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Cryptolaw for Distributed Ledger Technologies: A Jurisprudential Framework

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CRYPTOLAW FOR DISTRIBUTED LEDGER TECHNOLOGIES: A JURISPRUDENTIAL FRAMEWORK

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ABSTRACT: Both governments and private entities increasingly turn to distributed ledger technologies (DLT) for more efficient and transparent ways to implement administrative and other processes. When so doing requires grafting legal concepts onto computer code, changes will ripple outward to affect other areas of the law. Treating DLT as a foreign legal system allows comparative law to illuminate five areas of jurisprudential disruption from moving legal processes to DLT-based systems: substantive legal changes, new regulatory actors, legal structure changes, law-lag reduction, and legal culture changes. This article explores such ripple effects in the context of DLT-based corporate share registries in Delaware. The article argues that, in addition to changes to the Delaware General Corporation Law, DLT-based share registries may impact corporate law in other substantive ways, see the rise of new regulator-like entities, and magnify the shift in corporate culture reflected in the unicorn and platform technology company phenomena.

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In July 2017, Delaware Governor John C. Carney Jr. signed into law amendments to the Delaware General Corporation Law that allow corporations to issue shares through blockchain technologies.[1] Meanwhile, the governments of Sweden[2] and Cook County, Illinois have investigated the possibility of implementing a real-property recording system through blockchain technology.[3]

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1. Pete Rizzo, *Delaware Governor Signs Blockchain Bill into Law*, COINDESK (July 24, 2017, 1:30 PM), https://www.coindesk.com/delaware-governor-signs-blockchain-legislation-law [https://perma.cc/2DHN-BDYP].

2. Pete Rizzo, *Sweden Tests Blockchain Smart Contracts for Land Registry*, COINDESK (June 16, 2016, 3:55 PM), http://www.coindesk.com/sweden-blockchain-smart-contracts-land-registry [https://perma.cc/2Z9K-RWLK].

3. JOHN MIRKOVIC, COOK CTY. RECORDER OF DEEDS, BLOCKCHAIN PILOT PROGRAM: FINAL REPORT 21–22 (2017), http://cookrecorder.com/wp-content/uploads/2016/11/Final-Report-CCRD-Blockchain-Pilot-Program-for-web.pdf [https://perma.cc/KG77-S8WK]; Rizzo, *supra* note 2.

More ambitiously, Dubai seeks to move all government documents to blockchain-based systems by the year 2020.[4] The Department of Homeland Security and the Illinois Blockchain Initiative each demonstrate interest in the potential of self-sovereign identity solutions through a distributed ledger technology called Sovrin.[5] Although technology frequently spurs innovation in law and governance, the use of blockchain and distributed ledger technologies to do so introduces qualitatively different challenges, implications, and consequences.

When governments and regulators use blockchain technology or distributed ledger technology to implement and deliver law "through smart-contracting, semi-autonomous, cryptographic computer code," they create "crypto-legal structures."[6] This article predicts that enabling the use of crypto-legal structures through amendments to Delaware's General Corporate Law will have ripple effects in the law. Namely, using crypto-legal structures will impact the way lawmakers, lawyers, and everyday citizens think about law, and may alter the actual substantive rules that apply in certain circumstances. In prior work, I developed a framework for analyzing the use of crypto-legal structures, which I call "cryptolaw."[7] The intent of the cryptolaw framework for blockchain technologies is to create a jurisprudential space, which anticipates the nature of the ripple effects that crypto-legal structures will ignite. This article uses Delaware's efforts to allow the issuance of blockchain-based corporate shares to illustrate how engaging in a cryptolaw analysis creates a new jurisprudential discourse. To do so, the article first briefly introduces distributed ledger technology. The article then examines the considerations to use when evaluating whether to adopt a crypto-legal structure. Next, the article explores the six ripple effects that the cryptolaw analytical framework expects to result from adopting crypto-legal structures in the context of Delaware's blockchain-based corporate share innovations. The article concludes by predicting the next wave of corporate legal issues ignited by Delaware's current activity and highlighting areas in need of further research.

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4. Michael del Castillo, *Dubai Wants All Government Documents on Blockchain by 2020*, COINDESK (Oct. 5, 2016, 4:40 PM), https://www.coindesk.com/dubai-government-documents-blockchain-strategy-2020/ [https://perma.cc/2N6A-E3UG].

5. Jason Bloomberg, *Can Blockchain Solve the Equifax Identity Morass? Here's How*, FORBES (Oct. 6, 2017, 2:16 PM), https://www.forbes.com/sites/jasonbloomberg/2017/10/06/can-blockchain-solve-the-equifax-identity-morass-heres-how/#56fd3859296a [https://perma.cc/8ZNG-NTGX].

6. Carla L. Reyes, *Conceptualizing Cryptolaw*, 96 NEB. L. REV. 384, 387 (2017). I first coined the term "crypto-legal structures" and introduced the idea of cryptolaw as an emerging jurisprudence for the use of distributed ledger technologies in legal processes in *Conceptualizing Cryptolaw*, from which this article is derived. *Id.* at 389. I note that although the focus in both this article and in *Conceptualizing Cryptolaw* is the adoption of crypto-legal structures by government actors, the idea of crypto-legal structure is broad enough to capture any time a societal actor chooses to implement an arrangement recognized in law through computer code (such as business entities). *Id.* at 387.

7. *Id.* at 389.

I. A DISTRIBUTED LEDGER TECHNOLOGY PRIMER

Books can be, and have been, written to explain how the various implementations of distributed ledger and blockchain technology work.[8] That kind of detailed treatment of the technical elements of this technology lies beyond the scope of this short article. Nevertheless, to enable an in-depth discussion of the implications of crypto-legal structures for adjacent areas of the law, this article begins with a (very) brief introduction to distributed ledger technology, blockchain technology, and smart contracts. The focus of this section is to highlight the key elements of the technology that drive the need for the cryptolaw jurisprudential framework.

A. Distributed Ledger and Blockchain Technology

This article uses the term distributed ledger technology (DLT) to refer generally to "computer software that is distributed, runs on peer-to-peer networks, and offers a transparent, verifiable, tamper-resistant transaction-management system maintained through a consensus mechanism rather than by a trusted third-party intermediary that guarantees execution."[9] DLT is an umbrella term used to refer to any number of technical variations of systems that achieve these functions,[10] while blockchain technology is the term used to refer to a specific subset of distributed ledgers.[11] As Garrick Hileman and Michel Rauchs state:

> In general, the term "distributed ledger technology" refers to all initiatives and projects that are building systems to enable the shared control over the evolution of data without a central party, with individual systems referred to as "distributed ledgers." If one wants to describe a system that has global data

8. *See, e.g.*, ANDREAS M. ANTONOPOULOS, MASTERING BITCOIN: PROGRAMMING THE OPEN BLOCKCHAIN (2d ed. 2017); ARVIND NARAYANAN ET AL., BITCOIN AND CRYPTOCURRENCY TECHNOLOGY: A COMPREHENSIVE INTRODUCTION (2016).

9. *Id.* at 390–91 (citations omitted). Because I have previously written detailed explanations of how DLT works—see *id.* at 389–96 and Carla L. Reyes, *Moving Beyond Bitcoin to an Endogenous Theory of Decentralized Ledger Technology Regulation: An Initial Proposal*, 61 VILL. L. REV. 191, 196–202 (2016)—this DLT primer is particularly brief.

10. GARRICK HILEMAN & MICHEL RAUCHS, CAMBRIDGE CTR. FOR ALT. FIN., GLOBAL BLOCKCHAIN BENCHMARKING STUDY 21–22 (2017) ("The first blockchains were closely based on the architecture of Bitcoin, where transactions sent across the system are bundled into a new 'block.' This new block references the preceding block, effectively forming a chain of cryptographically linked transaction bundles. New database systems have emerged that are also often referred to as blockchains, but which do not share the main characteristics of 'traditional' blockchains used by cryptocurrencies. For instance, some are 'block-less' . . . others do not broadcast all transactions to each participant, and yet others do not reach consensus on the state of the global ledger but rather on the state of sub-ledgers or channels. . . . The development of these new types of systems, loosely built on the original Bitcoin blockchain concept, has resulted in the emergence of a new, more generic term—*distributed ledger technology (DLT)*.").

11. *Id.* at 24 ("Blockchains can be thought of as a special subset of distributed ledgers that share the same adversarial threat model, but have additional characteristics that set them apart.").

> diffusion and/or uses a data structure of chained blocks, one should call it a "blockchain."[12]

Essentially, any specific distributed ledger or blockchain operates as a computer protocol that sets the rules allowing networked computers to communicate with each other to reach agreement over the evolution and existence of shared facts and shared data.[13] Many distributed ledgers and blockchains (but not all) "are also robust enough to allow software developers to layer complex relationships into the computational material of the underlying protocol."[14] Such complex relationships are often built by computer programs referred to colloquially as "smart contracts."[15]

B. Smart Contracts

The term *smart contract* is widely used, and often misused. In particular, many people, and particularly those trained in legal studies, associate the term "smart contract" with the concept of a legal contract, including the contractual issues of offer, acceptance, and consideration.[16] Although smart contracts may, in fact, be written in ways that amount to a legal contract,[17] at a basic level, the term smart contract is routinely used to refer only to "a computer protocol—an algorithm—that can self-execute, self-enforce, self-verify, and self-constrain the performance" of its instructions.[18] Indeed, in reality, software developers use different terms to refer to the same functionality—Ethereum developers use the term *smart contract* while bitcoin developers use the term *script*.[19] Smart contracts (or scripts), quite simply, "are computer programs that can automatically

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12. *Id.* As in my prior work, this article adopts the terminology confirmed as best practice by Hileman and Rauchs—using the umbrella term DLT to refer to the technology in general and blockchain when referring to a specific distributed ledger that exhibits one or more of the characteristics unique to that subset of DLT. *Id.*

13. Richard Gendal Brown, *Introducing R3 Corda™: A Distributed Ledger Designed for Financial Services*, R3: POV BLOG (Apr. 5, 2016), https://www.r3.com/blog/2016/04/05/introducing-r3-corda-a-distributed-ledger-designed-for-financial-services/ [https://perma.cc/GX4X-4PHN] (describing DLT as "platforms, shared across the Internet between mutually distrusting actors, that allow them to reach consensus about the existence and evolution of facts shared between them"); Peter Van Valkenburgh, *What is "Blockchain" Anyway?*, COINCENTER (Apr. 25, 2017), www.coincenter.org/entry/what-is-blockchain-anyway [https://perma.cc/2FU5-7T8Y].

14. Reyes, *supra* note 6, at 396.

15. *See id.*

16. *Contra* HILEMAN & RAUCHS, *supra* note 10, at 57 ("Contrary to their name, smart contracts are neither extremely smart nor contracts (in the legal sense).").

17. *See* R3 & NORTON ROSE FULBRIGHT, CAN SMART CONTRACTS BE LEGALLY BINDING CONTRACTS? (2016), http://www.nortonrosefulbright.com/files/norton-rose-fulbright--r3-smart-contracts-white-paper-key-findings-nov-2016-144554.pdf [https://perma.cc/W7GT-LSJG]; Kevin Werbach & Nicolas Cornell, *Contracts* Ex Machina, 67 DUKE L.J. 313, 338–343 (2017).

18. TIM SWANSON, GREAT CHAIN OF NUMBERS: A GUIDE TO SMART CONTRACTS, SMART PROPERTY, AND TRUSTLESS ASSET MANAGEMENT 16 (2014); *see* MELANIE SWAN, BLOCKCHAIN: BLUEPRINT FOR A NEW ECONOMY 16 (Tim McGovern ed., 2015) ("[A] smart contract is both defined by the code and executed (or enforced) by the code, automatically without discretion.").

19. *See, e.g.*, ANTONOPOULOS, *supra* note 8, at 155–166 (describing the various forms of scripts that can be constructed using the Bitcoin Blockchain, many of which would be called a "smart contract" in Ethereum).

perform some function" upon the fulfillment of certain predetermined condition(s).[20] As such, smart contracts might be better described as "verifiable scripts."[21]

The concept of a smart contract is not new. In traditional database architectures, smart contracts are called "stored procedures."[22] As Hileman and Rauchs explain: "The key difference of running them in a distributed ledger is that the execution of smart contracts is guaranteed by system rules and the outcome is verifiable and auditable by all network participants."[23] Thus, the key elements that make these verifiable scripts both unique and powerful "lie in their autonomous, self-sufficient, distributed nature."[24] Current uses of verifiable scripts in the private sector include the securities-trading platform developed and launched by Overstock.com Inc.—the t0 platform,[25] decentralized file storage,[26] and decentralized notary services,[27] among others.[28]

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20. HILEMAN & RAUCHS, *supra* note 10, at 57.

21. This is the term adopted by the Coalition of Automated Legal Applications working group members at its recent meeting at Stetson University College of Law on October 28–29, 2017 (in addition to the author, the following members of the working group were in attendance: Assistant Professor of Law Paolo Saguato, Antonin Scalia Law School at George Mason University; Ms. Wendy Lawson, Director Advisory Services at the International Association for Contract & Commercial Management; Mr. Christopher Cervellera, Juris Doctor, Stetson University College of Law; Mr. Dan Virgil Puscasiu, Ph.D. Candidate, University of Milan; Ms. Primavera de Filippi, Faculty Associate, Berkman Klein Center for Internet & Society at Harvard University, and Ms. Constance Choi, Founder, Seven Advisory). The COALA working group members strongly encourage others to adopt this term as a more precisely descriptive term than the confusion-causing term "smart contract."

22. HILEMAN & RAUCHS, *supra* note 10, at 57.

23. *Id.*

24. Reyes, *supra* note 6, at 398.

25. David Floyd, *Overstock's t0: Reconciling Fiat Currency and the Bitcoin Blockchain,* NASDAQ (Dec. 16, 2015, 1:30 PM), https://www.nasdaq.com/article/overstocks-t0-reconciling-fiat-currency-and-the-bitcoin-blockchain-cm555617 [https://perma.cc/Q2ZS-7AAF] ("Overstock.com Inc. . . . has issued bonds on the bitcoin blockchain, becoming the first company to offer a crypto-security, and has gained regulatory approval to do the same with equity.").

26. Shawn Wilkinson, Storj: A Peer-to-Peer Cloud Storage Network 2 (Dec. 15, 2014) (unpublished manuscript) (outlining a proposal for a "decentralized cloud storage platform that implements end-to-end encryption on a decentralized and open network"), http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.693.785&rep=rep1&type=pdf [https://perma.cc/U57P-SQDR].

27. Luke Parker, *Bitnation Starts Offering Blockchain Public Notary Service to Estonian e-Residents*, BRAVE NEWCOIN (Dec. 1, 2015), http://bravenewcoin.com/news/bitnation-starts-offering-blockchain-public-notary-service-to-estonian-e-residents [https://perma.cc/M5ZF-PBAB].

28. For a more complete discussion of potential and developing use cases, see for example, J. DAX HANSEN & CARLA L. REYES, PERKINS COIE, LEGAL ASPECTS OF SMART CONTRACT APPLICATIONS: DIGITAL ASSET SALES AND CAPITAL MARKETS, SUPPLY CHAIN MANAGEMENT, LAND REGISTRIES, GOVERNMENT RECORDS AND SMART CITIES, AND SELF-SOVEREIGN IDENTITY (2017), https://www.virtualcurrencyreport.com/wp-content/uploads/sites/13/2017/05/Perkins-Coie-LLP-Legal-Aspects-of-Smart-Contracts-Applications.pdf [https://perma.cc/A6TQ-UNQG] and SMART CONTRACTS ALL. WITH DELOITTE, SMART CONTRACTS: 12 USE CASES FOR BUSINESS & BEYOND (2016), https://digitalchamber.org/wp-content/uploads/2018/02/Smart-Contracts-12-Use-Cases-for-Business-and-Beyond_Chamber-of-Digital-Commerce.pdf [https://perma.cc/V4AN-SNBE].

Increasingly, the public sector is also indicating interest in potential applications of verifiable scripts and distributed ledger technology for use in government and legal processes.[29] Such contemplated uses call for the law and those that develop it—academics, practitioners and lawmakers alike—to prepare for a time when verifiable scripts and distributed ledger technology disrupt the law itself. In other words, public sector implementation or other enabling of verifiable scripts and distributed ledger technology calls for engagement with a cryptolaw jurisprudential framework for blockchain technology and distributed ledger technology.

II. RECENT ADOPTION OF CRYPTO-LEGAL STRUCTURES AND THE NEED FOR CRYPTOLAW JURISPRUDENCE

According to *Black's Law Dictionary*, in "the proper sense of the word," jurisprudence

> is the science of law, namely, that science which has for its function to ascertain the principles on which legal rules are based, so as not only to classify those rules in their proper order, and show the relation in which they stand to one another, but also to settle the manner in which new or doubtful cases should be brought under the appropriate rules.[30]

Cryptolaw, then, is the science of ascertaining the principles applicable when societal actors (whether governmental or private) adopt crypto-legal structures in two specific contexts: first, in identifying when adoption of a crypto-legal structure is actually warranted, and second, in determining how and in what manner we should assess the applicability of existing rules and the relation of existing rules to crypto-legal structures. This section sets forth the key elements of each of these pieces of cryptolaw for DLT.

A. Help or Hype: When is a Crypto-Legal Structure Actually Warranted?

Current public sector DLT applications under active investigation include real property registries,[31] government archives and record retention,[32] UCC-1

29. MARK WHITE ET AL., WILL BLOCKCHAIN TRANSFORM THE PUBLIC SECTOR? 2 (2017), https://www2.deloitte.com/content/dam/insights/us/articles/4185_blockchain-public-sector/DUP_will-blockchain-transform-public-sector.pdf; *see also infra* notes 30–37 and accompanying text.

30. *Jurisprudence*, BLACK'S LAW DICTIONARY (6th ed. 1992).

31. *See* MIRKOVIC, *supra* note 3; Rizzo, *supra* note 2.

32. *E.g.*, Del Castillo, *supra* note 4; Andrea Tinianow & Caitlin Long, *Delaware Blockchain Initiative: Transforming the Foundational Infrastructure of Corporate Finance*, HARV. L. SCH. F. CORP. GOVERNANCE & FIN. REG. (Mar. 16, 2017), https://corpgov.law.harvard.edu/2017/03/16/delaware-blockchain-initiative-transforming-the-foundational-infrastructure-of-corporate-finance/ [https://perma.cc/L6SP-7X37] ("The first milestone on [the Delaware Blockchain Initiative's] roadmap has been reached. It is the rollout of distributed ledger technology at the Delaware Public Archives, which has been the 'beta' test for the technology within State government. New 'smart records' technology automates compliance with laws pertaining to retention and destruction of archival documents, among other features.").

filings for secured lending transactions under UCC Article 9,[33] anti-money laundering regulation compliance;[34] issuance and maintenance of identity documents,[35] protection of health data,[36] compliance with evidentiary standards,[37] and allowing the issuance of corporate shares on DLT-based systems,[38] among others. The variety and breadth of the subjects represented in this list make it tempting to assume that DLT applications really represent more efficient and secure database, cloud, or cryptography-based applications technologies.[39] Hence, there appears to be a certain rush to "upgrade" existing database structures to DLT-based systems.[40] However, leading technologists agree that the cost of using large networks of computers to reach distributed or decentralized consensus about the existence and evolution of shared facts exceeds the benefits of DLT in scenarios where existing databases work well.[41] Many commentators

33. Tinianow & Long, *supra* note 32 ("The second milestone will be 'smart UCC' filings. . . . UCC filings on a distributed ledger will (1) automate the release or renewal of UCC filings and related collateral, (2) increase the speed of searching UCC records, (3) reduce mistakes and fraud and (4) cut cost.").

34. *See* HENNING DIEDRICH, ETHEREUM: BLOCKCHAINS, DIGITAL ASSETS, SMART CONTRACTS, DECENTRALIZED AUTONOMOUS ORGANIZATIONS 19 (2016) (noting the European Union's research into blockchain-based anti-money laundering regulation compliance systems).

35. *See* CRAIG HOLLOWAY, DEP'T OF INNOVATION & TECH., STATE OF ILLINOIS: REQUEST FOR INFORMATION (RFI): DISTRIBUTED LEDGER AND BLOCKCHAIN APPLICATIONS IN THE PUBLIC SECTOR 4–5 (2016), https://www2.illinois.gov/sites/doit/Documents/BlockchainInitiative/RFI+Blockchain+and+Distributed+Ledger+Applications+in+the+Public+Sector.pdf [https://perma.cc/F7VC-Z32Q] (naming identity, attestation and ownership registries as one of the public-sector applications slated for further investigation); Bloomberg, *supra* note 5.

36. *See* Joseph Bradley, *U.S. Department of Health Calls for Blockchain Research*, CCN (July 8, 2016, 10:11 AM), https://www.cryptocoinsnews.com/u-s-department-of-health-calls-for-blockchain-white-papers [https://perma.cc/MH2T-R3LH].

37. *See* Joanna Diane Caytas, *Blockchain in the U.S. Regulatory Setting: Evidentiary Use in Vermont, Delaware, and Elsewhere*, COLUM. SCI. & TECH. L. REV. (May 30, 2017), http://stlr.org/2017/05/30/blockchain-in-the-u-s-regulatory-setting-evidentiary-use-in-vermont-delaware-and-elsewhere/ (noting that Vermont enacted legislation "on recognizing validity of blockchain records and their admissibility in courts as evidence without need for authentication," and Nevada also enacted legislation providing "for recognition of validity of blockchain records, blockchain-enabled electronic signatures, and smart contracts").

38. Tinianow & Long, *supra* note 32 ("When then-Governor Markell launched the [Delaware Blockchain Initiative], he committed State government to use the technology and asked the Delaware State Bar Association's Corporation Law Council to consider clarifying Delaware corporate law to expressly authorize tracking of share issuances and transfers on a distributed ledger.").

39. DIEDRICH, *supra* note 34, at 49–50 (demonstrating that many current proposals for blockchain-based applications are really database, cloud-service, or cryptography-based applications instead).

40. *See, e.g.*, Anna Irrera & John McCrank, *Wall Street Rethinks Blockchain Projects as Euphoria Meets Reality*, REUTERS (Mar. 27, 2018, 9:58 AM), https://www.reuters.com/article/us-alphabet-google-ads-exclusive/exclusive-google-unveils-vetting-process-for-drug-rehab-ads-idUSKBN1HN28X [https://perma.cc/ZU5A-37L6].

41. Nolan Bauerle, *What is the Difference Between a Blockchain and a Database?*, COINDESK, https://www.coindesk.com/information/what-is-the-difference-blockchain-and-database/ [https://perma.cc/25AS-QQAL] ("[I]f confidentiality is the only goal, and trust is not an issue, blockchain databases pose no advantage over a centralized database. Hiding information on a blockchain requires lots of cryptography and a related computational burden for the nodes in the network.

nevertheless argue that public sector DLT applications offer opportunities to increase efficiency and transparency, enhance security of government systems, and establish trustable audit trails.[42] How, then, can scenarios where crypto-legal structures will actually help be separated from the hype? We start by building a jurisprudence of cryptolaw.

Professor Lawrence Lessig famously wrote "[c]ode is law," to emphasize that "we must understand how . . . the software and hardware that make cyberspace what it is regulate cyberspace as it is."[43] In other words, code, as the architecture of the Internet, constrains the ability of Internet users to take action via technological means.[44] Building on this idea of "code is law," DLT code can be conceptualized as a foreign legal system for the purpose of creating analytical space for determining whether—and under which circumstances—the creation of a crypto-legal structure is warranted.[45] Comparative law, or comparative jurisprudence, described as the study of the principles of law by comparing legal systems,[46] uses the functional method to "consider[] elements of a legal system in light of the function that it serves in responding to a societal problem."[47] In so doing, comparative law recognizes legal systems as subsystems of a larger cultural system.[48] As such, the comparative functional method employs a methodology that requires researchers comparing one legal system to another system to ask whether, in the absence of an equivalent legal structure, some other institution, legal or non-legal, fills the same function.[49] To determine whether a crypto-legal structure is warranted, and upon which DLT architecture such a crypto-legal structure should be based, we use the comparative functional method to ascertain: (1) the function of the distributed ledger, and (2) the functions of the components that make-up its architecture.

There is no way to do this that is more effective than simply hiding the data completely in a private database that does not even require network connectivity.").

42. *See, e.g.*, Darcie Piechowski, *Blockchain for Government*, IBM CTR. FOR BUS. GOV'T (Mar. 27, 2017, 6:45 AM), http://www.businessofgovernment.org/blog/business-government/blockchain-government-0 [https://perma.cc/C2PL-P7NP]; Samantha Radocchia, *What Are Some Ways Blockchain Smart Contracts Can Improve Government?*, QUORA (Nov. 9, 2017), https://www.quora.com/What-are-some-ways-blockchain-smart-contracts-can-improve-government/answer/Samantha-Radocchia [https://perma.cc/74ZK-7YDB].

43. LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE 6 (1999) (emphasis omitted).

44. Primavera De Filippi & Samer Hassan, *Blockchain Technology as a Regulatory Technology: From Code Is Law to Law Is Code*, 21 FIRST MONDAY (Dec. 5, 2016), http://firstmonday.org/ojs/index.php/fm/article/view/7113/5657 [https://perma.cc/6B6C-DUQ7] ("[C]ode is ultimately the architecture of the Internet, and—as such—is capable of constraining an individual's actions via technological means.").

45. Reyes, *supra* note 6, at 415.

46. *Comparative Law*, BLACK'S LAW DICTIONARY (6th ed. 1992).

47. Reyes, *supra* note 6, at 416 (citing Ralf Michaels, *The Functionalism of Legal Origins*, *in* DOES LAW MATTER? ON LAW AND ECONOMIC GROWTH 21, 23 (Michael Faure & Jan Smits eds., 2011)).

48. *See id.* (citing Tom Ginsburg, *Lawrence M. Friedman's Comparative Law, with Notes on Japan*, 5 J. COMP. L. 92, 102 (2010)).

49. *Id.* (citing Ralf Michaels, *Comparative Law by Numbers? Legal Origins Thesis,* Doing Business *Reports, and the Silence of Traditional Comparative Law*, 57 AM. J. COMP. L. 765, 778 (2009)).

The first issue, the function of a distributed ledger, is not difficult to ascertain, as the very definition of DLT conveys its function: allowing mutually distrusting actors to reach consensus on the evolution and existence of shared facts.[50] Viewed in the light of its function, DLT-based systems offer a cost-justified solution to implementation or enforcement of a legal or regulatory process in the public sector when the problem in the existing system relates to the relative inability of multiple parties to reach a consensus about the existence and evolution of shared facts.[51] The second issue will be viewed differently by different actors in the DLT ecosystem,[52] but many coders, such as R3's Richard Gendal Brown view the ultimate function of DLT as being achieved by a "bundle of five services (consensus, validity, uniqueness, immutability, and authentication) that can be selected, like items on a menu, in whatever combination is needed to address a problem."[53] Thus, determining which DLT or blockchain architecture is best suited for the basis of a crypto-legal structure will depend upon the unique combination of these five services and the effect on the function of the bundled service caused by the design trade-offs made in selecting that combination.

According to Brown, the first of the five bundled services offered through DLT is consensus, which he defines as "creat[ing] a world where *parties to a shared fact* know that the fact they see is the same as the fact that other stakeholders see. . . . across the Internet between mutually untrusting parties."[54] By providing the second service, validity, DLT has the capacity "to know whether a given proposed update to the system is valid."[55] DLT also enables uniqueness, "the capacity, in the face of conflicting valid updates to the system, 'to know which, if either, of those updates we should select as the one we all agree on.'"[56] As I stressed in an earlier article: "Immutability [is] the feature of DLT whereby 'nobody *else* [in the DLT system] will accept a transaction from me if it tries to build on a modified version of some data that has already been accepted by other stakeholders.'"[57] And finally, by performing the service of authentication, DLT enables "every action in the system [to be] almost always associated with a pri-

50. Brown, *supra* note 13 (defining DLT as "platforms, shared across the Internet between mutually distrusting actors, that allow them to reach consensus about the existence and evolution of facts shared between them").

51. Reyes, *supra* note 6, at 402.

52. Indeed, there are debates on just about everything relating to architecture and design of DLT and blockchain-based systems.

53. Reyes, *supra* note 6, at 401 (citing Brown, *supra* note 13).

54. Brown, *supra* note 13.

55. *Id.*

56. Reyes, *supra* note 6, at 395 (quoting Brown, *supra* note 13).

57. *Id.* (quoting Brown, *supra* note 13). Note here that "immutability" really amounts to tamper-resistance. *Id.* at 395 n.64. It is a short hand term used to denote that it is extremely difficult for one user, acting alone, to change the agreed upon state of shared facts between participants. *Id.* It does not literally mean "never able to change."

vate key; [such that] there is no concept of a 'master key' or 'administrator password' that gives God-like powers."[58] When creating a crypto-legal structure, if the emphasis is on tamper-resistance, then the crypto-legal structure should be built using a distributed ledger that emphasizes what Brown calls the service of "immutability."[59] If, instead, the key function to be achieved is authentication, then the crypto-legal structure should be built on a distributed ledger that emphasizes that service.

For example, Brown's own Corda platform limits the consensus service to only those parties (in Corda's case, regulated financial institutions) that need to agree on particular shared data.[60] Corda offers a distributed ledger for financial institutions engaged in deals with each other.[61] The idea is that only the parties to those deals need to see the shared data about the transactions.[62] A similar approach is taken to validity in Corda's design, where Corda allows participants themselves to choose the level of the uniqueness service offered by DLT to suit the particular deal at hand.[63] The final services of very strong tamper-resistance (immutability) and authentication, on the other hand, resemble very closely the features of the original Bitcoin blockchain.[64] Ultimately, then, treating DLT as a foreign legal system offers a conceptual framework for determining whether a crypto-legal structure may be an appropriate tool for implementing and enforcing a legal process and what type of distributed ledger should be used as the basis for that crypto-legal structure.

B. Crypto-Legal Structures Operate Like Legal Transplants, Anticipating Five Areas of Jurisprudential Ripple Effects

Treating the code that comprises DLT protocols as a foreign legal system also creates a launching pad for exploring the broader jurisprudential implications of creating and adopting crypto-legal structures. It should be noted that "[i]f DLT is approached as a form of foreign law, the creation of a crypto-legal structure by taking an existing legal rule and rewriting it into computer code should be approached as an exercise in legal transplantation."[65] In the comparative legal literature on legal transplants, a legal transplant occurs when a legal rule, institution, or structure in one system is copied and implemented in a foreign system.[66] The extensive comparative legal literature discussing legal transplants[67] also teaches how to expect legal transplants to behave and how to decide

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58. Brown, *supra* note 13.
59. *Id.*
60. *Id.*
61. *Id.*
62. *Id.*
63. *Id.*
64. *Id.*
65. Reyes, *supra* note 6, at 415.
66. *Id.*
67. For further discussion of the debate and literature on legal transplants in comparative law, see, for example, *id.* at 421–22 (citing ALAN WATSON, LEGAL TRANSPLANTS: AN APPROACH TO

what the transplant should look like.[68] These lessons from comparative law translate into five areas of jurisprudential ripple effects that should be expected to emerge as governments adopt crypto-legal structures to implement and enforce law.[69]

First, as crypto-legal structures are adopted to enforce or implement law, they should be expected to offer an opportunity to simplify existing substantive law.[70] Comparative law's functional method ensures that when designing a transplant to be implanted in the foreign system, those orchestrating the transplant rely upon endogenous legal rules, structures, and institutions in that receiving jurisdiction and consider how these endogenous elements will interact with the new rule.[71] In other words, after having first considered whether the basic function of DLT helps resolve a problem that the legal rule, institution, or structure struggles to adequately address in its current form, and after then considering which distributed ledger's mix of services best advances that functional goal, "the transplantation process [next] requires a consideration of any institutions or elements of the receiving system, here the DLT, that serve some or all of the same function. Only then can the transplant, the crypto-legal structure, be successfully designed."[72] During that process, those designing the crypto-legal structure will identify areas in which DLT acts, or can be coded to act as, functionally equivalent to legal rules.[73] In such circumstances, creating crypto-legal structures offers an opportunity to simplify substantive law.[74]

Second, those designing and implanting crypto-legal transplants should expect new legal elements and actors to emerge.[75] Comparative legal scholarship instructs that the very nature of a transplant is that "when those vested with authority have decided what law to import, the process of adaptation to the local

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COMPARATIVE LAW 21–30 (2d ed. 1993)); and Pierre Legrand, *The Impossibility of 'Legal Transplants'*, 4 MAASTRICHT J. EUR. & COMP. L. 111 (1997).

68. *See* Michele Graziadei, *Comparative Law as the Study of Transplants and Receptions*, *in* THE OXFORD HANDBOOK OF COMPARATIVE LAW 441, 443 (Mathias Reimann & Reinhard Zimmermann eds., 2006).

69. *See* Reyes, *supra* note 6, at 415–37 (categorizing these ripple effects into three broad areas of legal system disruption: disruption of substantive law, disruption of legal structures, and disruption of legal culture).

70. *See id.* at 416–21.

71. *See id.* at 417 (arguing that the functional method of comparative law, and the systems analysis of computer science, encourages regulators and DLT computer coders alike to "first assess[] a specific existing legal structure, identifying its functional relation to society, breaking out subsystems of the legal structure, and identifying their functions, and then assessing which elements of DLT, if any, endogenously fill those functions").

72. *Id.* at 416.

73. *Id.* at 417.

74. *Id.*; *see also* Carla L. Reyes, *Blockchain-Based Agencies*, ADMIN. & REG. L. NEWS, Summer 2017, at 9, 10 ("Imagine, for example, simplifying the rules related to Article 9 UCC-1 filing search errors or simplifying priority analysis.").

75. Reyes, *supra* note 6, at 421.

environment will often add new and unexpected elements to the import."[76] Put another way, studies show that, historically, transplanted "laws have everywhere been adapted to suit local conditions, and transplants everywhere manifest themselves as new hybrids."[77] In the context of crypto-legal structures, the result is simple: a legal rule implemented through computer code may not operate in the same manner as that same legal rule carried out by individuals.[78] In particular, the self-executing elements of the computer code and the software developers that code them might exert more regulatory power than intended, and may introduce new regulatory pitfalls, including unintended biases and questions of access to redress for faulty decisions.[79]

Third, using crypto-legal structures will disrupt choices in legal forms and, as a result, may lead to new patterns of enforcement and regulation.[80] Anthony Casey and Anthony Niblett argue that predictive technology will enable lawmakers to create "microdirectives" that allow individuals to understand their legal rights and obligations in specific situations.[81] A microdirective would be created by technology first taking "a standard-like policy objective, analyz[ing] its application in all possible contexts, and creat[ing] a vast catalog of legal rules—each of which is tailored to best achieve the objective in a specific scenario."[82] Then, as Casey and Niblett point out, "when a regulated actor is in any actual scenario, the technologies will search the vast catalog and identify the specific rules that are applicable . . . [to] translate those rules into a simple microdirective on how the regulated actor can comply with the law."[83] Finally, the microdirective would be communicated to the regulated individual,[84] and the individual would decide whether to comply with the microdirective.[85] Crypto-legal structures represent the potential for technology to eventually move beyond microdirectives to something more akin to automatic compliance.[86] If

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76. Graziadei, *supra* note 68, at 465; *see also* Gunther Teubner, *Legal Irritants: Good Faith in British Law or How Unifying Law Ends Up in Divergences*, 61 MOD. L. REV. 11, 12 (1998) (arguing that transplants must be understood instead as "legal irritants," the adoption of "which triggers a whole series of new and unexpected events").

77. WERNER MENSKI, COMPARATIVE LAW IN A GLOBAL CONTEXT 51 (2d ed. 2006).

78. Reyes, *supra* note 6, at 422.

79. *Id.* at 423–26.

80. *Id.* at 428–32.

81. Anthony J. Casey & Anthony Niblett, *The Death of Rules and Standards*, 92 IND. L.J. 1401, 1403, 1410–12 (2017) (describing a "microdirective" as an easy-to-follow behavioral directive for legal compliance created by technology).

82. *Id.* at 1412.

83. *Id.*

84. *Id.*

85. Reyes, *supra* note 6, at 432 (citing Anthony J. Casey & Anthony Niblett, *Self-Driving Laws*, 66 U. TORONTO L.J. 429, 439 (2016)).

86. *Id.* at 424 ("In other words, cryptolaw would enable a world of microdirectives in which, instead of delivering a microdirective or range of microdirectives to an individual for choice of compliance, a range of microdirectives is derived, a choice is made, and the choice is executed, all by the crypto-regulatory agent that exists within the crypto-legal structure.") (citations omitted). Whether this outcome is desirable is one of the issues left for further exploration in the jurisprudential space of cryptolaw for blockchains.

enough crypto-legal structures emerge, certain systems will automatically comply with regulatory requirements.[87] In such circumstances, the choice left to individuals is whether to participate in a *prima facie* compliant system or to participate in an alternative, perhaps noncompliant system.[88] Such a possibility offers both promises and perils—the promise of allowing regulation to more closely mirror economic and social realities and the risk that a form of automatic restraint may significantly reduce individual autonomy.[89]

Fourth, crypto-legal structures may enable a reduction in law-lag.[90] Prevalent in the law and technology context, law-lag refers to the fact "that existing rules and institutional structures for rulemaking are becoming less capable of addressing the rapid pace of change."[91] In considering functional equivalents, the discipline of comparative law often considers the differences between the law on the books and the law in action. The law on the books is the blackletter statement of the law, while the law in action is the law as it actually works in practice.[92] The gap between these two versions of law contributes significantly to the law-lag that perpetually plagues law and technology.[93] By transferring the law on the books into DLT-based computer code, crypto-legal structures transform the law on the books to the law in action, thereby significantly reducing or eliminating the gap that feeds law-lag.[94]

Fifth, and finally, crypto-legal structures will be coded by software developers, which may shift the locus of legal culture away from lawyers and towards software developers.[95] Defined (by some)[96] as the "attitudes, values, and opinions held in society, with regard to law, the legal system and its various parts," legal culture "determines when, why, and where people use law, legal institutions, or legal process; and when they use other institutions, or do nothing."[97] Scholars have described "the law in lawyers' heads" as a significant source of legal culture—the way lawyers practice law and their understanding of local rules and procedures impacts how the law on the books translates into law in action.[98] If the crypto-legal structures begin to transform the law on the books

87. *Id.* at 432–33

88. *Id.*

89. *Id.* at 433.

90. *Id.* at 435–36.

91. Wulf A. Kaal, *Evolution of Law: Dynamic Regulation in a New Institutional Economics Framework*, *in* FESTSCHRIFT ZU EHREN VON CHRISTIAN KIRCHNER [FESTSCHRIFT IN HONOR OF CHRISTIAN KIRCHNER] 1211, 1212 (Wulf A. Kaal et al. eds., 2014).

92. Reyes, *supra* note 6, at 435.

93. *See id.*

94. *Id.*

95. *Id.* at 436–37.

96. For a discussion of some of the other definitions used in the literature, see *id.* at 434–35.

97. LAWRENCE M. FRIEDMAN, LAW AND SOCIETY 76 (1977).

98. *See* Lynn M. LoPucki, *Legal Culture, Legal Strategy, and the Law in Lawyers' Heads*, 90 NW. U. L. REV. 1498, 1500–01 (1996); *see also* FRIEDMAN, *supra* note 97, at 76, 79 (describing "internal legal culture" as the attitudes and values of professionals that work within the system); LAWRENCE M. FRIEDMAN, THE REPUBLIC OF CHOICE: LAW, AUTHORITY, AND CULTURE 4 (1990) (same).

into law enacted through computer code, the law in software developers' heads may impact legal culture more strongly than lawyers do.[99] This shift in the factors that impact legal culture, as with many of the other analytical results discussed here, offers both the promise of more uniform application of law and the peril of imbedding the biases of software developers into the law.[100]

The prevalence and relative importance of any of these five factors will vary with the use case to which the crypto-legal structure is applied. This is not a formula for constructing successful crypto-legal structures so much as it is a framework for beginning to analyze, discuss, and create a philosophy of law implemented through self-executing cryptographic computer code; it is a framework for beginning to build a jurisprudence of cryptolaw for blockchain technology.

III. DELAWARE AND BLOCKCHAIN-BASED CORPORATE SHARE ISSUANCE: A CASE STUDY

To better understand how the cryptolaw framework might be applied in a specific circumstance, this article now turns to a case study: Delaware's efforts to allow corporations to issue shares using distributed ledger technology. This section first offers the background scenario that brought the share registry forward as a potential case for implementing a crypto-legal structure. Then this section uses the principles of the cryptolaw framework to consider three potential legal ripple effects that may result: the need for further simplification of substantive law, the emergence of new actors requiring regulatory oversight, and a potential shift in corporate culture.

A. Delaware's Existing Share Registry Systems Are Broken

The saga of changing the Delaware General Corporation Law to enable DLT-based corporate share issuance began in May 2016 when Delaware's then Governor Jack Markell created the Delaware Blockchain Initiative.[101] The Governor charged the Delaware Blockchain Initiative with, among other things, pursuing "the amendment of Delaware law to accommodate distributed ledger shares."[102] The move was welcomed by Delaware Chancery Court Vice Chancellor J. Travis Laster, who, in a speech given to the Council of Institutional Investors just five months later, said that distributed ledger technology enables

99. Reyes, *supra* note 6, at 436.

100. *Id.* at 424–26.

101. Marco A. Santori, *Governor Jack Markell Announces Delaware Blockchain Initiative*, GLOBAL DEL. BLOG (June 10, 2016), https://global.delaware.gov/2016/06/10/delaware-to-create-distributed-ledger-based-share-ownership-structure-as-part-of-blockchain-initiative/ [https://web.archive.org/web/20180305210213/https://global.delaware.gov/2016/06/10/delaware-to-create-distributed-ledger-based-share-ownership-structure-as-part-of-blockchain-initiative/].

102. *Id.*

"a utopian vision of a share ownership system where there is only one type of owner: record owners."[103]

The vice chancellor later took the opportunity to underscore the practical importance of his position on distributed ledger technology's potential by offering commentary in a February 15, 2017 memorandum opinion *In Re Dole Food Company, Inc. Stockholder Litigation*.[104] Dole reached a settlement agreement with its former shareholders, who had sued alleging that the conflicting interests of key persons during a merger caused shareholders to receive a reduced price for their shares.[105] To distribute the settlement funds, the court and the parties needed to determine who owned shares that entitled them to an award.[106] As part of the claim process, "shareholders representing 49,164,415 shares claimed settlement proceeds, but the class contained only 36,793,758 shares."[107] The institutions charged with keeping track of who owns which shares, the Depository Trust Company (DTC),[108] could not confirm which claimants actually owned existing shares.[109]

Commenting on this troubling state of affairs, Vice Chancellor Laster explained in a footnote of the memorandum opinion in which he decided who would receive the settlement funds that

> [t]his problem is an unintended consequence of the top-down federal solution to the paperwork crisis that threatened Wall Street in the 1970s. Through the policy of share immobilization, Congress and the Securities and Exchange Commission addressed the crisis using the 1970s-era technologies of depository institutions, jumbo paper certificates, and a centralized ledger.[110]

Noting that "[i]t was an incomplete solution" even at the time it was created, Laster explained the law lag only grew over time, compounding the problem.[111] Laster further commented that "[d]istributed ledger technology offers a potential technological solution by maintaining multiple, current copies of a single and comprehensive stock ownership ledger."[112] Although the Delaware Blockchain Initiative had been considering this very use case for nearly one year, the media attention given to the vice chancellor's comments in the *Dole* case

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103. Andrew Quentson, *Take Back Stock and Share Voting with Blockchain Tech, Says Delaware Judge*, CCN (Oct. 25, 2016, 10:09 PM), https://www.cryptocoinsnews.com/take-back-stock-and-share-voting-with-blockchain-tech-says-delaware-judge/ [perma.cc/BL5J-KGJG].

104. No. 8703-VCL, 2017 WL 624843 (Del. Ch. Feb. 15, 2017).

105. *Id.*; Steven Davidoff Solomon, *Dole Case Illustrates Problems in Shareholder System*, N.Y. TIMES (Mar. 21, 2017), https://www.nytimes.com/2017/03/21/business/dealbook/dole-case-illustrates-problems-in-shareholder-system.html.

106. *See* Solomon, *supra* note 105.

107. Caytas, *supra* note 37.

108. The DTC is a subsidiary of the Depository Trust & Clearing Corporation (DTCC). *Id.*

109. *Id.*

110. *In re* Dole Food Co., Inc. Stockholder Litigation, No. 8703-VCL, 2017 WL 624843, at *4 n.1 (Del. Ch. Feb. 15, 2017) (citing *In re* Appraisal of Dell Inc. (Dell Ownership), No. 9322-VCL, 2015 WL 4313206, at *3–7 (Del. Ch. July 30, 2015)).

111. *See id.*

112. *Id.* (citing Santori, *supra* note 101).

seemed to spur action.[113] By April of 2017, the Delaware Bar Association's Corporate Law Council proposed modifications to the Delaware General Corporation Law that would allow distributed-ledger share issuance.[114] Just three months later, in July 2017, Delaware Governor John C. Carney Jr. signed the bill[115] that amended Section 219 and 224 of the Delaware General Corporation Law to permit corporations to use records on a distributed ledger as a stock ledger under certain circumstances.[116]

B. Delaware Is Enabling Crypto-Legal Structures and Should Expect Ripple Effects in Adjacent Areas of the Law

The efforts to enable DLT-based corporate shares can be viewed as efforts to enable crypto-legal structures in the field of corporate law. A corporation allows diffuse and large numbers of individuals, many of whom may not personally know each other, to come together in the economically efficient pursuit of profit.[117] A corporate stock ledger functions to enable those diffuse and numerous actors to quickly distinguish who is entitled to what amount of economic return on their investment.[118] In other words, corporate share registries allow mutually distrusting shareholders to reach agreement about the evolution and existence of the relative ownership claims between them. As the *Dole* case demonstrated, existing mechanisms for maintaining share registries failed to keep pace with the technology individuals used to trade ownership interests.[119]

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113. Jeff Mordock, *Delaware Betting Big on Blockchain*, DELAWAREONLINE (Apr. 7, 2017, 3:34 PM), http://www.delawareonline.com/story/money/2017/04/07/delaware-betting-big-blockchain/100162782/ [perma.cc/33L7-BQWM].

114. *Id.*

115. Rizzo, *supra* note 1.

116. *Newly Released Delaware Corporate Law Amendments Would Permit Blockchain Shares*, COOLEY ALERT (Mar. 15, 2017), https://www.cooley.com/news/insight/2017/2017-03-15-newly-released-delaware-corporate-law-amendments-would-permit-blockchain-shares [https://perma.cc/LR6P-AHBA]; *see also* Lowell D. Ness & Valeria R. Bystrowicz-Liendo, *Delaware Law Embraces Digital Securities*, VIRTUAL CURRENCY REP. (Aug. 1, 2017), https://www.virtualcurrencyreport.com/2017/08/delaware-law-embraces-digital-securities/ [http://perma.cc/Q4XV-AMD4]. In particular, the ledger must: (a) be "convertible into clearly legible paper form within a reasonable time;" (b) "be used to prepare the list of stockholders specified in Section 219 as well as in Section 220, dealing with stockholder demands to inspect the corporations books and records;" (c) be able to "record[] the information specified in Section 156 for consideration for partly paid shares, Section 159 for the transfer of shares for collateral security, Section 217(a) for pledged shares, and Section 218 for voting trusts;" and (d) be able to "record[] transfers of stock as governed by Article 8 of the Delaware Uniform Commercial Code." *Id.*

117. *See, e.g.*, Margaret M. Blair & Lynn A. Stout, *A Team Production Theory of Corporate Law*, 85 VA. L. REV. 247, 250 (1999) ("We argue that public corporation law can offer a second-best solution to team production problems because it allows rational individuals who hope to profit from team production to overcome shirking and rent-seeking by opting into an internal governance structure we call the 'mediating hierarchy.'") (citations omitted).

118. *See* Ness & Bystrowicz-Liendo, *supra* note 116 (noting the purpose is to "know exactly who [the] true stockholders are at all times").

119. *See In re* Dole Food Co., Inc. Stockholder Litigation, No. 8703-VCL, 2017 WL 624843, at *4 n.1 (Del. Ch. Feb. 15, 2017).

As a result, the current structure routinely fails to enable shareholders to adequately reach consensus about who owns which shares—making this an area ripe for creating a crypto-legal structure.

Delaware's exercise in examining whether DLT-based corporate share issuance warranted changes to existing substantive law represents an example of the first ripple effect of crypto-legal structures at play: examining how the crypto-legal structure, in this case a distributed ledger share registry, will interact with, and call for changes to, existing substantive law. The next step in the first factor's analysis is to ask whether and how corporate shares issued on a distributed ledger will interact with federal securities exchange rules, should a public company wish to use a distributed ledger share registry.[120] For example, are there any conflicts with existing federal securities laws that regulate public companies that would prevent public companies from using digital shares? The answer to that question under current law may result in private companies being the primary adopters of distributed ledger share registries. In such a case, a further opportunity to simplify existing substantive law may arise. If no such conflict, whether legal or practical, to public company adoption of DLT-share registries arises, then Professor George Geis argues that the substantive "legal implications of traceable shares will be profound."[121] In particular, Professor Geis argues that traceable shares could enable more responsive shareholder governance models, impact the nature of shareholder lawsuits, and offer the opportunity to rethink the separation of corporate and shareholder liability.[122] Thus, whether obstacles to adoption arise or not, greater impact to corporate law beyond the changes already enacted to the Delaware General Corporation Law should be expected to materialize.

In keeping with another ripple effect predicted by the cryptolaw framework, we might also expect new actors with regulatory-like power related to privately held digital shares to emerge. For example, the requirements for compliant DLT-based share registries created by the amendments to the Delaware General Corporation Law include recording information that is not endogenously or routinely recorded by public blockchains like the Bitcoin Blockchain or Ethereum.[123] Rather, the capacity to routinely record such information into a DLT-based system will need to be developed, likely by a proprietary DLT-solution provider such as Symbiont, which has already worked closely with Delaware in this and other initiatives.[124] The technology companies that create

120. *See* Ness & Bystrowicz-Liendo, *supra* note 116 ("[N]one of the existing Stock Exchanges are currently set up to trade digital securities.").

121. George S. Geis, *Traceable Shares and Corporate Law*, 113 Nw. U. L. Rev. (forthcoming 2018–2019) (manuscript at 5), ssrn.com/abstract=3129042.

122. *See generally id.*

123. *Newly Released Delaware Corporate Law Amendments Would Permit Blockchain Shares*, *supra* note 116.

124. *See, e.g.*, Caitlin Long, *Blockchain Crosses the Delaware: Smart Securities to Disrupt Corporate Finance*, MARKETS MEDIA (July 31, 2017), https://marketsmedia.com/blockchain-crosses-delaware/ [http://perma.cc/CH58-Q92K] (noting that "Symbiont and its legal team assisted

DLT-based share registries may thus retain a certain level of control over the data contained in the distributed ledger and, depending upon the technical details of the distributed ledger, over the chain of records themselves.[125] Such companies will become the DLT equivalent of the DTCC. While the DTCC is not a regulatory body, but rather, is regulated by the SEC,[126] commentators have argued that "[i]n fact, the DTCC operates with minimal SEC oversight," and the DTCC has been treated in various ways as though it is a government entity.[127] As evidenced by the *Dole* case, the accumulation of such soft power can have important and unexpected effects on the corporate legal system. Delaware regulators should be prepared to exercise oversight over the companies that provided DLT-based systems to companies for use as share registries. Similarly, companies that develop such systems should prepare for a new level of potential regulation over the software they provide, particularly if they use a software as a service model and remain involved in the actual delivery and functioning of the system.

If startups adopt DLT-based share registries at the outset, and if doing so makes it more difficult for such companies to be traded publicly, then Delaware's DLT-based share recording system may inadvertently set the stage for fewer publicly traded companies and more unicorns.[128] As Abbey Stemler suggests: "Unicorns are able to avoid regulation and dictate the rules that will govern them in traditional and nontraditional ways."[129] Ultimately, it is important to note that in "a global economy that can be digitally wired and connected, massive potential exists for new business models and consumer experiences to disrupt industrial-era structures and institutions that have existing regulatory

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in crafting" the blockchain-related amendments to the Delaware General Corporation Law and that the full benefit of the amendments will not manifest until "the Delaware Division of Corporations announces completion of its integration with Symbiont's blockchain").

125. Adam Krellenstein, *Blockchain Technology and Institutional Finance*, SYMBIONT (Aug. 2, 2017), https://symbiont.io/blog/2017/8/2/blockchain-technology-and-institutional-finance [https://perma.cc/FWY2-4VUU] ("Note that so-called 'permissioned blockchains' (such as the one Symbiont is building) are networks in which the identities of all the participants are known to each other."); *Explainer: Permissioned Blockchains*, MONAX, https://monax.io/explainers/permissioned_blockchains/ [http://perma.cc/K2S2-AK9Y] ("Permissioned blockchain networks allow the network to appoint a group of participants in the network who are given the express authority to provide the validation of blocks of transactions. Or, to participate in the consensus mechanism.").

126. Alexis Brown Stokes, *In Pursuit of the Naked Short*, 5 N.Y.U. J.L. & BUS. 1, 6 (2009).

127. John W. Welborn, *The 'Phantom Shares' Menace*, REGULATION, Spring 2008, at 52, 54.

128. Abbey Stemler, *The Myth of the Sharing Economy and Its Implications for Regulating Innovation*, 67 EMORY L.J. 197, 199 n.11 (2017) ("A 'unicorn' is a startup company valued at over a billion dollars.") (citing *Words We're Watching: The Billion-Dollar Unicorn*, MERRIAM-WEBSTER, https://www.merriam-webster.com/words-at-play/unicorn-words-we're-watching).

129. *Id.* at 231.

frameworks."[130] Many start-ups are already on such paths of regulatory entrepreneurship.[131] Arguably, such power to engage and change the regulatory structures that would otherwise apply to a proposed business model has had a negative effect on corporate culture.[132] In particular, when private companies grow to such a scale that previously anticipated a public offering, but no longer face the same regulatory and market pressures to do so, a separation of ownership and control that mirrors the situation in public companies emerges, but is subject to none of the same governance oversight.[133] If DLT-based share registries are widely adopted, and adjacent areas of substantive legal or infrastructure conflicts, or both, are not resolved, Delaware's adoption of DLT-based share registries may lead to magnification of the shift in corporate culture that is already underway.

IV. THE NEXT WAVE OF CORPORATE LEGAL QUESTIONS FOR CRYPTOLAW

The changes to the Delaware General Corporation Law go a long way to showing mainstream companies the potential value of distributed ledger technologies for their purposes. However, by engaging in a discourse around DLT-based share registries rooted in the cryptolaw framework, this article makes clear that we should not expect the changes made to the Delaware General Corporation Law to be the only changes resulting from the adoption of DLT for corporate share registries. Instead, we should expect ripple effects to manifest in adjacent areas of law and regulation for some time to come. More than that, we should begin discussing the implications of those ripple effects for corporate law and policy—that is what cryptolaw for DLT is all about.

In the meantime, a significant amount of economic activity is taking place through businesses that engage DLT in an entirely different way—namely, businesses built on top of a blockchain and conducting operations through computer code. Some such businesses are quasi and fully autonomous. Such businesses take the type of legal questions that Delaware asked during the process of enabling DLT-based stock ledgers and multiplies them tenfold. Even as the cryptolaw discussion should not prematurely conclude with regard to Delaware digital stock ledgers, the next wave of corporate legal questions for cryptolaw

130. Elizabeth Pollman, *The Rise of Regulatory Affairs in Innovative Startups*, *in* THE HANDBOOK OF LAW AND ENTREPRENEURSHIP IN THE UNITED STATES (D. Gordon Smith & Christine Hurt eds., forthcoming 2018) (manuscript at 4), https://ssrn.com/abstract=2880818.

131. *See generally* Elizabeth Pollman & Jordan M. Barry, *Regulatory Entrepreneurship*, 90 S. CAL. L. REV. 383, 384–385 (2017).

132. Renee M. Jones, *The Unicorn Governance Trap*, 166 U. PA. L. REV. ONLINE 165, 165–167 (2017), https://www.pennlawreview.com/online/166-U-Pa-L-Rev-Online-165.pdf (describing Uber's recent scandals as symptoms of deeper problems with the company's corporate culture).

133. *Id.* at 168–169 ("[R]ecent market trends and deregulatory reforms have weakened or eliminated the principal mechanisms that imposed discipline on start-up company founders.").

are already manifesting.[134] Such new questions call equally upon regulators, policy makers, practitioners, business executives, early stage entrepreneurs and legal academics to engage in the discourse of cryptolaw to anticipate the potential challenges, implications, and consequences of moving legal and regulated economic activity to distributed ledger technology and blockchain technology-based systems.

134. I begin exploring some of these new questions in Carla L. Reyes, *If Rockefeller Were a Coder*, 87 GEO. WASH. L. REV. (forthcoming 2018), https://ssrn.com/abstract=3082915.