifically, such technologies are distributed ledgers, blockchains, smart contracts, Big Data and AI/machine learning. To refer to all such technologies as applied to corporate governance functions, we introduce the term CorpTech as a distinct phenomenon from RegTech: the latter is the use of technology in the context of risk management, regulatory oversight, reporting and compliance;[28] it thus overlaps with CorpTech only in part, *i.e.* in its component relating to risk management

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[26] This is, of course, an important qualification, and one that is hard to put a number of years on. If predictions, as per the old saw, are difficult especially about the future, predictions about technology and its impact are even harder. Our ambition is much less to make the right prediction for the long-term than to highlight the technology and corporate governance features of today that make the scenario of corporate boards obsolescence unrealistic in the absence of technological (or other human history) developments that cannot be currently anticipated.

[27] *See generally* STUART J. RUSSEL & PETER NORVIG, ARTIFICIAL INTELLIGENCE: A MODERN APPROACH 2-3 (3d ed., 2016) (arguing that the testing standard of artificial intelligence is human parity).

[28] *See e.g.* Luca Enriques, *Financial Supervisors and RegTech: Four Roles and Four Challenges*, 2017 REVUE TRIMESTRIELLE DE DROIT FINANCIER 53, 53-54 (defining RegTech). *See also supra* note 10, and Emily Lee, *Financial Inclusion: A Challenge to the New Paradigm of Financial Technology, Regulatory Technology and Anti-Money Laundering Law*, 6 J. BUS. L. 473-98 (2017) (analyzing the benefits and challenges of RegTech-driven Anti-Money Laundering checks); Nizan G. Packin, *Regtech, Compliance and Technology Judgment Rule*, 93 CHI.-KENT L. REV. 193, 2017 (2018) (analyzing the impact of RegTech on compliance and the business judgment rule).

oversight and compliance. As we define it, CorpTech comprises all solutions relating to corporate governance broadly defined, including tools to: set executive compensation; identify candidates for top positions within the organization; facilitate investor relations, corporate voting and the internal workings of the board of directors; manage risk; and enhance compliance functions. However, it excludes operations software products such as those used for sales, R&D and production management.

Part II presents the tech proponents' view about the impact of these technologies on corporate boards. In particular, they predict that boards will no longer perform the monitoring and mediating functions that currently characterize them: CorpTech solutions will supplant the monitoring board, while shareholder direct involvement will make the mediating board obsolete.

Part III counters these claims. It argues that the fundamental questions underlying corporate governance are unlikely to change under the influence of technology. In particular, conflicts of interest are bound to remain at the heart of corporate governance. That is because the allocation of power over the selection of particular CorpTech solutions will determine the degree of control that any constituency (directors, management, shareholders, and other stakeholders) can exert over the firm. Who selects the CorpTech for the firm will determine whose interests, among the many conflicting interests within the firm, CorpTech products will cater to, which in turn will determine corporate governance outcomes in an algorithmic world.

Part IV considers the implications of a CorpTech-dominated governance landscape. We suggest that the advent of CorpTech is unlikely to justify broad-sweeping reforms of federal or state law and listing requirements relating to corporate boards. Rather, companies should establish tech committees or, in companies that already deploy such a committee, broaden their remit from the current focus on cybersecurity and IT-related operational risk to CorpTech oversight. We also make the case for mandatory disclosure of CorpTech-related corporate governance arrangements.

We conclude that, barring unpredictable technological breakthroughs that eventually displace human judgment in corporate decision-making processes entirely, CorpTech will not make existing corporate governance mechanisms, and boards' core functions in particular, obsolete (Part V). While CorpTech may speed up procedures, and governance practices may include a greater degree of code deployment and data analytics, the question of who decides what code is deployed and what data is processed will be answered by the same means as today, so long as humans yield influence over the firm. Traditional corporate governance mechanisms will retain their core function of, ultimately, allocating decision-making powers.

## I. THE PROMISE OF CORPTECH

This part briefly describes the newly available technologies that are affecting, or are likely to affect, the functions typically associated with corporate boards: distributed ledgers, the blockchain and smart contracts (section I.A); and, next, big data analytics, artificial intelligence and machine learning (section I.B).

### *A. Distributed Ledgers, Blockchains and Smart Contracts*

#### 1. The Technologies

A distributed ledger is "a database that is consensually shared and synchronized across networks spread across multiple sites, institutions or geographies, allowing a transaction to have [multiple private or] public 'witnesses'."[29] The sharing of data results in a sequential database distributed across a network of servers all of which together function as a ledger.[30] Distributed ledgers are characterized by an absence of, or minimal, central administration and no centralized data storage. They are, hence, "distributed," in the sense that the authorization for the recording of a given piece of information results from the software-driven interaction of multiple participants. Coupled with cryptographic solutions, such features (decentralization and distribution across a network of computers) curtail the risk of data manipulation, thereby solving the problem of trusting (human) third parties, and specifically data storage service providers.[31]

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[29] WORLD ECONOMIC FORUM, INNOVATION-DRIVEN CYBER-RISK TO CUSTOMER DATA IN FINANCIAL SERVICES – WHITE PAPER 5 (Figure 2) (2017), http://www3.weforum.org/docs/WEF_Cyber_Risk_to_Customer_Data.pdf.

[30] *See* David Mills et al., *Distributed Ledger Technology in Payments, Clearing, and Settlement* 10–11 (Wash.: Bd. of Governors of the Fed. Reserve Sys., Finance and Economics Discussion Series 2016-095, 2016), https://doi.org/10.17016/FEDS.2016.095.

[31] *See* MICHÈLE FINK, BLOCKCHAIN REGULATION AND GOVERNANCE IN EUROPE 12-14 (2019). *See also* Sinclair Davidson, Primavera De Filippi, & Jason Potts, *Blockchains and the economic institutions of capitalism*, 14 J. INST. ECON. 639 (2018) (arguing that Blockchain technology is a new institutional technology of governance that competes with other economic institutions of capitalism, namely firms, markets, networks, and even governments); Christian Catalini & Joshua S. Gans, *Some Simple Economics of the Blockchain*, MIT Sloan Research Paper No. 5191-16 (arguing that blockchain technology will lead to disintermediation due to lower costs of verification and networking); Primavera De Filippi & Aaron Wright, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia* 10-12 (2015), Working Paper, www.ssrn.com/abstract=2580664, (hereinafter, De Filippi & Wright, Lex Crytpgraphia) (arguing that widespread deployment

The modus operandi of distributed ledgers is best understood by looking at their counterpart, the concentrated ledger. Let us assume that a centralized register administered by a single entity, like a custodian bank, contains all the relevant data. That arrangement entails a number of risks. First, if the hardware where the register is "located" is destroyed, the information content, as well as the authority to ascertain that they are correct, are lost. Second, disloyal employees of the database administrator or an unfaithful administrator may manipulate the information content of the register. Third, manipulations and data losses may be the product of a cyber-attack. While not every server will be cyberattacked, any server *can* be manipulated with sufficient computing power and time (even if no other weakness in an encryption system is known to the attackers).[32]

Distributed ledgers address these problems by raising the barrier for manipulation. The underlying technology requires consensus of many data storage points (nodes) rather than the approval of just one storage administrator. If there are *n* nodes (instead of one concentrated ledger) and *e* describes the effort necessary to break into any single server, all other conditions being equal (safety per server etc.), the effort necessary to manipulate all the servers linked to a blockchain will be *n* x *e* rather than 1 x *e*.

Distributed ledgers are usually paired with a blockchain protocol.[33] Blockchain refers to the storage of all data parts as data bundles (the 'blocks') in a strict time-related series which links each block to the previous and subsequent blocks. The chronology of storage is revealed through a time stamp imprinted on each of the blocks. The blockchain renders data corruption even harder, because a successful cyberattack would require simultaneously corrupting not just one set of data (let us say the amount saved on a deposit), but multiple data sets (i.e. the whole blockchain) as well as the time stamps.

Distributed ledgers have provided fertile ground for the application of another innovation that may solve the problem of trust in human interactions: smart contracts.[34] While neither smart, nor contracts, they are in fact self-executing software protocols that reflect the terms of an agreement between

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of blockchain will lead to tech-based business practices that could prompt a loss in importance of centralized authorities, such as government, and urging a more active regulatory approach). For further references *see also supra* note 8.

[32] *See generally* WILLIAM J. BUCHANAN, CRYPTOGRAPHY (Kindle e-book, 2017), ¶1156-1407; JEAN-PHILIPPE AUMASSON, SERIOUS CRYPTOGRAPHY: A PRACTICAL INTRODUCTION TO MODERN ENCRYPTION 10-18, 40-48 (2017).

[33] For a technical description of crypto currency transactions using the Bitcoin Blockchain *see* BUCHANAN, *supra* note 32, ¶ 3735-3829.

[34] *See supra* note 9 for references.

two parties.[35] The conditions of the agreement are directly written into lines of code. Smart contracts permit the execution of transactions between disparate, anonymous parties without the need for an external enforcement mechanism (such as a court, an arbitrator, or a central clearing facility). They render transactions traceable, transparent, and irreversible.

Although distributed ledgers and blockchains are information storage devices, and smart contracts are information processing tools, the latter can "run" on distributed ledgers. For this reason, we refer to these three technologies collectively as distributed ledger technologies (DLTs).

### 2. DLT-based CorpTech Solutions

DLTs are already altering, and will further alter, the business landscape and, specifically, the way companies are directed and controlled. The blockchain and smart contracts may well redraw the boundaries between firms and markets, by depriving a number of intermediary institutions of their role.[36]

More relevant for our purposes, some technology firms are experimenting with the use of DLTs to improve the voting process. For instance, Boston-based Fidelity Investments, the world's fourth-largest asset manager and institutional investor, has developed SOCOACT, a blockchain-based voting system designed to authenticate voters and ensure fair (corporate) voting processes.[37]

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[35] *See e.g.* Casey & Niblett, *Self-Driving Contracts*, *supra* note 7, at 5; Joshua Fairfield, *Smart Contracts, Bitcoin Bots, and Consumer Protection*, 71 WASH. & LEE L. REV. ONLINE 35, 36 (2014); Merit Kõlvart, Margus Poola & Addi Rull, *Smart Contracts*, *in* THE FUTURE OF LAW AND ETECHNOLOGIES 133 (Tanel Kerikmäe & Addi Rull eds., 2016); Riikka Koulu, *Blockchains and Online Dispute Resolutions: Smart Contracts as an Alternative to Enforcement*, 13 SCRIPTED 40, 43-69 (2016); Karen E. C. Levy, *Book-Smart, Not Street-Smart: Blockchain-Based Smart Contracts and The Social Workings of Law*, 3 ENGAGING SCI., TECH. & SOC'Y 1 (2017); Cheng Lim et al., *Smart Contracts: Bridging the Gap Between Expectation and Reality* (11 Jul 2016), Oxford Bus. L. Blog, https://www.law.ox.ac.uk/business-law-blog/blog/2016/07/smart-contracts-bridging-gap-between-expectation-and-reality; Werbach & Cornell, *supra* note 34, at 313; De Filippi & Wright, Lex cryptographia, *supra* note 31, at 10-12 (2015).

[36] *See e.g.* Assaf Hamdani, Niron Hashai, Eugene Kandel & Yishay Yafeh, *Technological Progress and the Future of the Corporation*, 6 J. BRITISH ACAD. 215, 225 (2018) (arguing that, because DLTs reduce fraud and enhance trust, they have the potential to displace "powerful intermediaries").

[37] *See* U.S. Patent Office, Patent Application Publication, Pub. No. US 2017/0046689 A1, Pub. Date: Feb. 16, 2017, at (57) https://www.lens.org/lens/patent/135-803-859-153-697/fulltext ("The Crypto Voting and Social Aggregating, Fractionally Efficient Transfer Guidance, Conditional Triggered Transaction, Datastructures, Apparatuses, Methods and Systems (SOCOACT) transforms vote request, vote input inputs via SOCOACT components into vote UI, vote confirmation

On the issuers' side, service providers such as Computershare and Broadridge have presented DLT solutions. Computershare is a provider of share registers-as-a-service, tabulator services and technical vote processing at shareholder meetings. It has teamed-up with SETL, a provider of blockchain-based central securities depositary (CSD) services, in an effort to establish the world's first blockchain-based immutable register of securities ownership.[38] Broadridge, in turn, provides investor communications, technology-driven solutions, and data analytics to the financial services industry. More specifically, it manages information flows through the custodian chain, that is, from the institutional investor holding the shares to the issuer, passing through the variable number of custodians in-between.[39] Following a proxy voting trial with J.P. Morgan, Northern Trust, and Banco Santander utilizing the Ethereum blockchain in April 2017,[40] Broadridge obtained a patent for a blockchain technology that streamlines proxy voting and facilitate repurchase transactions.[41]

DLT use cases go far beyond shareholder voting. For instance, Northern Trust, one of the largest and oldest U.S. banks, has developed a blockchain solution with technology giant IBM for all corporate meetings. The package includes two smart contracts that record meeting attendance by collecting biometric information from the various devices an attendee may carry and collects all pertinent information about the meeting, such as the action points and associated dates. It also converts all such information into meeting minutes, following a standardized format. A third smart contract will post the minutes of the meeting and associated documents in a pre-determined repository.[42] That will allow meeting attendance and individual contributions to be instantaneously stored in a predetermined and well-searchable format. In addition, Northern Trust has developed a blockchain-

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outputs.").

[38] *See* Press Release, SETL, Computershare and SETL demonstrate Australia's first working blockchain solution (Apr. 28, 2016, updated Nov. 7, 2017), https://www.setl.io/blog/computershare-and-setl-demonstrate-australia-s-first-working-blockchain-solution.

[39] On custodian chains *see generally* Marcel Kahan & Edward B. Rock, *The Hanging Chads of Corporate Voting*. 96 Georget. L. J. 1227, *passim* (2008).

[40] Jim Manning, Major Finance Companies Complete Blockchain-Based Proxy Vote Solution (Apr. 11, 2017), https://www.ethnews.com/major-finance-companies-complete-blockchain-based-proxy-vote-solution.

[41] Jordan Danielle, Broadridge Patents Blockchain Solution For Proxy Voting And Repurchase Agreements (May 10, 2018), https://www.ethnews.com/broadridge-patents-blockchain-solution-for-proxy-voting-and-repurchase-agreements.

[42] Christine Kim, Northern Trust Wins Patent for Storing Meeting Minutes on a Blockchain (Jun. 6, 2018), https://www.coindesk.com/northern-trust-wins-patent-storing-meeting-minutes-blockchain.

based digital identity management system that delivers the information to be stored in Northern Trust's meeting software.

Developments such as these have stimulated the tech proponents' optimism that DLT applications could also tackle a particularly thorny area of corporate governance: executive compensation. Specifically, smart contracts could be used to make compensation arrangements harder to alter in opportunistic ways further down the road, a phenomenon known as "backdating."[43] More generally, it has been suggested that, instead of relying on (potentially) conflicted compensation consultants and their own (often self-serving) biases,[44] boards could use smart contracts to determine compensation structures and bonuses.[45] To the best of our knowledge, though, there is no publicly available evidence that any such product has yet been developed.

### *B. Big Data, Artificial Intelligence and Machine Learning*

#### 1. The Technologies

Big data analytics refers to the collection and processing of data sets that are either too large or too complex for traditional data processing applications to

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[43] *See* David Yermack, *Corporate Governance and Blockchains*, 21 REV. FIN. 1, 9 (2017). For an account of the option backdating scandal *see e.g.* Jesse M. Fried, *Option Backdating and Its Implications*, 65 WASH. & LEE L. REV. 853, 858-864 (2008) (describing three forms of secret option backdating, including the backdating of executives' option grants; the backdating of nonexecutive employees' option grants; and the backdating of executives' option exercises).

[44] On the role of compensation consultants *compare* Kevin J. Murphy & Tatiana Sandino, *Executive Pay and "Independent" Compensation Consultants*, 49 J. ACC'T & ECON. 247-262 (2010) (finding evidence for higher recommended levels of CEO pay when executive compensation consultants "cross-sell" services, but also (somewhat counterintutively) that board pay is higher when consultants work for the board rather than for executives) *with* Christopher S. Armstrong, Christopher D. Ittner & David F. Larcker, *Corporate Governance, Compensation Consultants, and CEO Pay Levels*, 17 REV. ACC'T STUD. 322-351 (2012) (finding that differences in governance quality explain much of the higher pay in clients of compensation consultants, while there is no support for claims that potentially "conflicted" consultants result in higher CEO pay) and Jenny Chu, Jonathan Faasse & P. Raghavendra Rau, *Do Compensation Consultants Enable Higher CEO Pay? A Disclosure Rule Change As a Separating Device*, 64 MGMT. SC. 2845 (2017) (arguing in favor of a more nuanced view on consultants after concluding that "not all multiservice consultants are conflicted while not all specialist consultants are guardians of shareholder value").

[45] Hamdani et al., *supra* note 36, at 229.

handle.[46] Big data applications look at the bulk of data points from an indefinite amount of users and apply advanced data analytics methods such as predictive or behavioral data analysis to generate value.[47] Big data analytics can be used to detect unexpected correlations in large data pools, test expected correlations for causation, or determine the probability of a predefined pattern.

While the two are not the same, big data is closely connected to artificial intelligence (AI) because the latter assists in putting the mass of data gathered to good use.[48] Computer scientists define AI as the devices that perceive their environment and take actions that maximize their chances of successfully achieving their task.[49] The base line of AI is a computer that mimics human cognitive functions, such as "learning" and "problem solving."[50]

Machine learning is a subset of AI that uses statistical, data-based methods to progressively improve the performance of computers on a given task, without humans reprogramming the computer system to achieve

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[46] *See* VIKTOR MAYER-SCHÖNBERGER & KENNETH CUKIER, BIG DATA: A REVOLUTION THAT WILL TRANSFORM HOW WE LIVE, WORK, AND THINK 12-14 (2013) (predicting that big data will not only be a new source of economic value but will also transform the organization of society).

[47] *See id.*, at 6 (stating that the volume of information in the last decades has outpaced IT engineers' manual data handling capacity so that engineers need to reinvent the tools they use for analyzing information; the latter will result in new forms of value creation that impact on markets, organizations and other institutions).

[48] In particular, AI rests on Bayes' theorem where conclusions as to the probability of an event can be drawn from prior knowledge of conditions related to the event. The big data presents the prior knowledge that allows to establish how likely an event is. The higher the volume of data, the more insightful and likely the conclusion drawn from that data. At the same time, humans are incapable of processing all the data accumulated, so the human mind needs to be replaced through logic and automated computation. *See* RUSSEL & NORVIG, *supra* note 27, at 495-99 (describing Bayes' theorem and its use in the context of AI).

[49] *See* DAVID POOLE, ALAN MACKWORTH & RANDY GOEBEL, COMPUTATIONAL INTELLIGENCE: A LOGICAL APPROACH 1 (1998) (defining AI research); RUSSEL & NORVIG, *supra* note 27, at viii, 1-4 (defining AI as "the study of agents that receive percepts from the environment and perform actions" where each of these agents "implements a function that maps percept sequences to actions", but expressing preference for the term "intelligent agent" or "rational agent"); for legal articles discussing AI and machine learning *see supra* note 7.

[50] RUSSEL & NORVIG, *supra* note 27, at 2-3 (describing the origin of the term AI in the Turing Test where "a computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer", and defining six core capabilities that together compose most of AI, including natural language processing, knowledge representation, automated reasoning, machine learning, computer vision, and robotics). The seminal work on AI is of course Alan M. Turing, *Computing Machinery and Intelligence*, 49 MIND 433 (1950).

enhanced performance.[51] In practice, the learning is achieved through extensive "practice" with multiple feedback rounds through which the machine is told whether it has passed or failed a task.

### 2. AI-based CorpTech

Due to their superior performance in data gathering and processing, big data analytics, AI and machine learning (hereinafter, referred to together as "AI") can be expected to affect all operational as well as internal control matters, from strategy setting[52] to risk management[53] and compliance.[54] While humans tend to have core data at their disposal and actively use only these data for decisions, technology can consider not only core, but also seemingly unrelated data.

Further, technology can handle data of the past as effectively as data of the present. This is particularly important for risk management: simply put, people tend to forget. To the same extent that accessibility of data of the past by humans (*i.e.* memory) declines, risk management of these risk categories unduly becomes of secondary importance. AI can thus be effective in the early detection and subsequent mitigation of violations of antitrust law, data protection rules, environmental regulations etc. That, in turn, should prove particularly valuable in reducing penalties for such violations, the magnitude of which has starkly increased in the last decade.[55]

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51 RUSSEL & NORVIG, *supra* note 27, at 693-859 (describing the training methods).

52 *Cf.* Armour & Eidenmüller, *supra* note 15, at 15 (while "strategic questions considered at the C-suite level" are unlikely to justify machine learning analysis, given the insufficiency of available data, "external generic data can be used to assist in scenario planning").

53 *See* Saqib Aziz & Michael M. Dowling, *Machine Learning and AI for Risk Management*, *in* DISRUPTING FINANCE. PALGRAVE STUDIES IN DIGITAL BUSINESS & ENABLING TECHNOLOGIES 33 (Theo Lynn et al. eds., 2019).

54 *See* Bamberger, *supra* note 10, at 690-93, 701-02.

55 For instance, in the case of Volkswagen, executives manipulated emissions data for cars manufactured for the US markets, resulting, so far, in penalties and damages of USD 19 billion. *See* U.S. Department of Justice, Office of Public Affairs, Volkswagen AG Agrees to Plead Guilty and Pay $4.3 Billion in Criminal and Civil Penalties; Six Volkswagen Executives and Employees are Indicted in Connection with Conspiracy to Cheat U.S. Emissions Tests (Jan. 11, 2017), https://www.justice.gov/opa/pr/volkswagen-ag-agrees-plead-guilty-and-pay-43-billion-criminal-and-civil-penalties-six. Further, the European Commission imposed a record $ 5 billion antitrust fine upon Alphabet inc., ordering it to change its contracts with handset manufacturers that require the implementation of push technology, in an effort to increase a user's awareness of Alphabet's apps. *See* Press Release, European Commission, Antitrust: Commission Fines Google €4.34 Billion for Illegal Practices Regarding Android Mobile Devices to Strengthen Dominance of Google's Search

Technology is also said to be unbiased,[56] albeit in the limited sense that technology does not follow its own agenda and is not itself subject to humans' cognitive biases.[57] In particular, by airing unconventional and (fact-based) contrarian views, machines could neutralize two related group dynamics that seriously hamper boards' effectiveness, namely "groupthink"[58] and the strong social pressure against the expression of dissent in boardrooms.[59]

An oft-cited example of the early adoption of AI to improve board decision-making dynamics occurred in Hong Kong,[60] where venture capital firm Deep Knowledge Ventures assigned a (sort of) board position to an artificially intelligent algorithm named VITAL. VITAL is programmed to automate due diligence "by scanning prospective companies' financing, clinical trials, intellectual property and previous funding rounds."[61] Its task is to identify overhyped projects and protect the firm from investing in trendy,

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Engine (Jul. 18, 2018), http://europa.eu/rapid/press-release_IP-18-4581_en.htm. On the risks involved by data protection violations, *see e.g.* Sam Schechner, *Facebook Faces Potential $1.63 Billion Fine in Europe Over Data Breach*, DOW JONES INST. NEWS., Sept. 30, 2018 (reporting that the data breach disclosed by Facebook in fall 2018, in which more than 50 million accounts were compromised, could result in penalties of up to $2 billion in Europe alone).

[56] *See* Gramitto Ricci, *supra* note 17, at 37-38; Petrin, *supra* note 17, at 34-35.

[57] *But see e.g.* Barocas & Selbst, *supra* note 6, at 692 (describing the risk that decision makers with prejudiced views mask their intentions by using biased data and promoting data selection with a view to enforce their biases). *See also infra*, notes 132 to 136and accompanying text.

[58] On groupthink *see generally* IRVING JANIS, VICTIMS OF GROUPTHINK (1972).

[59] *See* Gramitto Ricci, *supra* note 17, at 37-38. Akshaya Kamalnath, *The Perennial Quest for Board Independence - Artificial Intelligence to the Rescue?*, ALBANY L. REV. (forthcoming), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3360349, (manuscript at 8-9). *See generally* JONATHAN R. MACEY, CORPORATE GOVERNANCE. PROMISES KEPT, PROMISES BROKEN 61-62 (2008) (describing the pressure to conform to social norms of collegiality and cooperation within boardrooms as increasing the probability of board capture).

[60] Gramitto Ricci, *supra* note 17, at 34; Möslein, *supra* note 16, at 1-3; Michal S. Gal, *Algorithmic Challenges to Autonomous Choice*, 25 MICH. TECH. L. REV. 59, at 61 (2018); Mark Fenwick, Wulf A. Kaal & Erik P.M. Vermeulen, *The "Unmediated" and "Tech-Driven" Corporate Governance of Today's Winning Companies* 42 n114, TILEC Discussion Paper No. 2017-009 (2017) ; Armour & Eidenmüller, *supra* note 15, at 3.

[61] *See* Press Release, Deep Knowledge Venture's Appoints Intelligent Investment Analysis Software VITAL as Board Member – Hong Kong Venture Capital Fund Appoints Machine Intelligence as Board Member, May 13, 2014, *available at* https://globenewswire.com/news-release/2014/05/13/635881/10081467/en/Deep-Knowledge-Venture-s-Appoints-Intelligent-Investment-Analysis-Software-VITAL-as-Board-Member.html.

but overpriced inventions.[62]

Better use of internal and external data will yield better decisions and improve intra-firm monitoring, which in turn should result in reduced agency costs[63] and alleviate the need for intra-firm monitoring, thus allowing for flatter organizational structures.[64]

AI and big data analytics may also allow companies to consider all relevant information and possibly learn from other companies' best practices to devise optimal compensation packages. An early example of this can be seen in the products offered by U.S.-based Equilar Inc., a provider of tech solutions for board recruiting, business development, executive compensation and shareholder engagement. Using available compensation disclosures, performance targets and performance data, its applications generate "pay-for-performance" scores that can be used to determine whether an executive is over- or under-paid relative to executives of similarly situated companies.[65]

## II. CORPTECH'S IMPACT: IS THE END NIGH FOR (HUMAN-POPULATED) CORPORATE BOARDS?

Since Melvin Eisenberg's seminal book *The Structure of the Corporation*, corporate law scholars posit that a monitoring board is necessary to keep self-interested managers at bay and to ensure that shareholder interests are catered to.[66] Corporate governance practices at U.S. listed companies have increasingly conformed to such a scholarly approach, which is now

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62 *Ibid*.

63 *See* Nicholas Bloom, Luis Garicano, Raffaella Sadun & John Van Reenen, *The Distinct Effects of Information Technology and Communication Technology on Firm Organization*, 60 MGMT. SC. 2859, *passim* (2014) (studying the impact of information and communication technology on worker and plant manager and finding evidence that better information technologies, such as enterprise resource planning for plant managers and computer-assisted design/computer-assisted manufacturing for production workers are associated with more autonomy and a wider span of control, whereas technologies that improve communication (like data intranets) decrease autonomy).

64 *See* Philippe Aghion, Benjamin Jones & Charles I. Jones, C., *Artificial Intelligence and Economic Growth* 23-24, NBER Working Paper 23928 (2017).

65 *See*, for instance, the Equilar's patent application for its "Equilar Pay for Performance Score", U.S. Patent Office, Patent Application Publication, Pub. No. US 2013/0159067 A1, Pub. Date: Jun. 20, 2013 (detailing the algorithms and data sources used for calculating the score).

66 *See* MELVIN A. EISENBERG, THE STRUCTURE OF THE CORPORATION, especially at 156-85 (1976).

dominant.[67]

Tech proponents argue that shareholders will no longer *need* boards to make sure that managers do not deviate from the strategies and policies that maximize shareholder value, because shareholders will be able to do the monitoring themselves.[68] In addition, there will be no need for boards to mediate between the company and its management on the one hand, and shareholders on the other.[69] Finally, because humans are not prepared for the challenges presented by tech developments, they may even be replaced, partially or fully, by CorpTech automata.[70]

We lay out the tech proponents' view, first, by relaying their argument that CorpTech will diminish the need for a monitoring and mediating board, given that CorpTech has the potential to eradicate information asymmetry, and enhance direct shareholder influence (section II.A). Second, we present the view that the remaining board tasks can be achieved more efficiently by CorpTech algorithms (section II.B).

### *A. Shareholders Will No Longer Need Boards*

#### 1. Real-time Accounting and "Full Transparency"

According to tech proponents, the days of information asymmetry between a firm's insiders and outsiders are numbered: the prediction is that real-time accounting will replace traditional accounting and that firms will voluntarily post their ordinary business transactions on a blockchain accessible to the public.[71] This would lead not only to a permanent record of transactions, but also to full transparency of the company's entire ledger for any shareholder or stakeholder. As David Yermack holds, "[a]nyone could aggregate the firm's transactions into the form of an income statement and balance sheet at any time, and investors would no longer need to rely on quarterly financial

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67 Jeffrey N. Gordon, *The Rise of Independent Directors in the United States, 1950-2005: Of Shareholder Value and Stock Market Prices*, 39 STAN. L. REV. 1465, 1518-40 (2007) (highlighting how the monitoring board model has prevailed in the U.S. in the decades following Melvin Eisenberg's influential work).

68 *See infra*, section II.A.

69 On the mediating function of boards, *see generally* Margaret M. Blair & Lynn A. Stout, *A Team Production Theory of Corporate Law*, 85 VA. L. REV. 248, 269-82 (1999) (arguing that the corporation is a "mediating hierarchy" of partially contradicting interests and that the board's core function is to balance those interests to the benefit of the firm).

70 *See infra*, sections II.B and II.C.

71 Yermack, *supra* note 43, at 18, 24-25.

statements prepared by the firm and its auditors."[72] Based on the assumption that technology will eventually lead to proprietary information being shared with investors and other market participants, these commentators argue that full transparency increases shareholder trust in the integrity of a corporation's data, and renders costly audits by potentially corrupt professional firms useless.[73] Further, it is argued that greater transparency and post-trade efficiency will reduce transaction costs and enhance liquidity in capital markets.[74]

In response to this enhanced transparency, tech proponents expect a reduction in agency costs arising in connection with key management and governance issues, such as the selection of directors and executives,[75] accrued earnings management,[76] related party transactions[77] and management compensation systems.[78] That, in turn, would reduce the need for boards to focus on such issues.[79]

### 2. More Direct Shareholder Influence

The optimism regarding enhanced transparency is not limited to accounting data, but extends to transparency of ownership,[80] prompting the view that

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72 Yermack, *supra* note 43, at 24.

73 Yermack, *supra* note 43, at 24-25; OECD, DIRECTORATE FOR FINANCIAL AND ENTERPRISE AFFAIRS – CORPORATE GOVERNANCE COMMITTEE, BLOCKCHAIN TECHNOLOGY AND CORPORATE GOVERNANCE - TECHNOLOGY, MARKETS, REGULATION AND CORPORATE GOVERNANCE 24-25 (2018); *see also* Reyes, Packin & Edwards, *supra* note 13, at 18-21 (albeit more cautiously as to the whether such a setup is desirable).

74 Yermack, *supra* note 43, at 18.

75 Hamdani et al., *supra* note 36, at 229 (referring to an experiment described in Isil Erel, Léa H. Stern, Chenhao Tan & Michael S. Weisbach, *Selecting Directors Using Machine Learning*, Working Paper 2018-05, Charles A. Dice Center for Research in Financial Economics (2018); . Kamalnath, *supra* note 59, *passim*.

76 Yermack, *supra* note 43, at 25.

77 *Ibid*.

78 Hamdani et al., *supra* note 36, at 229; Yermack, *supra* note 43, at 20-21 (also noting, though, that blockchain trading of a company's shares may reduce the effectiveness of equity-based management incentives: assuming that part of management's compensation is *legal* insider trading (*i.e.* trading in compliance with insider trading laws), he predicts real-time transparency to prompt less active managerial trading out of concern of sending adverse signals to the market. In turn, if management profits less from legal insider trading, firms might have to pay management more to offset their foregone gains.

79 Yermack, *supra* note 43, at 20-21, 25; Hamdani et al., *supra* note 36, at 229.

80 *See* Geis, *supra* note 11, at 255-262 (discussing distributed ledgers and blockchain for creating traceable shares in the clearing and settlement system) and 267-269 (arguing that traceable shares lead to a fully transparent "centralized ledger of owners").

DLT-induced transparency could replace mandatory disclosure of beneficial ownership and prevent empty voting.[81]

More generally, according to Yermack, DLTs have the potential of "dramatically affect[ing] the balance of power between directors, managers, and shareholders."[82] Greater transparency on trading and ownership data would erode profit opportunities for shareholder activists and raiders, while the (supposed) increased liquidity of a blockchain-based market would reduce the costs of selling and therefore lead to more emphasis being placed on exit (trading) as opposed to voice (voting).[83] This could have a profound effect on the strategies of active traders and activists,[84] reducing the importance of the board as a mediator among shareholder constituencies.

At the same time, various scholars have argued that a private distributed ledger recording shareholder voting could increase the speed, enhance the accuracy and reduce the costs of shareholder decision-making, which in turn would reduce shareholder apathy, leading to higher shareholder participation.[85] Furthermore, it has been suggested that blockchain allows for a state-of-the-art decentralized form of shareholder meeting with no need for a centralized meeting location.[86] That could motivate shareholders to

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81 Yermack, *supra* note 43, at 24 (arguing that "empty voting would become more difficult under blockchain share registration, which would provide both transparency and early warning of the rearrangement of voting rights prior to an election"). Empty voting refers to the exercise of shareholder voting rights without the underlying economic interest. *See* Henry T.C. Hu & Bernard Black, *Hedge Funds, Insiders, and the Decoupling of Economic and Voting Ownership: Empty Voting and Hidden (Morphable) Ownership*, 13 J. CORP. FIN. 343, 343 (2007); Henry T. C. Hu & Bernard Black, *The New Vote Buying: Empty Voting and Hidden (Morphable) Ownership*, 79 S. CAL. L. REV. 811, 828-36 (2006) (describing the concerns with empty voting); *see also* Jordan M. Barry et al., *On Derivatives Markets and Social Welfare: A Theory of Empty Voting and Hidden Ownership*, 99 VA. L. REV. 1103, 1120–24 (2013); Robert B. Thompson & Paul H. Edelman, *Corporate Voting*, 62 VAND. L. REV. 129, 160–62, 174–75 (2009) (arguing for a prohibition on voting by shareholders without economic interest).

82 Yermack, *supra* note 43, at 9.

83 Yermack, *supra* note 43, at 20.

84 Yermack, *supra* note 43, at 18 ("Better transparency would significantly impact the profit opportunities available to managers, institutional investors, and shareholder activists, among others, because the incentives to acquire ownership and to liquidate it could change markedly if their transactions were observable in real time.").

85 Yermack, *supra* note 43, at 23; Geis, *supra* note 11, at 267-69 (arguing that, while traceable shares would not provide a panacea for shareholder voting, an identifiable present shareholder would be more incentivized to vote that a non-identified shareholder that cannot vote at all or former shareholders, as in empty voting), 272-73 (arguing that the costs of shareholder activism decrease); De Filippi & Wright, Lex Cryptographia, *supra* note 31, at 9-12; Van der Elst & Anne Lafarre, *Blockchain and the 21st century Annual General Meeting*, 14 EUR. COMP. L. 167 *passim* (2017).

86 Lafarre & Van der Elst, *supra* note 13, at 25.

participate more directly in corporate governance and to demand votes on a wider range of topics and with greater frequency than is currently the case.[87] All in all, the advent of CorpTech would justify the opening of "a debate for a new equilibrium of the division of powers between the shareholders and the board of directors."[88] This could result in shareholders assuming indirect control over managerial behavior, reducing the need for the board's monitoring on behalf of shareholders.[89]

### *B. Towards the Algo-Board?*

An even bolder prediction is that machines will replace human (in) boards. There are two components to this view: first, board functions are becoming more challenging for humans;[90] and, second, CorpTech solutions can perform board functions better than humans.

With firms depending more and more on technology, and in an environment ever more characterized by uncertainty and constant disequilibrium,[91] humans may be becoming less fit to serve as board members than machines.[92] In addition, humans may also be less willing: in a fully IT-dominated environment it will become increasingly difficult to find board members that are willing to accept the increased risks associated with a board seat. Humans will in fact be increasingly incapable of reviewing and overseeing self-learning algorithms, yet, as board members, their reputation will be on the line if such algorithms prove to be deficient.

Where humans become either incapable or unwilling to serve as board members, technology will replace them. In particular, tech proponents view CorpTech as having the potential to improve a board's ability to monitor agents and process information, ultimately resulting in the demise of the monitoring board:[93] Hamdani et al. expect that "AI algorithms may become better on average at making governance decisions than individuals due to

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87 Lafarre & Van der Elst, *supra* note 13, at 25.

88 Lafarre & Van der Elst, *supra* note 13, at 25.

89 Bankewitz et al., *supra* note 16, at 63.

90 *See e.g.* Bankewitz et al., *supra* note 16, at 65.

91 *See e.g.* Mark Fenwick & Erik P.M. Vermeulen, *Technology and Corporate Governance. Blockchain, Crypto, and Artificial Intelligence* 5, Tilburg University Working Paper (Oct. 2018) (firms find themselves under new "conditions of radical cognitive and normative uncertainty").

92 *See* Fenwick & Vermeulen, *supra* note 91, at 16-18 (speculating about AI replacing board functions, and taking Alicia T and The DAO as examples); Möslein, *supra* note 16, at 1-2, 7-8, 13-16 (predicting use of AI in the board room and examining the need to adjust the contemporary legal environment to AI's replacing of boards).

93 Hamdani et al., *supra* note 36, at 229.

their superior ability to process information, freedom from biases, and lack of side interests."[94] If one role is left to the monitoring board, it is in the choice of algorithms.[95]

The conclusion is that technology may liberate boards from their monitoring tasks, allowing them to focus on strategic advice instead.[96] As a corollary, board composition will change. In particular, more business and fewer accounting and monitoring experts will be needed.[97]

But a more radical prediction is that boards will not necessarily continue to exist as we know them, namely being populated entirely by humans. From this view, boards' functions, or board seats, may rather be taken over by algorithms. In fact, experiments with the use of AI within boardrooms have been the subject of much hype. While qualifying VITAL as a board member[98] may be nothing more than a publicity stunt,[99] discussions about whether legal personality (so-called e-personhood) should be assigned to algorithms[100] and whether algorithms should be allowed to sit on boards[101] have already started.

## III. THE DEMISE OF THE BOARD: A TECH NIRVANA FALLACY

Can board functions be automated to the point of making corporate boards superfluous? As we have seen in Part II, some scholars have indeed predicted that board's core functions will be better performed by algorithms than by flesh-and-blood directors.[102] Others have argued that, with the help of new

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94 Hamdani et al., *supra* note 36, at 229.

95 Hamdani et al., *supra* note 36, at 230.

96 Hamdani et al., *supra* note 36, at 230; Mark Fenwick, Joseph A. McCahery & Erik P.M. Vermeulen, *The End of 'Corporate' Governance: Hello 'Platform' Governance* 22-23, Lex Research Topics in Corporate Law & Economics Working Paper No. 2018-5 (2018) .

97 Hamdani et al., *supra* note 36, at 230; Fenwick, McCahery & Vermeulen, *supra* note 96, at 22-23 (predicting a greater presence of "digital technology people" in management and boards).

98 *See supra* text accompanying notes 60-60.

99 And the same may be true for the appointment of an artificial intelligence nicknamed ALICIA T as a member of the leadership team of Finnish software company *Tieto's* data-driven businesses unit. *See* Antony Peyton, *Alicia key to Tieto's AI leadership team*, 19 Oct. 2016, *available at*: https://www.bankingtech.com/2016/10/alicia-key-to-tietos-ai-leadership-team/.

100 EUROPEAN PARLIAMENT, COMMITTEE ON LEGAL AFFAIRS, REPORT WITH RECOMMENDATIONS TO THE COMMISSION ON CIVIL LAW RULES ON ROBOTICS (2015/2103(INL)), A8-0005/2017, http://www.europarl.europa.eu/sides/getDoc.do?type=REPORT&reference=A8-2017-0005&language=EN.

101 Gramitto Ricci, *supra* note 17, at 32-40; Möslein, *supra* note 16, at 13-16.

102 *See supra*, Section II.B.

technologies, shareholders will be able to directly oversee management better than directors, rendering boards' monitoring and mediating functions obsolete.[103]

We argue in this section that, at least for the predictable future,[104] both claims are a manifestation of the Tech Nirvana fallacy, that is, the tendency to contrast a perfect technology-enhanced but hypothetical world with the real, imperfect one in which humans currently live. More precisely, the tech proponents' view reflects an excessively optimistic view about the present (and predictable) capabilities of the salient technological developments and disregards the persistence of humans' interaction with, and influence on, technology. We do not dispute the idea that technology *can* greatly improve corporate governance. What we take issue with is tech proponents' prediction that technology will redefine corporate boards' functions, if not make boards obsolete altogether.

We develop our Tech Nirvana fallacy argument regarding a board's monitoring and mediating functions in three steps. First, we briefly describe what boards do and why they do it (section III.A). We then take on the prediction that machines will make the monitoring board redundant (section III.B), before challenging the claim that technology will enable shareholders to oversee managers directly and make mediating boards obsolete (section III.C). We conclude that, although CorpTech will improve boards' performance, their present core functions will remain unchanged.

### *A. Boards' Core Functions*

Before discussing why the tech proponents' view suffers from a Tech Nirvana fallacy, let us first briefly review why we have boards and what they do. Although most readers are likely to be familiar with these concepts, a brief account of boards' core functions will set the stage for the following analysis of why technology in the foreseeable future cannot replace these functions.

The Delaware General Corporation Law (DGCL), as the most important state legislation on corporate law, states that the "business and affairs of every corporation … shall be managed by or under the direction of a board of directors."[105] In practice, however, boards do not manage

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103 *See supra*, Section II.A.

104 *See supra* note 26.

105 DEL. COD. ANN., tit. 8., § 141(a) (2016).

corporations, but rather they direct and monitor management.[106] In a nutshell, boards exercise their rights to steer a corporation by monitoring the top management, in an effort to reduce agency costs (*infra*, at III.A.1).[107] In addition, boards engage as mediators in an effort to reduce conflicts with and between shareholders and stakeholders (*infra*, at III.A.2).[108]

1. The Monitoring Board

As has been well-understood since the times of Berle & Means,[109] the interests of management and shareholders are at odds. Where interests clash, collective action problems among dispersed shareholders and their limited access to information may prevent shareholders from keeping management under control,[110] leaving room for managerial opportunism.[111] In particular,

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106 *See* EISENBERG, *supra* note 66, at 165 (stating that directors' task is to hold executives accountable for adequate results); Stephen M. Bainbridge & M. Todd Henderson, *Boards-R-Us: Reconceptualizing Corporate Boards*, 66 STAN. L. REV. 1051, 1060-62 (2014) (arguing that "the long-term trend has been to emphasize the board's role as monitors of the top management team"); STEPHEN M. BAINBRIDGE, CORPORATE LAW 80 (3d ed. 2015) ("Among the [various board's functions] […], the board's monitoring role reigns supreme").

107 *See* EISENBERG, *supra* note 66, at 165 (stating that directors' task is to hold executives accountable for adequate results); Stephen M. Bainbridge & M. Todd Henderson, *Boards-R-Us: Reconceptualizing Corporate Boards*, 66 STAN. L. REV. 1051, 1060-62 (2014) (arguing that "the long-term trend has been to emphasize the board's role as monitors of the top management team"); STEPHEN M. BAINBRIDGE, CORPORATE LAW 80 (3d ed. 2015) ("Among the [various board's functions] […], the board's monitoring role reigns supreme").

108 *See* Lynne L. Dallas, *The Relational Board: Three Theories of Corporate Boards of Directors*, 22 J. CORP. L. 1, 4-8 (1996) (stating that, in addition to monitoring, the board coordinates assumes a relational role with the external environment including information access and exchange, support of corporate business and ensuring legitimacy and status in the eyes of shareholders and stakeholders); Lynne L. Dallas, *Proposals for Reform of Corporate Boards of Directors: The Dual Board and Ombudsperson*, 54 Wash. & Lee L. Rev. 91, 101 (1997) (outlining the relational role of boards).

109 *See supra*, note 4.

110 *See* ROBERT C. CLARK, CORPORATE LAW 95 (1986) (detailing the effects of rational apathy on shareholder voting). *See also* Lynn A. Stout, *New Thinking on "Shareholder Primacy,"* 2 ACC'T, ECON. & L. 7 (2012) (stating that "shareholders' own rational apathy raises an often-insurmountable obstacle to collective action").

111 *See e.g* OLIVER WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM 47-9 (1985) (stating that opportunism involves self-interested behavior that involves some element of ploy, deception, misrepresentation or bad faith, resulting in management's appropriation of assets or shirking). *See also* ADAM SMITH, THE WEALTH OF NATIONS Book V, Ch. I, Pt. III, Art. II, para f7 (Edwin Cannan ed. 1904) (1st ed. London 1776).("It is the interest of every man to live as much at his ease as he can; and if his emoluments are to be precisely the same, whether he does, or does not perform some very laborious duty, it is certainly his interest […] either to neglect it altogether, or […] to perform it in [a] careless and slovenly a manner").

shareholders have traditionally been unable to act themselves upon any negative signal about managerial performance other than by voting with their feet.[112]

Where shareholder influence is limited, a well-functioning board of directors is one mechanism that can reduce agency costs:[113] an independent board may do better than shareholders at monitoring managers on their behalf. Directors can combine the signals of inferior performance coming from stock prices[114] with their access to inside information[115] in order to gain a better sense of whether negative relative stock performance is due to incompetence, bad luck, or neither: they may well come to the conclusion that managers are simply ahead of their times, *i.e.* busy implementing an idiosyncratic vision that the market is yet unable to comprehend and/or price correctly.[116] Directors also have the incentives to take the necessary steps, because not only are their reputations on the line if they remain passive[117] but they are also increasingly compensated with stock options that are of no value unless the company's stock performance is positive.[118]

They are therefore in the position of fruitfully engaging with managers if their company is underperforming and determining whether the CEO should stay or go. But, of course, monitoring goes way beyond that; in particular it includes three additional tasks.

First, oversight of management implies some degree of involvement

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112 *See e.g.* Edward B. Rock, *The Logic and (Uncertain) Significance of Institutional Investor Activism*, 79 GEO. L.J. 445, 453-57 (1991).

113 In addition to boards, other mechanisms that reduce agency conflicts include reputational incentives, the market for management services, the takeover market, as well as compensation schemes. *See generally* John Armour, Henry Hansmann & Reinier Kraakman, *Agency Problems and Legal Strategies*, *in* JOHN ARMOUR, LUCA ENRIQUES ET AL., THE ANATOMY OF CORPORATE LAW 30-35 (3d ed. 2017) (describing "legal strategies" to reduce agency costs).

114 *See* Gordon, *supra* note 66, at 1563.

115 *See* Enrichetta Ravina & Paola Sapienza, *What Do Independent Directors Know? Evidence from Their Trading*, 23 REV. FIN. STUD. 962 (2009) (finding that independent directors earn positive and substantial abnormal returns when trading in their company shares, which is of course an indication of superior information compared to the market as a whole).

116 *See* Zohar Goshen & Assaf Hamdani, *Corporate Control and Idiosyncratic Vision*, 125 YALE L.J. 560 (2016).

117 *See generally* John Armour, Henry Hansmann & Reinier Kraakman, *Agency Problems and Legal Strategies*, *in* JOHN ARMOUR, LUCA ENRIQUES ET AL., THE ANATOMY OF CORPORATE LAW 29, 35 (3d ed. 2017) (describing independent directors as "guided more strongly by conscience and reputation in making decisions").

118 *See e.g.* David Yermack, *Remuneration, Retention, and Reputation Incentives for Outside Directors*, 59 J. FIN. 2281, 2286-88 (2004).

in strategy setting:[119] a board formally approves a company's strategies, but it does so based on top managers' proposals and the information made available to it by the latter. Given the information disadvantage of (outside) board members,[120] they are unlikely to be in a position to really *define* a company's strategy. That is why a board's approval of strategies is better understood as part of its monitoring function: a board reviews the top managers' definition and implementation of the company's strategy more as a sounding board than as a (real) decision-maker.[121]

Second, a board's monitoring function, usually via one or more of its committees, focuses on the corporation's governance, risk management and compliance (hereinafter, "GRC") systems:[122] the board must oversee the company's internal control system, its risk management processes and policies, and its compliance functions. The board's oversight on GRC systems aims to ensure that, first, the level and characteristics of the risks undertaken by the company are consistent with its risk profile (as resulting also from its strategies), second, that the risk of infidelity on the part of managers and employees is kept low and, third, that violations of the law are reasonably prevented.

Finally, boards are charged with dealing with inherent as well as occasional conflicts of interest between managers and the corporation and therefore play an active role in making sure that executive compensation is in line with the corporation's interest and that managerial self-dealing and other forms of conflicts of interest are kept under control.[123]

### 2. The Mediating Board

In the last few decades, with the reconcentration of ownership in the hands of institutional investors[124] and the rise of giant asset management companies,[125] the focus of boards on monitoring, that we have just sketched

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119 *See e.g.* Renee B. Adams & Daniel Ferreira, *A Theory of Friendly Boards*, 62 J. FIN. 217, 218 (2007) ("active participation in the firm's decision making [including as regards strategy] characterizes the monitoring role of the board).

120 *Ibid*.

121 *Ibid*.

122 *See e.g.* GEOFFREY P. MILLER, THE LAW OF GOVERNANCE, RISK MANAGEMENT, AND COMPLIANCE 73, 543 (2014).

123 *See e.g.* MACEY, *supra* note 59, at 51-54.

124 *See e.g.* Lucian A. Bebchuk, Alma Cohen & Scott Hirst,, *The Agency Problems of Institutional Investors*, 31 J. ECON. PERSP. 89, 91–93 (2017).

125 John C. Coates, *The Future of Corporate Governance Part I: The Problem of Twelve 2*, Harv. Public Law Working Paper No. 19-07 (2018) (arguing that control of most

out, has partly changed. It is the norm, today, for institutional shareholders to engage in a dialogue with both company officers and independent directors. Whether boards should engage in such a relational role has been the subject of discussion among U.S. corporate law scholars,[126] but corporate practice has bypassed the theoretical dispute.

In recent years, institutional investors have pushed hard to establish a two-way communication channel between (non-executive) directors and themselves,[127] thereby breaking management's previously held monopoly in dealing with shareholders. As a matter of fact, the continuous dialogue between a company and its shareholders is increasingly carried out by boards,[128] turning mediation into a second core function of boards.

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public companies will soon be concentrated in the hands of a very small number of people, i.e. large management companies).

126 *Compare* John C. Coates IV, *Measuring the Domain of Mediating Hierarchy: How Contestable Are US Public Corporations?*, 24 J. CORP. L. 837, 840-46 (1999) (detailing cases when the mediating models fails); Stephen M. Bainbridge, *Director Primacy: The Means and Ends of Corporate Governance*, 97 NW. U. L. REV. 547, 559-560 (2003) (arguing that the mediating model has a small domain) *with* Dallas, *The Relational Board*, *supra* note 108, at 3; John H. Matheson & Brent A. Olson, *Corporate Cooperation, Relationship Management, and the Trialogical Imperative for Corporate Law*, 78 MINN. L. REV. 1443, 1446 (1994) (arguing that the board is the right organ to mediate among shareholders and management and holding that relationship management is part of the board's fiduciary duties). *See also*, with a non-shareholder constituencies perspective, Blair & Stout, *supra* note 69, at 288, and more generally, Margaret Blair & Lynn Stout, *Director Accountability and the Mediating Role of the Board*, 79 WASH. U. L. Q. 403, 423-438 (2001) (arguing that corporate law supports the board's mediating role).

127 *See* Giovanni Strampelli, *Knocking at the Boardroom Door: A Transatlantic Overview of Director-Institutional Investor Engagement in Law and Practice*, 12 VA. L. & BUS. REV. 187, 199 (2018) (reporting that U.S. corporations increasingly involve boards, in addition to management, in the dialogue with their shareholders). *See also* Jill Fisch & Simone M. Sepe, *Shareholder Collaboration* 14-15, ECGI Law Working Paper N° 415/2018 (arguing that in a new collaborative model "today's institutional investors bring their knowledge of the market rather than just capital to firms, most often concerning corporate governance and strategic planning").

128 *See* Bainbridge & Henderson, *supra* note 106, at 1061 (arguing that shareholder relationship management is an important board task); Strampelli, *supra* note 127, at 197-200 (reporting that U.S. corporations increasingly involve boards, in addition to management, in the dialogue with their shareholders). *See also* MCKINSEY & COMPANY, THE BOARD PERSPECTIVE – NUMBER 2: A COLLECTION OF MCKINSEY INSIGHTS FOCUSING ON BOARDS OF DIRECTORS 49 (Mar. 2018), *available at* https://www.mckinsey.com/featured-insights/leadership/the-board-perspective-number-2 (arguing that in 2017 boards have spent 9% of their meeting time on shareholder and stakeholder management, up from 0% in 2013).

### *B. Automation of Monitoring as the Solution?*

In sharp contrast with tech proponents' predictions, this section argues that the idea that CorpTech can make better board-level decisions than human-populated boards rests on an optimistic assessment of what technology can do and an overly simplistic view of a board's functions. Similar to how, up until today, operational, financial, legal, accounting, or risk experts advise boards, which then come to their own conclusions based on those experts' input, CorpTech can and will inform board members about options and opportunities but cannot replace them. We first discuss the tech arguments against the demise of the monitoring board (III.B.1) and then turn to the inherent traits of corporate governance that justify the prediction of monitoring as a persistent function of corporate boards (III.B.2).

#### 1. IT Limitations

Technology can clearly help avoid humans' decision-making errors and cognitive biases.[129] But technology has its own limits, which makes the proposed scenario of machines replacing boards less than compelling. Some of these limits[130] are outlined in this section. We summarize these issues in an effort to demonstrate that technology is no panacea and comes with its own very particular issues. Even once the sophisticated CorpTech is in place, boards can remedy CorpTech's deficiencies and thus prove themselves as necessary complements to the technology.

##### a. Data dependency

Technology has data dependency issues: an algorithm is only as good as the data it works with, as early contributions on AI and corporate governance have already highlighted.

First, despite claims to the contrary,[131] the data may suffer themselves

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129 *See e.g.* Cass R. Sunstein, *Algorithms, Correcting Biases*, SOC. RES. (forthcoming 2019) (arguing that algorithms can be designed to be unbiased and perform certain tasks better than biased humans). *But see supra* note 57 and *infra* text accompanying notes 132-136.

130 We do not discuss in this section two other very obvious problems with current IT solutions: deficient coding as a result of human inaccuracy and exposure to cyber risks. While currently troublesome, workable solutions are likely to be found for these issues in the predictable future.

131 *See supra* text accompanying notes 56-57

from biases. Where data of the past reflect biases so too will the machine results:[132] the data could reflect the biases of prior decision-makers[133] or biases that persist in society at large. As Solon Barocas and Andrew D. Selbst have put it: "data mining can discover surprisingly useful regularities that are really just preexisting patterns of exclusion and inequality."[134] In most cases, neither the programmers nor the coders are aware of either any particular deficiencies in the data set or the ensuing discrimination.[135] Take the example of social media's self-pricing advertising algorithm, which steers educational ads toward potential students. An analysis revealed that an algorithm designed to be gender-neutral still steered advertising for science, technology, engineering and mathematics courses to more men than women because the algorithm priced advertisement to women higher than advertisement to men; as a consequence, for a given budget more men than women were exposed to the advertisement.[136]

Second, machine learning depends on the training data. The "learning" of a machine refers to identifying patterns in existing data sets where instances of, say, fraud, insider trading or market manipulation are prelabeled as such. The machine then looks for patterns (*i.e.* a recurring subset of characteristics) among the labeled cases without using explicit instructions. That subset of recurring characteristics can then be used for all other data sets; where the subset characteristics are found to be present, the machine will assume that fraud, insider trading or market manipulation are also present. What the machine "learns" depends on the examples it has been exposed to, as well as on the quality of the labeling. The closer the training data to the real-world application, the better the predictive ability of the AI.[137]

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132 *See* Barocas & Selbst, *supra* note 6, at 617.

133 *See* Rashia Richardson, Jason M. Schultz & Kate Crawford, *Dirty Data, Bad Predictions: How Civil Rights Violations Impact Police Data, Predictive Policing Systems, and Justice*, 94 N.Y.U. L. REV. 192, 204-217 (2019) (detailing examples of manipulated data in the criminal justice system, reflecting racial bias).

134 *See* Barocas & Selbst, *supra* note 6, at 617.

135 Conscious choices may, however, be the result of conflicts of interests (*see infra*, III.B.2.b.). This does not exclude that we see some incidences of corrupt, racially or gender biased, or otherwise illegal practices, *see* Richardson et al., supra note 133, at 193-197 (detailing examples of such practices in the context of predictive policing).

136 *See* Anja Lambrecht & Catherine Tucker, *Algorithmic bias? An empirical study into apparent gender-based discrimination in the display of STEM career ads*, 65 MGMT. SC. (forthcoming 2019) (manuscript available at https://ssrn.com/abstract=2852260) (analyzing an advertisement algorithm intended to be gender-neutral in its delivery and concluding that any algorithm that simply optimizes cost-effectiveness in ad delivery will deliver ads in an apparently discriminatory way).

137 *See* RUSSEL & NORVIG, *supra* note 27, at 706-708 (describing preconditions of learning from examples).

For instance, a data set taken from Enron Corporation has often been used to train many AI-enhanced compliance tools.[138] As we know today, Enron's internal communication methods and (bad) governance were in many respects outliers, even compared to the less governance-aware corporate world of Enron's times.[139] Intuitively, AI that has been trained with outlandish and incomplete data from Enron will lack predictive accuracy for many, if not most, firms.

Third, if the AI training is done with data from the individual firm using the AI CorpTech product in order to increase CorpTech's analytical power, data availability may emerge as an issue. Even where firms have the right to use or transfer data,[140] small- and medium-sized firms are likely to lack data pools of sufficient size to train the technology,[141] while large firms that collect sufficient data may hesitate to share firm-specific data with external developers: in an environment where "data is the new oil,"[142] these data may be too valuable to share as they, or the training results thereof, can be, respectively, copied and (once incorporated into services) sold to competitors. Worse still, external developers may become competitors themselves after assembling a large enough data pool.[143]

The data dependency problems highlighted so far reflect the current

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138 *See* Armour & Eidenmüller, *supra* note 15, at 13 (stating that machine learning developers use coaching data from widely available data sets, such as the Enron email data set that was originally put online by the U.S. Federal Energy Regulation Commission (FERC)). The data set contains data from about 150 users, mostly senior management of Enron, with a total of about 0.5M messages, and is available for download at https://www.cs.cmu.edu/~./enron/.

139 On Enron *see supra note* 20 and accompanying text. In addition, 20-year-old communications are now outdated and exhibit language peculiarities. *See* Armour & Eidenmüller, *supra* note 15, at 13 (highlighting the limited use of the Enron data set for machine learning coaching). Furthermore, the e-mails' text had been redacted in response to privacy concerns and attachments to messages had been deleted to reduce data size. *See* William W. Cohen, Enron Email Dataset (2015), https://www.cs.cmu.edu/~./enron/.

140 The data pool available for Corptech training may be limited by legal barriers, including data protection, intellectual property laws and confidentiality agreements signed with customers and business partners. *See* Armour & Eidenmüller, *supra* note 15, at 14-15.

141 *See* Armour & Eidenmüller, *supra* note 15, at 14.15.

142 The origin of this sentence is uncertain. One of the earliest sources to use it dates back from 2006. *See* Michael Palmer, Data is the New Oil, Nov. 3, 2006, http://ana.blogs.com/maestros/2006/11/data_is_the_new.html (stating that "[d]ata is just like crude. It's valuable, but if unrefined it cannot really be used. It has to be changed into gas, plastic, chemicals, etc to create a valuable entity that drives profitable activity; so must data be broken down, analyzed for it to have value").

143 *See* Zetzsche, Buckley, Arner & Barberis, *supra* note 6, at 399-415 (analyzing the entrance of big data firms like Alibaba, Amazon, Apple, Baidou, Google, Microsoft, Tencent and Vodafone into the financial services sector and labelling those firms "TechFin").

state of the relevant technologies. These problems are likely to be overcome in the foreseeable future, thanks to progress in the relevant technologies. For instance, an application for bias analysis may recognize and remedy the impact of biased data; and the publicly available data pools can become large enough to allow for accurate training. Even then, however, the core issue with data dependency, namely, its backward orientation, will remain unresolved: in real life, it is normally the case that the right answers to the questions defining the success or failure of a firm, such as whether to enter a new market or to leave the CEO in place, cannot be found exclusively through past data. Those decisions could be supported by AI-based predictions, but in the end require something very human: judgment.[144]

Finding some regularities in past data (however recent and big) is more useful in some areas, such as medical diagnoses and stock trading, than in others, such as social dynamics. Human behavior is not totally predictable, as markets and people's preferences evolve and technology itself drives these changes. Because humans adapt to changes, responses to a given context that were observed regularly in the past will not necessarily be good predictors of the future. To generalize, complex, dynamic human interactions, such as those that take place within organizations that, in turn, have to interact with other organizations and an indefinite number of individuals (stakeholders, consumers, etc.), lend themselves poorly to correlation analysis.

b. Conflicts with human ethics

Machine objectives often conflict with human ethics.[145] Unfortunately,

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144 *See* Harry Surden, *Machine Learning and Law*, 89 Wash. L. Rev. 87, 97-98 (2014) (arguing that AI approximates intelligence by detecting proxies, patterns, or heuristics, and emphasizing that many complicated problems "may not be amenable to such a heuristic-based technique" and using the decision on a potential merger as example, given the scale, complexity, and nuance, with so many considerations, that a simple [approximation] would be inappropriate"); Mohammad Hosssein Jarrahi, *Artificial Intelligence and the Future of Work: Human-AI Symbiosis in Organizational Decision Making*, 61 BUS. HORIZONS 577, 580 (2018) (arguing that "[u]nlike board games, in which the probability of the next action can be calculated, real-world decision making is messy and reliance on probabilistic, analytical thinking tends to be insufficient."); Ajay Agrawal, Joshua S. Gans & Avi Goldfarb, *What to Expect from Artificial Intelligence*, MIT SLOAN MGM'T REV. DIGITAL 7 (2017), http://mitsmr.com/2jZdf1Y (expecting that "[i]ncreasingly, the role of the manager will involve determining how best to apply artificial intelligence. […] Managing in this context will require judgment both in identifying and applying the most useful predictions, and in being able to weigh the relative costs of different types of errors.").

145 Take the drastic example of a system designed to improve the well-being, or end the suffering, respectively, of a human being suffering from an incurable sickness. If the systems' limits do not include ethical restrictions (such as appreciating life as such) and other

training machines in ethical matters often falters since ethical "norms are fuzzy."[146] Even human actors often cannot tell what prompts their value judgments. Morally wrong algo-made determinations can seriously harm a firm's reputation and its share price, as illustrated by Facebook's inability, or possibly unwillingness, to fix its algorithms in order to filter contents on its platforms in real-time even where the most inappropriate content had been uploaded.[147] Because reputational risk is a core consideration of GRC functions, we expect boards of directors to remain in charge of the oversight of such aspects even in a CorpTech world.

c. Inferior handling of incomplete law

Where an incident (a violation of the law or an employee's wrongdoing) is reported, by IT or other means, it is far from clear as to whether the same response will consistently follow. In fact, most GRC issues imply discretion, even for cases that are very similar to prior ones. Hence, a pre-determined 1/0, yes/no algorithm will be unable to reach good decisions on how to react.[148] This is the inevitable implication of the incompleteness

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opportunities such as cheerful company are not available, the system could conclude that ending the human's life is the best solution. *See* RUSSEL & NORVIG, *supra* note 27, at 1052. *See also* Dirk Lindebaum, Mikko Vesa & Frank den Hond, *Insights from* The Machine Stops *to Better Understand Rational Assumptions in Algorithmic Decision-making and Its Implications for Organizations*, ACAD. MGMT. REV., *in press* (manuscript at 28-37) (discussing conflicts with human ethics and machine objectives).

146 Eric A. Posner, *Law, Economics, and Inefficient Norms*, 144 U. PA. L. REV. 1697, 1699 (1996); *see also* John C. Coffee, *Do Norms Matter? A Cross-Country Evaluation*, 149 U. PA. L. REV. 2151, 2175 (2001) (arguing that "[n]orms do matter [in steering human behavior], but exactly when and to what extent remain more problematic issues").

147 *See e.g.* Giles Turner & Molly Schuetz, Facbook's Live Streaming Is Criticized After Mosque Shooting, 15 March 2019 (https://www.bloomberg.com/news/articles/2019-03-15/facebook-s-live-streaming-is-criticized-after-mosque-shooting) (stating that live footage streamed by the terrorists pursuing the attack on the mosque in Christchurch, New Zealand, was available on platforms Twitter and YouTube hours after being first uploaded to the alleged shooter's Facebook account). *See also* Julia Carrie Wong & Kari Paul, *Sri Lanka's Social Media Blackout Reflects Sense That Online Dangers Outweigh Benefits*, 22 April 2019 (https://www.theguardian.com/world/2019/apr/22/sri-lankas-social-media-blackout-reflects-sense-that-online-dangers-outweigh-benefits).

148 1/0 is the paradigm of Boolean logic. But human judgment follows neither Boolean logic nor any other conventional mathematical discipline. This is also true when you soften the 0/1 paradigm using probability theory or fuzzy logic (since fuzzy logic can operate with all infinite values within the interval <0, 1>. *See e.g.* Václav Bezděk, *Using Fuzzy Logic in Business*, 124 PROCEDIA - SOC. & BEHAVIORAL SCI. 3 7 1, 372-379 (2014)). Whether an observer holds an incident to be probable (from her subjective point of view) or whether she puts an incident into the "more negative rather than positive" box (using fuzzy logic, which requires preferences in a given order) is the outcome of an ethical assessment applying an *ad hoc* mix of factors and resulting in the qualification of conduct as likely (probability) or

that characterizes the legal environment, where not only are contracts incomplete, but so too is the law itself:[149] neither contracts nor the law can provide for clear-cut rules for every situation. Drafting exhaustive contracts and laws would be incredibly expensive and, in fact, outright impossible, and so too would the creation of a CorpTech solution attempting to do just that.[150] Indeed, even assuming that the effort of drafting such a potentially infinite set of clear-cut "yes-no" rules was undertaken, it would most likely restrict firms in their development and evolution: firms are quintessentially tools used to cope with bounded rationality, uncertainty and changing environments.[151] Governance arrangements themselves are incomplete on purpose, and hence unfit for strict tech-based execution. It is a board's task to continue writing chapters of the corporate contract where necessary.

Even where a board finds that management is in fact responsible for a GRC failure, a formal sanctioning reaction might not always be warranted: handling GRC situations will often involve an aspect of judgment and/or adjudication under conditions of significant uncertainty regarding the response of the sanctioned person(s) and that of stakeholders (including employees, the public and others), resulting in the discretionary, creative and non-rule based decision-making that is, at least for the predictable future, part of the human skillset that machines are unlikely to be able to replicate.[152] In an environment that is otherwise under the increasing influence of technology, the board brings in the unpredictable, and yet indispensable human factor.

To sum up on this point, rather than undermining the board's role, GRC CorpTech is bound to *strengthen* it.

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"more harmful than helpful" (fuzzy logic). If the factors that justify 0 or 1, a given probability assessment or the preferences for fuzzy qualification are impossible to discern ex ante, they cannot be put into code.

149 *See generally* HERBERT L.A. HART, THE CONCEPT OF LAW (2d ed., 1994), 127-28, and, more recently, Katharina Pistor & Chenggang Xu, *Incomplete Law*, 35 N.Y.U.J. INT'L L. & POL. 931, 938-44 (2003). With specific reference to compliance issues, *see* Donald C. Langevoort, *Caremark and Compliance: A Twenty Year Lookback*, 90 TEMPLE L. REV. 727 (2018) (arguing that "complication arises from the subjective nature of law and legal risk. Law is often full of ambiguity, even when factual questions are posed clearly."). *See also* from an ethical perspective Davis, *supra* note 7, at 10-13 (arguing that AI is incapable of mimicking value-based decisions since it misses the first person perspective).

150 *See* Aghion et al., *supra* note 64, at 41-42 (arguing that AI technologies will not overcome contractual incompleteness).

151 See *infra*, at 154-155.

152 *See* Dylan Hadfield-Menell & Gillian K. Hadfield, *Incomplete Contracting and AI Alignment*, especially at 6-7, University of Southern California Legal Studies Working Paper 265 (2018) (arguing that coders are yet incapable of replicating norms and standards that grant discretion to their addressees).

2. Governance's Inherent Traits

a. The incomplete corporate contract

A corporation is often described as a nexus of contracts,[153] that is, a bundle of formal and informal relationships among the various stakeholders. These contracts are incomplete, and intentionally so, since writing a multiplicity of complete contracts between a firms' stakeholders would be either excessively costly or unduly constraining.[154] For these reasons, governance arrangements are incomplete on purpose, and hence unfit for strict tech-based execution. It is a board's task to continue writing chapters of the corporate contract where necessary. Corporate governance provides the tools to deal with such incompleteness: as circumstances change and new information becomes available, management, boards and shareholders react by making decisions, each in their own sphere, that allow for adaptation and optimization to a degree that ex ante planning could not match.[155]

CorpTech will not eradicate contractual incompleteness, whether by perfect ex ante planning or by better-than-human ex post decisions. Such eradication would require not only access to, and correct processing of, *all* existing data in the world (something that CorpTech may well provide for in the future), but also the ability to predict all future developments. In a non-deterministic world like the one that humans inhabit, and where humans still take meaningful decisions, such eradication obviously exceeds what even the

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153 *See e.g.* Frank H. Easterbrook & Daniel R. Fischel, *The Corporate Contract*, 89 COLUM. L. REV. 1416, 1426 (1989).

154 *See generally* FRANK H. EASTERBROOK & DANIEL R. FISCHEL, THE ECONOMIC STRUCTURE OF CORPORATE LAW 91-93 (1991). This point is explicitly recognized and reflected upon in the literature on new technologies. *See* Sklaroff, *supra* note 9, at 263 (arguing that human-based contracting is flexible due to inherent incompleteness, while machine-based contracting creates new inefficiencies from automation, decentralization and anonymity, and warning that it is "extremely costly to form smart contracts in a volatile environment or whenever there's a level of uncertainty surrounding the agreement"); Adam J. Kolber, *Not-So-Smart Blockchain Contracts and Artificial Responsibility*, 21 STAN. TECH. L. REV. 198 (2018) (arguing that the code does not reflect the entirety of the parties' agreement and that "unadulterated commitment to the code-is-the-contract slogan increases artificial responsibility and its associated risks"); Hadfield-Menell & Hadfield, *supra* note 152, especially at 12 (emphasizing "parallels between the challenge of incomplete contracting in the human principal-agent setting and the challenge of misspecification in robot reward functions").

155 *See generally* Easterbrook & Fischel, *supra* note 153, at 1437-39 (arguing that the contract adopted as optimal ex ante may not be optimal ex post, for instance due to changing circumstances such as a takeover bid).

most powerful machines can muster. Any set of codes predicting future events would require a significant level of speculation and thus would be certain to be flawed (notwithstanding its high costs).

To be sure, the benchmark of technology, and AI in particular, is not perfection, but human parity.[156] Any CorpTech solution yielding *better* monitoring outcomes than human boards would justify algorithmic boards. And it is easy to acknowledge that human boards are themselves far from perfect in writing the incomplete corporate contract. Arguably, they are also limited in their ability to learn, as recurring governance scandals demonstrate. Still, one thing human boards are, and can be predicted to be for a long time, better than CorpTech at is *complex* interactions with humans.[157] Take the example of the 1MDB scandal.[158] After the role of Goldman Sachs came to light, the investment bank was forced to switch to political mode, in order to minimize the reputational damage and the sanctions from regulators.[159] Such a mode includes intense lobbying action, public relations efforts, and generally presenting in a positive light a firm's corporate culture, values and ethics. Soft skills and fuzzy matters such as these are unsuitable for automation:[160] any sufficiently intricate, politically charged matter requires humans to interact with humans.

b. Conflicts of interest

Technologies are not "impartial" tools: they assist their creators in settling affairs within a community according to their preferences.[161] So long as algorithms are written by humans and, even more importantly, sold to humans, claims that algorithms can be non-conflicted or neutral are ill-founded: CorpTech solutions are bound to reflect the interests and views of those ultimately in control of the code selection and design process. If, as has hitherto been the case across corporations, management wields influence over

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156 *See supra* note 27 and accompanying text.

157 *Simple* communication between machines and humans does take place regularly and frequently.

158 *See supra* note 1 and accompanying test.

159 *See e.g.* Laura Noonan, *Goldman Eyes Monitoring of High-Risk Staff after 1MDB*, FIN. TIMES (New York), Dec. 2, 2018, at 13 (reporting that Goldman Sachs was "considering a special surveillance programme to monitor higher risk employees in far-flung locations so the bank can demonstrate that 'lessons have been learned' from the 1MDB scandal").

160 *Cf.* Hadfield-Menell & Hadfield, *supra* note 152, at 12 (acknowledging that "alignment of artificially intelligent agents with human goals and values is a fundamental challenge in AI research").

161 *See* LANGDON WINNER, THE WHALE AND THE REACTOR: A SEARCH FOR LIMITS IN AN AGE OF HIGH TECHNOLOGY 21-22 (1986). *See also* Hadfield-Menell & Hadfield, *supra* note 152, at 1.

the CorpTech system as a component of its IT system,[162] then CorpTech solutions will reflect management's interests and views. If management's incentives are not perfectly aligned to those of their principals, then boards' (and shareholders') trust in the relevant CorpTech will be misplaced.[163]

If management believes a certain data correlation signals a profit opportunity that would positively affect the value of its compensation, or if management believes that it can influence that correlation to its own benefit, it may instruct the coder (whether a firm's employee or an independent supplier) to make use of that data correlation and disregard other correlations which may be more significant for the purposes of maximizing shareholders' welfare. Take the example of how to determine variable pay: a formula will be used for that purpose and that formula can be expressed as an algorithm. Management has two illicit ways to influence the outcome. The first is the way management commonly turned to in the past when "backdating options;"[164] this involves manipulation of the data processed by the algorithm. CorpTech facilitates the use of a second method that is more difficult to detect: implementing the formula in code so that input of the *correct* data leads to the results desired by management (i.e. performance-related pay) more often than not.

The coders (perhaps with the help of their marketing departments if they are independent suppliers) will know who, within each corporation, is in charge of selecting them as code suppliers and directing their work. They will naturally make product choices that fit such buyers' interests.

To illustrate this general point about conflicted coding, take the troublesome issue of managerial compensation. It has been debated whether this is an area where abuse and suboptimal bad practices are ripe, be it because CEO compensation packages are excessive or because prevailing compensation practices generate skewed incentives for managers.[165]

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162 Chief Information (or Technology) Officers usually report to the CEO or the CFO: *see e.g.* ALEXANDER HÜTTER & RENÉ RIEDL, CHIEF INFORMATION OFFICER ROLE EFFECTIVENESS. LITERATURE REVIEW AND IMPLICATIONS FOR RESEARCH AND PRACTICE 12 (2017).

163 In other words, the governance risk of CorpTech does not stem from "bad coding" in a technical sense, but from the fact that code developed under management influence is bound to be skewed towards management's interests. *Cf.* John Armour, Luca Enriques, Ariel Ezrachi & John Vella, *Putting Technology to Good Use for Society: The Role of Corporate, Competition and Tax Law*, in 6 J. BRITISH ACAD. 285, 298 (2018) ("the incentives of the persons designing a firm's internal performance monitoring systems are likely to become even more significant").

164 *See supra*, note 43.

165 *Compare* Lucian A. Bebchuk, Jesse M. Fried & David I. Walker, *Managerial Power and Rent Extraction in the Design of Executive Compensation*, 69 U. CHI. L. REV. 751 *passim* (2002) (arguing that structural flaws in corporate governance have enabled

Contrary to the tech proponents' view,[166] unless the analogic mechanics of executive compensation setting are fixed, digital solutions will be insufficient. If the current system relying on compensation consultants selected by independent board committees and assisting the latter in their determinations is flawed,[167] then there is little reason to believe that an algorithm will improve upon current practices: it would rather reflect any flaws arising from such practices. What it can achieve is the devising of the perfect compensation package *that the existing compensation practices allow for*: this is a different kind of perfect—perfect not in the sense of being optimal for shareholders, but in the sense of perfectly processing all relevant information and at the same time perfectly catering to the interests of those who control the process and are responsible for compensation decisions.

### c. Information flows

The biggest hindrance to a more balanced distribution of power between management, boards and shareholders in publicly held corporations is management's exclusive access to the inner workings of the corporate business and its ensuing filtering role as regards the information set that is needed to monitor its performance.[168] Can IT solutions overcome such a hitherto inevitable corporate governance trait? So long as management retains control of the coding, data sources and algorithms used for reporting

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managers to influence their own pay and extract rents to the detriment of shareholders) *with* Kevin J. Murphy, *Explaining Executive Compensation: Managerial Power Versus the Perceived Cost of Stock Options*, 69 U. CHI. L. REV. 847 *passim* (2002) (criticizing Bebchuk, Fried and Walker's theses) and Steven N. Kaplan, *Are US CEOs Overpaid?*, 22 ACAD. MGMT. PERSP. 5, 8-14 (2008) (criticizing the view that US CEOs are overpaid and not paid for performance).

166 As we have seen *supra* notes 43-45 and accompanying text, some have suggested that AI and Big Data may allow a company to consider all relevant information and possibly learn from other companies' best practices to devise the optimal compensation package, while smart contracts could make the compensation arrangement harder to alter in opportunistic ways further down the road.

167 The jury, of course, is still out on whether executive compensation is more a solution to, or a manifestation of, managerial agency problems. For a recent discussion of the various facets of the problem *see e.g.* Guido Ferrarini & Maria Cristina Ungureanu, *Executive Remuneration*, *in* THE OXFORD HANDBOOK OF CORPORATE LAW AND GOVERNANCE 334 *passim* (Jeffrey N. Gordon & Wolf-Georg Ringe eds., 2018).

168 *See e.g.* EISENBERG, *supra* note 66, at 144 ("the amount, quality, and structure of the information that reaches the board is almost wholly within the control of the corporation's executives"). *Cf. also* Bengt Holmlström, *Pay without Performance and the Managerial Power Hypothesis: A Comment*, 30 J. CORP. L. 703, 711 (2005) (highlighting how boards need to have the CEO's trust for the latter to be willing to share essential information about the company's with the former).

to a board (which may well be inevitable for the reasons outlined in Section III.B.1.a.), the answer is no.

Take again here the example of executive compensation. Optimal compensation packages are firm-specific rather than one-size-fits-all. Hence, coding optimal compensation models requires in-depth firm-specific and forward-looking information, which is usually monopolized by management. If management is involved, it can be expected to use its superior knowledge to make sure that the code reflects its interests.

In an environment, like that of today and the predictable future, where it has become impossible to let boards handle data themselves due to their sheer volume, filtering is in fact even more crucial, and prone to opportunistic manipulation, than in the past. When an AI CorpTech product processes data, understanding the extent to which management manipulates a board by providing more or less data than necessary and whether the algorithm presents them in an unbiased way is increasingly difficult. The risk of algo-supported board members becoming executives' puppets without the slightest suspicion of being manipulated may be even higher than for analogue boards. In fact, well-functioning analogue boards are trained to second-guess the completeness and reliability of the supporting information selected by the CEO. They may rely on their experience and on their instincts. In an algorithmic world, these instincts may prove less useful and it may be harder to question the completeness and reliability of information that a supposedly objective machine, rather than a self-interested human, has selected and processed.

### *C. The Board Disintermediation Hypothesis*

Involvement in shareholder dialogue grants independent directors an important mediating role between shareholders and the company's management. The mediating role is premised on shareholder identification and shareholder intelligence: companies have to get to know their shareholders (something that DLTs will facilitate[169]). In addition, if companies are to secure shareholder backing, they also have to know their individual shareholders' preferences. Shareholder dialogue, finally, is more than simple information transmission (something at which CorpTech is particularly good): it can include conveying the difficult task of persuading shareholders that something (apparently) at odds with their preferences should nevertheless be given support. In practice, this often involves various rounds of negotiations and requires – as we argue in this section – a significant

169 *See* the examples *supra* notes 38-41 and accompanying text.

degree of human judgment.

Tech proponents argue that CorpTech will change the (relatively new) mediating role of a board in two ways: first, it may enable shareholders to monitor themselves, making a board's monitoring of management on their behalf obsolete. In a CorpTech-dominated environment where the costs of shareholder engagement, and voting in particular, are greatly reduced, direct shareholder-to-management relations may substitute for the present board-centered governance framework.[170] Second, CorpTech could make the mediating functions of non-executive members similarly passé, as the new information tools may allow shareholders to directly engage with management just as effectively. We call these two possible developments, together, the board disintermediation hypothesis.

We argue in this section that the board disintermediation hypothesis is flawed: again, it disregards IT limitations and inherent governance features which technology cannot cure.

1. Governance's inherent features

The board disintermediation hypothesis rests on two assumptions: first, that CorpTech allows for real-time accounting and "full transparency;" and, second, that CorpTech further reduces the cost of processing available information and of deciding on how to vote. The combination of the two should enable shareholders to do the monitoring board's job themselves. We do not question the technical possibility of processing and analyzing an unlimited volume of information (and we also leave apart the fact that DLTs reduce the risk of data manipulation but do not ensure that data stored via DLTs are correct[171]). We argue instead that the full transparency assumption is unrealistic; even if it was well-grounded, shareholder monitoring would still be patchy at best. In addition, we contend that shareholder dialogue exclusively involving executives, rather than directors, would lead to inferior outcomes.

a. Information asymmetry is part and parcel of corporate governance and trading markets

Corporations are engines of innovation. Shareholders delegate the power to conduct a company's business to a management team, which has full control over this company's operations under the board's oversight. Delegation is also needed to preserve confidentiality of a company's plans and strategies,

170 *See supra* section II.A.2.

171 *See e.g.* Zetzsche, Buckley & Arner, *supra* note 8, at 374.

which in turn is necessary for it to make profits. This is a simple fact that is ignored in the assumption that technology-enabled full transparency can be realized.[172]

While issuer disclosures, whether mandatory or voluntary, have become more frequent and richer,[173] it is still the case that U.S. corporations can be particularly reticent when it comes to discussing one's plans, strategies, R&D projects, and anything that may be of crucial interest to competitors. One example of that is Apple's protracted silence over its Apple Watch sales: while analysts agree that such sales figures would be extremely valuable information for investors,[174] U.S. securities regulation does not require Apple to disclose it and Apple's management has consistently refused to voluntarily provide the market with the relevant figures.[175]

Not only are corporate disclosures bound to remain patchy, but it is also highly unlikely that technology will prevent traders from concealing their trades. Tech proponents themselves acknowledge this, presenting the scenario of full trading and ownership transparency as just one option that may become available on the market for individual issuers to choose.[176] We find it improbable that even the issuers most worried about hostile takeovers and activist campaigns will consider that kind of trading environment as the solution to their problems. Other tools exist that allow firms to insulate themselves from such phenomena without making it impossible for informed traders to gain from their superior information and, in the process, ensure that markets are informationally efficient.

Note, incidentally, that our argument against the idea that full transparency can be achieved is independent of technical progress. In particular, *some* information asymmetry will persist even where, in line with Moore's law, the amount of data processors will grow exponentially,[177] and

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172 *See e.g.* Kevin S. Haeberle & M. Todd Henderson, *Making a Market for Corporate Disclosure*, 35 YALE J. ON REG. 383, 391-92 (2018) (highlighting how sharing information about a firm's successes and failures may have a negative impact on its profitability).

173 *See* Gordon, *supra* note 66, at 1545-61.

174 *See e.g.* Don Reisinger, *Here's How Popular Apple Watch Was Last Quarter*, FORTUNE, Feb. 8, 2017, available at http://fortune.com/2017/02/08/apple-watch-2016-sales/ (reporting analysts' estimate of Apple Watch's sales during the fourth quarter of 2016).

175 Reisinger, *supra* note 174 ("While Apple has said that its smartwatch is popular, the company has never revealed actual sales figures. Apple CEO Tim Cook has argued that sharing sales figures could help competitors"); *cf. also* Haeberle & Henderson, *supra* note 172, at 392-94 (using the example of Apple's iPad sales to illustrate how disclosure thereof would lead to an increase in the share price in the short-term, but also to reduced cash-flows in the longer term).

176 Yermack, *supra* note 43, at 18.

177 According to Intel's founder Gordon Moore's prediction in 1965 (referred to as Moore's law), the number of transistors that could be fixed per square inch on integrated

where, in line with Kryder's law, data storage capacity will also grow exponentially.[178] Both laws support the view that the amount of data available for analytics and the speed of data analytics will increase rapidly in the next decades. Super-fast AI processing and super-powerful DLT-based storage does not ensure that all inside information will be made available to shareholders, because *some* secrecy is in the obvious interest of the corporation.

b. Passive and closet index funds: collective action problems are bound to persist

Even in a world with lesser (or no) information asymmetry, the board disintermediation hypothesis disregards the real problem with informed voting: rational reticence. If a passive mutual fund invests in information in order to cast the right (shareholder-value maximizing) vote, it will improve a company's stock performance (assuming it is right), which means that free-riding competitors will gain more than the passive mutual fund does.[179] Unless the costs of getting informed and voting become negligible, technology will not alter the incentive of passive institutional investors (and closet index funds[180]) to remain reticent. We expect reticence to be particularly persistent given the increasing market share of passively

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circuits doubles every two years, while the costs are halved. Moore's law predicted an enormous increase in data processing capacity. *See* Gordon E. Moore, *Cramming More Components onto Integrated Circuits*, ELECTRONICS, Apr. 19, 1965, at 114, *reprinted in* 86 PROC. IEEE 82 (1998). To this day, Moore's law has held true. *See, e.g.*, Chris A. Mack, *Fifty Years of Moore's Law*, 24 IEEE TRANSACTIONS ON SEMICONDUCTOR MANUFACTURING 202, 202-03 (2011).

178 Mark Kryder was a Seagate Corp.'s senior vice president of research and chief technology officer who focused on information storage throughout his life. Former CNN journalist Chip Walter honored Mark Kryder's lifetime achievement in an article highlighting the rising hard-disk capacity against the background of rising processor capacity (referred to as Moore's law, *see supra* note 177). *See* Chip Walter, *Kryder's Law*, SCI. AM., Aug. 2005, at 32. *See also* Katz, *supra* note 7, at 916 (discussing Kryder's law as a precondition for big data analytics).

179 *See* Ronald J. Gilson & Jeffrey N. Gordon, *The Agency Costs of Agency Capitalism: Activist Investors and the Revaluation of Governance Rights*, 113 COLUM. L. REV. 863, 867 (2013).

180 In addition to overtly passive index funds, a number of "closet index funds" exist that are marketed as actively managed funds but de facto replicate the composition of entire markets or segments thereof. *See* K.J. Martijn Cremers & Quinn Curtis, *Do Mutual Fund Investors Get What They Pay for: Securities Law and Closet Index Funds*, 11 VA. L. & BUS. REV. 31, especially at 46-67 (2016) (finding that 10 percent of mutual fund assets can be categorized as closet index funds).

managed mutual funds in the asset management market.[181]

Delegating the whole process of deciding how to vote to a machine would drive down the (marginal) costs of becoming informed and voting to close to zero: an algorithm would gather all available information, evaluate it according to a set of criteria and present a voting recommendation. That, albeit with a human touch, is what proxy advisors already do.[182] It is immediately clear, though, that developing proprietary software for these purposes would be too large an investment for an institution that mainly competes on management fees. Existing providers of proxy services are thus most likely to be the ones that will come up with such a product. Alternatively, perhaps asset management services providers, such as BlackRock, could develop this product as part of their management and administration analytics tools.[183] BlackRock itself, though, is an unlikely supplier of such a product: were it also to provide the tools for determining other institutions' voting decisions, existing concerns about the disproportionate power of behemoth institutional investors would increase. The prospect of a negative political reaction would likely discourage BlackRock (or other large players in the asset management industry) from entering into the proxy advice and voting processing market.[184]

Even if we assume, for the sake of argument, that one large investment house develops voting decisions algorithms, it is open to question whether an algorithm would, on average, do better at issuing voting recommendations than the staff of Institutional Shareholder Services or Glass Lewis, the two dominant proxy advisors today.[185] If those designing and selling the software are these two firms themselves, as would be reasonable to predict, their product may avoid some human error. But it is far from clear that the relevant software would succeed in overcoming the (apparent) deficiencies of today's

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181 *See e.g.* Lucian A. Bebchuk & Scott Hirst, *Index Funds and the Future of Corporate Governance: Theory, Evidence, and Policy*, 119 COLUM. L. REV. (forthcoming).

182 *See e.g.* Paul H. Edelman, Randall S. Thomas & Robert B. Thompson, *Shareholder Voting in an Age of Intermediary Capitalism*, 87 S. CAL. L. REV. 1359, 1398-99 (2014).

183 For a description of BlackRock's management and administration analytics tools suite, known as Aladdin, *see* Daniel Haberly et al., *Asset Management as a Digital Platform Industry: A Global Financial Network Perspective* 17-18 (2018), http://dx.doi.org/10.2139/ssrn.3288514 (also quoting Larry Fink's dubbing of Aladdin as "the Android of finance").

184 *See* Coates, *supra* note 125 at 12-13 (arguing that "the bulk of equity capital of large companies with dispersed ownership will be owned by a small number of institutions," so that "the majority of the 1,000 largest U.S. companies will be controlled by a dozen or fewer people over the next ten to twenty years").

185 *See e.g.* Stephen J. Choi, Jill E. Fisch & Marcel Kahan, *The Power of Proxy Advisors: Myth or Reality?*. 59 EMORY L. J. 869, *passim* (2010) (finding that ISS is the most influential proxy advisor, with Glass Lewis coming closely behind ISS).

proxy advisory services, which many characterize as box-ticking, one-size-fits-all exercises mirroring the majority views among institutional investor clients,[186] which are themselves in some cases laden with conflicts of interests.[187] From a purely theoretical perspective, algorithms may be equally good at that, if not better, but it is hard to understand how they could do things in a different, more tailored and more granular way without obtaining specific input from the institutional investor client using it, which clients other than the world's largest would find burdensome and hence competitively harmful.[188]

c. Active investing, and actively overweighted investors

Rational reticence is not a problem for institutional investors that are overweighted on a given stock, as they own more shares in a company than the average (passive) investor, which is usually the case of (truly)[189] actively managed funds and activist funds.[190]

Active traders and activist investors are in fact among the main participants in the dialogue between corporate boards and shareholders: active investors may respond to unexpected negative information by selling the corporate stock unless the company's ongoing dialogue with them has laid the foundations for good relations and trust long before difficulties emerged. Activist investors' demands, in turn, keep boards on their toes, requiring them to assess their merits and, more often than not, persuade the activists that their demands are unjustified and/or secure support from other shareholders (and especially active investors) against the activists.

Tech proponents predict lower returns for both investor types because of the full transparency they envisage, which would reduce the likelihood of profiting from informational advantages. If both strategies became less profitable, fewer investors of this kind are to be expected. That, in turn,

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186 *See* Stephen Choi, Jill Fisch & Marcel Kahan, *The Power of Proxy Advisors: Myth or Reality?*, 59 EMORY L.J. 869, 883 (2010).

187 *See* Tao Li, *Outsourcing Corporate Governance: Conflicts of Interest and Competition in the Proxy Advisory Industry*, 64 MGMT. SC. 2951, 2969 (2018).

188 Proxy advisors already provide tailored services to their larger clients. See Luca Enriques & Alessandro Romano, *Institutional Investor Voting Behavior: A Network Theory Perspective*, 2019 U. ILL. L. REV. 223, 238. Machines could of course do the same, but the fact remains that they would either be developed by proxy advisors themselves or by the few giant institutions whose size would justify their (nontrivial) development costs.

189 *See supra* note 180.

190 *See e.g.* Leo Strine, *Who Bleeds When the Wolves Bite? A Flesh-and-Blood Perspective on Hedge Fund Activism and Our Strange Corporate Governance System*, 126 YALE L. J. 1870, 1885-1910 (2017) (describing activist hedge funds and their governance-related strategies).

should reduce the need for board mediation.[191]

For the sake of argument, let us leave aside the fact that the full transparency scenario is unrealistic.[192] Even in a hypothetical full transparency scenario, it would follow from the Grossman-Stiglitz paradox that there would be room for active (informed) trading.[193] Consider that even in a CorpTech world, information gathering and processing requires *some* investment. If share prices perfectly and constantly reflected all available information, those who spent resources to obtain information would receive no compensation, and hence would have no incentive to invest in information gathering and processing. Without active trading, however, prices would no longer reflect all available information, which in turn would make it profitable for active traders to come back to the market and push prices "back" to the levels justified by the available information.

We go one step further, and argue that it is far from certain that *less* active investing would follow the widespread adoption of CorpTech. We can understand active investing as the outcome of an inequation with three values: information costs (I), trading costs (T), and returns from trading (R). If $R – (I + T) > 0$, active investing will follow. CorpTech, by making big data analytics tools widely available, may indeed reduce profit opportunities from informed trading (resulting in a lower R) by ensuring greater informational efficiency. But at the same time, both information costs (I) and trading costs (T) would also reduce: DLT (as a storage tool) and AI (as an analytical tool) will reduce information costs, while one of DLT's core applications will be clearing and settlement, thereby reducing trading costs. If, due to technology, I and T become lower than today, then *more* informed trading could result, even where R is lower than today. All in all, similar to the present world we expect an "equilibrium degree of disequilibrium",[194] with a varying degree of active trading – sometimes more, sometimes less – to continue.

This insight can be transferred to activist strategies. Let us assume that activist strategies are the outcome of a similar inequation as above: if $R – (I + E) > 0$, activism will follow,[195] where I stands for information costs, E

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191 *See supra* note 83-88 and accompanying text.

192 *See supra*, section III.C.2.a.

193 *Cf.* Sanford J. Grossman & Joseph Stiglitz, *On the Impossibility of Informationally Efficient Markets*, 70 AM. ECON. REV. 393, *passim* (1980) (arguing that a competitive equilibrium, "defined as a situation in which prices are such that all arbitrage profits are eliminated," is impossible "for then those who arbitrage make no (private) return from their (privately) costly activity. Hence, the assumptions that all markets, including that for information, are always in equilibrium and always perfectly arbitraged are inconsistent when arbitrage is costly").

194 *Id.*, at 393.

195 *Cf.* Brian R. Cheffins & John Armour, *The Past, Present, and Future of*

for engagement costs[196] and R for returns from activism. If only R, thanks to CorpTech, were to fall, then the outcome would be less activism. However, big data and AI will reduce not only R, but also I and E; hence, a lower R may suffice to generate profits through activist strategies.

The important point here is that, as long as there is *any* gain to be made from informed trading or activist strategies, with the introduction of CorpTech we may well see *more*, rather than less, active trading, or activism, respectively. If this is the case, CorpTech would make the need for a mediating institution like a board of directors even greater than it is today.

d. Direct dialogue with conflicted managers will be less fruitful

If dialogue with and among shareholders reverted to being mediated by managers, outcomes would be different, and arguably worse: to start with, some ideas presented by shareholders would not find fertile ground when presented to management. For instance, shareholders asking for the removal of a CEO or other officer, proposing a control sale, or requesting a departure from the CEO's pet project that, in their view, destroys corporate value, will receive, at best, a lukewarm response when they contact the CEO.

In addition, in the absence of board involvement, information flows among shareholders, as currently mediated to some degree by the companies' boards, may become less fluid. If shareholders fear that management is taking advantage of the views they share with it, they may be less inclined to air them, preventing the company from relaying such views to other shareholders. With less fluid communications among shareholders, the risk of polarization of views among shareholders would increase and, simultaneously, uncompromising, value-destroying positions would be more likely to prevail.

2. IT Limitations

Alternatively, one could imagine a world in which algorithms replace boards in their mediating functions. For such a scenario to be realistic, it would have to be the case that the relevant CorpTech is able to imitate the full variety of human behavior, in an effort to accommodate various parties with

*Shareholder Activism by Hedge Funds*, 37 J. CORP. L. 51, 61-62 (2011) (for a similar simple model for predicting when activists will engage with a given company).

196 In addition to investment into engagement itself, engagement costs may include capital expenditures to make an engagement worthwhile, as well as regulatory costs for compliance with securities laws in the build-up of the stake in the firm with which the activist seeks to engage.

antagonistic views and to facilitate the emergence of value-creating solutions. Available technologies appear not to be ready for that.

Technology experimenting with adjudication functions does exist[197] but is limited to either non-complex adjudication tasks (including claims collection for traffic violations, paying/denying insurance and public benefits) or supervisory orders in time-sensitive situations (such as gas leaks, nuclear fall-outs and intervention in algo-based trading systems).[198] Neither of these examples presents similarities with board-style mediation tasks.

To be sure, technology will make progress, and will possibly become able to manage complex social interactions: the critically acclaimed Google's virtual assistant scheduling barber appointments[199] is one prototypical example, with many more certain to follow. We can imagine some distant reality where technology is ready to interact socially with humans, as humans themselves would do with each other. Nevertheless, the coding of mediating board functions will be particularly challenging: while technology may be particularly good at juggling a variety of conflicting interests (i.e. in data terms: variables), in corporate matters it is rarely certain which constituencies pursue which interests. At the beginning of controversial processes, all constituencies demand the maximum, use side demands to cloak their true motives, or remain silent, according to the circumstances, in an effort to generate strategic advantages in negotiations.

Given AI CorpTech's dependency on data,[200] where there is no (or in this case: no reliable) data to process, technology cannot help. Human board members spend significant time (through conversations and other forms of human interaction) on "fact-finding" and identifying crucial and less crucial interests, in an effort to pinpoint the crunch line for a brokered compromise among antagonistic shareholder groups and/or between management and the

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197 Note that algorithmic adjudication differs from algorithmic big data-driven legal predictions; the latter have been developed to reach an impressive degree of accuracy. *See* Katz, *supra* note 7, at 928-947 (citing prediction results from e-discovery, securities litigation and U.S. Supreme Court cases).

198 On "auto-adjudication" *see* Cary Coglianese & David Lehr, *Regulating by Robot: Administrative Decision-Making in the Machine-Learning Era*, 105 GEO. L.J. 1167-75 (2017) (describing and giving examples for automated decisionmaking in the U.S. context); Gregory Scopino, *Do Automated Trading Systems Dream of Manipulating the Price of Futures Contracts?: Policing Markets for Improper Trading Practices by Algorithmic Robots*, 67 FLA. L. REV. 221, *passim* (2015) (discussing digital supervision of trading systems).

199 *See* Press Release, Reuters Business News, Google Eases Tech Stress with App Controls, Table-Booking Assistant, May 8, 2018, https://www.reuters.com/article/us-alphabet-developers-idUSKBN1I92ME.

200 *See supra*, at III.B.2.a.

shareholder base.[201] In technical terms, the challenge lies in the dynamic nature of such interactions. Governance mediation takes place within a highly volatile system involving multiple actors, diverse interests and a firm's very future, which is, of course, uncertain. In short, this system is a complex one in the scientific meaning, that is, a system with "a significant number of interconnected parts that as a whole tend to interact in a nonlinear manner."[202] From a technological perspective: "[a]s the dynamics of the system being modeled become more volatile, so too do the predictions of that system's behavior."[203] In plain language, in such a setting, AI-driven predictions are random and therefore of little predictive certainty. Even assuming that constituencies are willing to accept a tech-driven process as superior to a human-brokered one, they are highly unlikely to accept random results.

## IV. ADAPTING TO A CORPTECH ENVIRONMENT

As we have shown in the previous part, corporate governance challenges will persist even in a tech-dominated environment, so long as human beings wield influence over firms' assets. As ever, corporate governance will ultimately be about who controls corporate assets and how much the interests of those in control deviate from those of the shareholders (and other constituencies, insomuch as corporate governance is instrumental in handling relationships with them as well). As a corollary, contrary to the tech proponents' view, technological changes are unlikely to marginalize boards and significantly impact upon their core monitoring and mediating functions.

Yet, the focal point of corporate governance conflicts will indeed change and is arguably changing already:[204] the question of who controls the decision of which CorpTech the firm will deploy (*i.e.* which coder programs the algorithm, which algorithms are licensed for which purpose, which data pool is analyzed, etc.) is becoming key. If management is in control of that decision, we expect it to choose coders and technology designs catering to its own interests, which may not be perfectly aligned with the interest of shareholders.

In the following sections we consider some possible responses to this new algo-driven dimension of corporate governance, which we call

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201 On the complex dynamics of negotiations with activists *see e.g.* Lucian A. Bebchuk, Alon Brav, Wei Jiang and Thomas Keusch, *Dancing with Activists* 5, 29, Harvard Law and Economics Discussion Paper No. 906 (2017), https://ssrn.com/abstract=2948869 (examining negotiations between issuers and activists and their outcome).

202 Katz, supra note 7, at 959.

203 Katz, *supra* note 7, at 953.

204 *See supra*, Section III.B.2.b.

CorpTech governance.

### *A. Product Market Competition*

A focus on CorpTech governance is only justified if market mechanisms do not already ensure that CorpTech serves shareholders' interests. In fact, one could counter that the natural solution to the new tech-centered dimension of intracorporate conflicts of interest is the market itself, that is, competition among suppliers of CorpTech products.[205] This section casts doubt on the idea that product market competition can be sufficient to let us stop worrying and unreservedly embrace the tech.

First of all, there are reasons to be skeptical about the likelihood of the market for CorpTech solutions delivering products that are genuinely in line with the interests of shareholders. For one, product market competition works only where a sufficient number of suppliers of CorpTech systems offer services, struggling for clients' attention through innovation and product differentiation. With the sector still being in its infancy, it is pure speculation whether one, two or a handful of CorpTech providers will survive in the medium to long term. Yet, if past trends are of any guidance, time and again long-term software market dynamics yield a small number of dominant IT platforms.[206]

To be sure, even in a market dominated by a few firms, one or more among them may start competing by building a pro-shareholder brand. Corporations' use of CorpTech products with a pro-shareholder reputation could bring some gains in the form of higher stock prices.

Consider, though, that a brand-building strategy is much more likely to pay off for standardized software tools than for tailored, firm-specific ones. In fact, the more firm-specific the CorpTech, the less credible the pro-shareholder signal sent by choosing a given CorpTech application. That is because management input for the development of the tailored code will be key. Correspondingly, the greater the coder's specific investments in the relationship with an individual company, the weaker the signal of independence. For this reason, a brand-building strategy is unlikely to work

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205 *Cf.* Bamberger, *supra* note 10, at 713 (arguing in favor of diversification of risk management systems to counter implicit biases).

206 TIM WU, THE MASTER SWITCH: THE RISE AND FALL OF INFORMATION EMPIRES (2010) (arguing that information markets tend to turn into monopolies until they are replaced by superior technology). *See also* Lina M. Khan, *Amazon's Antitrust Paradox*, 126 YALE L. J. 564 (2017) (detailing how traditional antitrust law interpretation furthers the build-up of monopolies in platform markets); Aghion et al., *supra* note 64, at 32-33 (arguing that data access may act as an entry barrier for creating competing networks, hence the incumbent's platform prevails).

wherever the CorpTech's added value comes from customization, as is arguably the case with most CorpTech applications. In fact, no two firms are alike; software developed for one firm will not work so well for others.

In addition, similar to what has traditionally happened with audit firms and other gatekeepers, unless the governance of a firm's (and its management's) relationship with the supplier is effectively taken care of, there is a risk of collusion with managers, *i.e.* of deviation ex post from shareholders' interests.[207] Developing a reputation for producing good (*i.e.* shareholder-friendly) CorpTech would arguably be even harder than developing a reputation for providing good audit services, if only because there are, to date, no generally accepted coding standards that outsiders could use to understand what the coders have done. In addition, outside monitoring and review of algorithms is problematic.[208]

The contractual governance point can be generalized to cast doubt on the ailing effects of product market discipline: competitors will have to sell products that the relevant decision-makers within corporations will find attractive. Unless such decision-makers' incentives are fully aligned with the interests of shareholders, there is scope for suboptimal products to prevail on the market.

### *B. Adjusting Best Practices: Expanding the Tech Committee's Remit*

Technology and IT have traditionally been outside the board of directors' remit: the selection and management of technological solutions has rather been, and still is, part of the executives' domain.[209] Banks represent an

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[207] *See generally* JOHN C. COFFEE JR., GATEKEEPERS: THE PROFESSIONS AND CORPORATE GOVERNANCE 15-47 (2006) (describing the failure of gatekeepers and their collusion with management in the early 2000s corporate scandals).

[208] *See* Joshua A. Kroll et al., *Accountable Algorithms*, 165 U. PA. L. REV. 633, *passim* (2017) (arguing that research on AI review is in its infancy and that disclosure of results does not allow review of the underlying algorithm). *See also* Pauline T. Kim, *Auditing Algorithms for Discrimination*, 166 U. PA. L. REV. ONLINE 189 (2017) (arguing that code review does not result in desirable outcomes since the biases lie in broader social processes that cannot be countered by reviewing the code alone, but asking for code disclosure to let the public review the code outcome).

[209] *See* HÜTTER & RIEDL, *supra* note 162, at 11-12 (stating the CIOs either belong to the top management team or a department reporting to top management); *see also* Sid L. Huff, P. Michael Maher, Malcom C. Munro, *Information Technology and the Board of Directors: Is There an IT Attention Deficit?*, 5 MIS QUART. EXECUTIVE, Issue No. 2, 55, *passim* (2006) (stating that boards are focused on IT risks only and that only half of the financial firms and none of the non-financial firms surveyed discuss regularly IT issues other than IT risks, and also arguing that discussing the CIO's IT vision for the company, the IT strategic plan, major IT application decisions, IT leadership, IT functional structure, IT

important exception here: with the ever-growing use of algorithms in risk management, banks have started to bring the technological aspects of risk management within the purview of the risk committees that they are required to set up.[210]

But even in non-financial corporations, where technology has typically been part of the oversight functions of the compliance or audit committee,[211] things are changing fast. With technology taking center stage both as a managerial and a governance tool, and with boards lacking the ability to collectively focus on such aspects,[212] more systematic oversight of technology on the part of boards and/or a(n independent) risk or audit committee is becoming more common.[213]

Importantly, the practice of having separate tech committees is

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function effectiveness, and whether or not IT applications provide competitive advantage deserve board attention).

210 *See* Lawrence Trautman & Kara Altenbaumer-Price, *The Board's Responsibility for Information Technology Governance*, 29 J. MARSHALL J COMPUTER & INFO. L. 313, 319 (2011). Morgan Stanley has introduced a technology committee in 2015 that advises the board and management team on Big Data tools and systems that control stock trading. *See* Kim S. Nash, *Morgan Stanley Board Pushes Emerging Area of Tech Governance*, WALL ST. J., Mar. 26, 2015, https://blogs.wsj.com/cio/2015/03/26/morgan-stanley-board-pushes-emerging-area-of-tech-governance/. Tech advisory boards are becoming common outside the banking sector as well. *See e.g.* Josh King, The Growth of digital advisory boards (2016), https://www.linkedin.com/pulse/growth-digital-advisory-boards-josh-king/ ("All types of firms, from start-ups and growth companies to Fortune 500 businesses and even PE/advisory firms, are developing these advisory boards").

211 Richard Nolan & F. Warren McFarlan, *Information Technology and the Board of Directors*, HARV. BUS. REV., Oct. 2005, at 96, 101 (2005).

212 Elizabeth Valentine & Glenn Stewart, *Director Competencies for Effective Enterprise Technology Governance* 5, Working Paper (2013), https://www.researchgate.net/publication/289654058_Director_competencies_for_effective_enterprise_technology_governance (highlighting the need for boards to provide enterprise technology governance oversight of technology-related strategy, investment and risk, and to be competent in doing so, and arguing that "the gaps are large between the stated importance of business technology, actual board involvement … [and] knowledge and experience to effectively oversee technology strategy."). *See also* MCKINSEY & COMPANY, *supra* note 128, at 48 (arguing that approximately 45 percent of directors claim to have neutral or no competence on digitization, 49 percent on disruptive business models, and approximately 60 percent on cybersecurity).

213 *See* Lawrence Trautman & Kara Altenbaumer-Price, *The Board's Responsibility for Information Technology Governance*, 29 J. MARSHALL J COMPUTER & INFO. L. 313 (2011). *See also* INFORMATION SYSTEMS AUDIT AND CONTROL ASSOCIATION (ISACA), CONTROL OBJECTIVES FOR INFORMATION AND RELATED TECHNOLOGY ('COBIT') 5: A BUSINESS FRAMEWORK FOR THE GOVERNANCE AND MANAGEMENT OF ENTERPRISE IT 174 (2013) (proposing as part of a firm's IT governance framework cross-disciplinary membership of the Enterprise Risk Management Committee). ISACA is the professional association of IT auditors.

spreading out,[214] with cyber-attacks and technology-related operational risk representing their core focus.[215] To the best of our knowledge, however, tech committees are not in the business of monitoring the conflicts of interest inherent to CorpTech governance.[216] An extension of their remit to include CorpTech governance would seem to be a natural evolution for the role of tech committees:[217] their extended focus should be on monitoring contract negotiations with coders, designing the governance of the contractual relationship with the coders, the review of the design settings of crucial algorithms as well as, possibly, a say on (internal) coders' compensation.

As with any governance tool, a tech committee would be no silver bullet either. Again, we can distinguish between technological limitations and governance's inherent traits. One considerable challenge in terms of technological limitations is that, at least at the current stage of IT development, ex post review of the functions, limits and biases of an algorithm is of limited effectiveness.[218] Moreover, while independent directors themselves can work better than shareholders as monitors of management, including in overseeing management's exercise of discretion when it comes to CorpTech, they are bound to suffer themselves from information asymmetries and the imperfect alignment of incentives.[219]

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214 *See* Bankewitz et al., *supra* note 16, at 65 (reporting that as of 2011, special board committees dealing with tech and cybersecurity were in place in less than 25 percent of organizations and expecting that the "changing board agenda based on the shifts in organizational threats and opportunities may as well affect the committee structure of an organization," resulting in a greater role for, and wider diffusion of, tech committees).

215 *See* Bankewitz et al., *supra* note 16, at 65 (arguing that the "[m]ain tasks of such a [tech] committee may be for instance to ratify that information systems architecture will support the strategies of the company to validate the effective use of data security tools to evaluate data breach response plans and to oversight the managements' abilities to execute them."); *see also* Julia L. Higgs, Robert E. Pinsker, Thomas J. Smith & George R. Young, *The Relationship Between Board-Level Technology Committees and Reported Security Breaches* 30:3 J. INFORMATION SYSTEMS 79, 79-83 (2016) (arguing that tech committees are understood as part of the firm's information technology governance to signal the firm's ability to detect and respond to security breaches).

216 *Cf.* Martin Lipton, Spotlight on Boards (Dec. 3, 2018), *available at* https://corpgov.law.harvard.edu/2018/12/01/spotlight-on-boards-2/: while this client alert memorandum refers to oversight of technological risks as one of the items boards are expected to focus on in 2019 (*id*. at 1), oversight of CorpTech solutions is conspicuous by its absence.

217 *Cf.* Armour & Eidenmüller, *supra* note 15, at 18 (similarly suggesting the setup of a committee of independent directors in charge of "data governance").

218 *See supra* note 208 (and accompanying text).

219 *See generally* Stephen M. Bainbridge, *The Board of Directors*, *in* THE OXFORD HANDBOOK OF CORPORATE LAW AND GOVERNANCE, *supra* note 167, 275, at 316-20, 327-31 (describing independent directors' time constraints, limited access to the relevant firm's

As a corollary, giving an independent tech committee the task of selecting CorpTech would sacrifice business efficiency in the name of conflict monitoring. In fact, in modern corporations, business operations depend on the efficiency of systems, while such efficiency depends, in turn, on accuracy as to process details. Meanwhile, putting an independent tech committee in between management and tech deployment could slow down information transfer from management to coders.[220] In turn, strengthening tech committee oversight–rather than replacing management with this committee–seems to be a prudent compromise.

### *C. Law Reforms?*

Does the prospectively pervasive role of CorpTech in listed companies' governance warrant any changes in the statutory law (state or federal) of corporations?

We are hesitant to suggest so (with one exception, laid out at the end of this section). The main reason behind being cautious and recommending a wait-and-see approach is that corporate governance practices are bound to change in the direction of sharpening the focus on CorpTech issues.[221] It would be premature, and contrary to a long-standing tradition in corporate governance reforms, to implement corporate governance-focused changes in state corporate statutes, federal securities regulation or stock exchange listing rules before best practices have emerged on the market. Furthermore, corporate governance practices are firm-specific. Firms differ, for instance, in the extent to which they rely on their employees' creativity, suppliers' tailored inputs, intellectual property, and technology integration among other factors. The downside of any prescriptive rule would be the risk of freezing much-needed experimentation in this area.

This is particularly true for a CorpTech licensing regime:[222] any

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inside information, and skewed incentives, even after they started being given stock-based compensation, and summarizing the available empirical evidence).

220 This is all the more true for firms where algorithms take operating decisions since in those cases severing operations software from CorpTech would affect both negatively. In this case the transfer of decision-making powers to a tech committee would take managerial powers away from management that is selected and compensated for such task.

221 *See supra* section IV.2.

222 As an indirect way of licensing, regulators could demand a liability insurance as a precondition for doing business where technology takes most business decisions such as in self-driving corporations or algorithmic entities. *See* Armour & Eidenmüller, *supra* note 15, at 31 (proposing a mandatory liability insurance for "self-driving corporations").

licensing regime potentially limits innovation since innovators would focus on the development of permissible products only. Besides general concerns aired against public tech oversight,[223] a licensing regime also raises the perennial issue of who would enforce these rules. If authorization is in public hands, we would expect supervisory expertise and resources to be limited, resulting in slow-motion supervision, while potential liability and the risk of reputational loss may skew incentives towards a timid, anti-innovative supervisory approach.[224] If authorization is put, by way of indirect supervision, in private hands, the question of "who watches the watchers?" has been long and widely discussed (and rarely answered convincingly) in the arguably similar context of auditors and rating agencies.[225] Second, CorpTech licensing is compounded by an additional layer of IT complexity. The difficulties with code review are particularly pronounced for advanced machine-learning algorithms that receive feedback from non-human sources, for instance the price data feeds from stock and other markets. To our knowledge, technical means to review the function of self-learning algorithms, and in particular the limitations of those functions, do not yet exist.[226]

Instead of product regulation, policymakers could require the disclosure of the CorpTech *code*. The case for disclosure would rest on the assumption that knowledgeable shareholders, market analysts and traders

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223 *See* Julie E. Cohen, *The Regulatory State in the Information Age*, 17 THEORETICAL INQURIES L. 369, 370-71 (2016) (stating that there is widespread consensus that administrative law and process is in crisis in the informational age since it has become difficult to define "what constitutes 'normal' economic activity and what qualifies as actual or potential harm" for society, firms and its shareholders and stakeholders; hence it is "more difficult to articulate compelling accounts of what precisely should trigger compliance obligations, enforcement actions, and other forms of regulatory oversight.").

224 *See* Chris Brummer & Yesha Yadav, *Fintech and the Innovation Trilemma*, 107 GEO. L.J. 235, 248-49 (2019) (describing the challenges imposed by innovation as a trilemma: regulators are to pursue financial innovation, simple rules *and* market integrity at the same time).

225 *See e.g.* JOHN C. COFFEE JR., GATEKEEPERS: THE PROFESSIONS AND CORPORATE GOVERNANCE 15-47 (2006) (describing the failure of gatekeepers and their collusion with management in the early 2000s corporate scandals).

226 *See supra* note 208 (and accompanying text). Code reviews are limited to experiments where certain data feeds are provided to the algorithm, and the algorithm's output is assessed. But these experiments are by no means complete, nor can those experiments mimic real life conditions for enterprise software, especially if the exercise is undertaken without access to all the firm's and market data that feed into the software. In order to control risks stemming from the self-learning dimension of algorithms, IT coders tend to limit the data access and processing functions of self-learning algorithms, thereby weakening one of the competitive advantages of CorpTech vis-à-vis humans, which is that those algorithms consider all available data and correlations.

would analyze the disclosures and trade on the basis of their analysis until the share price fully reflects the implications of those disclosures relative to the company's profitability.[227] Anticipating market scrutiny, management would have an incentive to choose good software. Applying this logic, external IT experts, whether individually or as a group, could undertake such code reviews on an experimental basis. The more experiments of this kind that are undertaken, the greater the likelihood of imperfect CorpTech solutions being exposed as such. In fact, in IT circles, crowdsourced testing has been acknowledged as a powerful (yet sometimes difficult to manage[228]) analytical tool for detecting code deficiencies.[229]

However, code disclosure will likely stifle innovation since it facilitates, if not encourages, the copying of the code; less investment in code development would follow. Furthermore, code disclosure is of little use where few, if any, firm-specific data are available to crowd testers.[230] Firms will not voluntarily disclose the data they process in algorithms, as their disclosure may harm their competitiveness and contravene confidentiality duties and privacy protection obligations.

One contiguous area where a change in the law would help is the disclosure of listed companies' tech governance arrangements. Given the increasing centrality of tech issues for corporate governance, existing periodic disclosures on corporate governance arrangements could be supplemented with additional explanations on, for instance, whether the issuer has a tech committee or another committee with CorpTech oversight functions, whether

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227 *See generally* Zohar Goshen & Gideon Parchomovsky, *The Essential Role of Securities Regulation*, 55 DUKE L.J. 711 (2005).

228 *See* Junjie Wang et al., *Effective Automated Decision Support for Managing Crowdtesting*, Working Paper, 7 May 2018, *available at* https://export.arxiv.org/pdf/1805.02744 (emphasizing the power of crowdsourced testing while highlighting that "it is difficult to estimate … the remaining number of bugs as yet undetected or … the required cost to find those bugs" and that results of crowdsourced testing strongly depend on real-world crowtesting data).

229 *See* Ivo Blohm, Jan Marco Leimester & Helmut Krcmar, *Crowdsourcing: How to Benefit from (Too) Many Great Ideas*, 4:12 MIS Q. EXECUTIVE 199 (2013) (stating that crowdsourcing is an emerging trend of software development); Niklas Leicht, Ivo Blohm & Jan Marco Leimeister, *Leveraging the Power of the Crowd for Software Testing*, 34:2 IEEE SOFTWARE 62, 62-63 (2017) (arguing that crowdsourced testing replaces manual testing since manual testing is becoming less economically viable and useful, and distinguishing between three approaches of crowdsourced testing: (1) engage an external crowd of Internet users, (2) engage their employees, or (3) engage their customers).

230 Any more limited disclosure allows management to argue that the deficiencies that shareholders and/or IT expert groups may spot by analyzing algo-related disclosures are due to "wrong" data used for the test or to an incomplete embedding of the test software into the firm's operating system.

its members are tech experts and independent, and so on. This could be either part of Securities and Exchange Commissions's annual disclosures[231] or of the New York Stock Exchange's Listing Rules' corporate governance guidelines disclosures.[232] Like similar disclosures, for instance on internal controls and executive compensation,[233] the dissemination of information about individual companies' practices may help issuers become aware of better practices and adopt them in a timelier and less costly way.

## V. CONCLUSION

CorpTech is bound to have a significant impact on *how* corporate boards perform their functions: new technologies will in fact enhance them by perfecting the information collection and processing tools available to them. Yet, CorpTech will not significantly change *what* boards do, namely monitoring managers and mediating between them and the company's shareholders, because technology will not by itself solve the core intra-corporate agency problems.

The core insight of this article is in fact that intracorporate agency problems will not be "coded away." Contrary to the tech proponents' view, optimal code design is impaired by the same problems affecting other governance mechanisms today: as long as human-dominated corporate governance mechanisms are imperfect, neither will be machine-driven solutions. A key manifestation of those conflicts of interest will revolve around the selection and implementation of CorpTech solutions themselves: corporate agents can be expected to choose the CorpTech products that best cater to their own interests, rather than those of shareholders. The (pro-management) bias can be built into the algorithm by way of determining either which data are to be processed, how they should be interpreted and whether they should be acted upon. At the same time, without advanced reviewing technology, which is currently missing for so-called self-learning algorithms,[234] it is impossible to identify the degree to which a specific CorpTech product serves opportunistic goals. That makes board oversight on

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231 *See* Item 407, Regulation S-K (17 C.F.R. § 229.407) (requiring disclosure on a number of corporate governance arrangements).

232 *See* New York Stock Exchange Listed Company Manual § 303A.09 (2009), *available at* http://wallstreet.cch.com/LCMTools/TOCChapter.asp?print=1&manual=/lcm/sections/lcm-sections/chp_1_4/chp_1_4_3/default.asp&selectedNode=chp_1_4_3 (listing the subjects to be included in the disclosures on corporate governance guidelines).

233 *Ibid.*

234 *See supra* note 208 and accompanying text.

management trickier, but no less needed.

In a world of second-best solutions, we have proposed to counter CorpTech manifestations of the conflict issue through traditional corporate governance mechanisms, including: (1) the establishment of independent board committees that focus on CorpTech solutions and governance;[235] and (2) disclosure of tech governance arrangements.[236]

These proposals extend the old solutions that have been developed in the forty years since boards in U.S. companies started undertaking monitoring functions to the new digitalized toolkit for corporate boards. These old-style, "analogic" tools, imperfect as they may be, could actually reduce the risk that algorithms exacerbate corporate governance problems by making it even easier for managers to pursue their own agendas. As long as human beings (with their preferences and biases) wield significant influence over a firm, tools of this kind will remain necessary. Once humans no longer control corporations, they will indeed become obsolete and by that stage humans would likely have more pressing issues to worry about than corporate governance.

235 *See supra*, at IV.B.

236 *See supra*, at IV.C.3.

## about ECGI

The European Corporate Governance Institute has been established to improve *corporate governance through fostering independent scientific research and related activities.*

The ECGI will produce and disseminate high quality research while remaining close to the concerns and interests of corporate, financial and public policy makers. It will draw on the expertise of scholars from numerous countries and bring together a critical mass of expertise and interest to bear on this important subject.

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