2016

Moving beyond Bitcoin to an Endogenous Theory of Decentralized Ledger Technology Regulation: An Initial Proposal

Carla L. Reyes
Southern Methodist University, Dedman School of Law

Author ORCID Identifier:

https://orcid.org/0000-0002-2448-8309

MOVING BEYOND BITCOIN TO AN ENDOGENOUS THEORY OF DECENTRALIZED LEDGER TECHNOLOGY REGULATION: AN INITIAL PROPOSAL

CARLA L. REYES*

INTRODUCTION

THE world is captivated by the emergence of decentralized ledger technologies[1] such as the blockchain[2] and their increasingly widespread use to facilitate everything from decentralized payments[3] to a decentral-

* J.D., LL.M. in International & Comparative Law, Duke University School of Law; M.P.P., Duke University Terry Sanford School of Public Policy. I am grateful for feedback received from my colleagues at Perkins Coie LLP, who work in the trenches with me on these issues. I would also like to thank my husband, Mario C. Reyes, for his unwavering support.

1. This Article uses the terms *decentralized ledger technology* or *decentralized ledger technologies* to refer broadly to distributed network technology that (1) enables users to upload programs and to leave the programs to self-execute; (2) maintains a permanent and public record (ledger) of the current and past states of every program; (3) is decentralized; (4) uses public key cryptography for authentication; and (5) uses economic incentives to ensure that the network maintains the technology. *See* Vitalik Buterin, *Visions, Part 1: The Value of Blockchain Technology*, ETHEREUM BLOG (Apr. 13, 2015), https://blog.ethereum.org/2015/04/13/visions-part-1-the-value-of-blockchain-technology/ [https://perma.cc/F3RB-E4TA]. The term *decentralized ledger technology* as used in this Article is therefore broad enough to encompass the blockchain that underlies the bitcoin payments application, which is currently receiving incredible attention, but is not so narrow as to exclude other forms of the technology or other practical applications other than payments. The term therefore intends to capture other distributed technology—such as Ripple and Ethereum—and is not intended to reference any one application of the technology.

2. The "blockchain" is the decentralized ledger technology that powers the payments application known as bitcoin. At a high level, the blockchain "combin[es] peer-to-peer networks, cryptographic algorithms, distributed data storage, and a decentralized consensus mechanisms [sic]" to "provide[ ] a way for people to agree on a particular state of affairs and record that agreement in a secure and verifiable manner." Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of* Lex Cryptographia 4–5, 5 & n.15 (Mar. 12, 2015) (unpublished manuscript), *available at* https://www.intgovforum.org/cms/wks2015/uploads/proposal_background_paper/SSRN-id2580664.pdf [https://perma.cc/K7HM-4GG7].

3. Although bitcoin, the decentralized virtual currency that may be exchanged through the blockchain, is currently receiving the most widespread attention, bitcoin itself is simply one payments-related application of the underlying technology. It is worth noting here that this Article adopts the term *decentralized virtual currency* to refer to decentralized payments applications because that term is now commonplace in the industry. However, the term *decentralized virtual currency* itself was somewhat controversial just several years ago. *Decentralized virtual currency* only became widely adopted as a term after the U.S. Department of Treasury's Financial Crimes Enforcement Network (FinCEN) released its guidance on virtual currencies on March 18, 2013. In that document, FinCEN defined *decentralized*

ized Internet of Things.[4] Software developers,[5] start-up companies,[6] and venture capitalists[7] all jubilantly declare the efficiency-maximizing,[8] cost-reducing,[9] and accessibility-enhancing[10] characteristics of decentralized cryptographic technologies. Academics predict that the blockchain and

---

virtual currency as "virtual currency (1) that has no central repository and no single administrator, and (2) that persons may obtain by their own computing or manufacturing effort." U.S. DEP'T OF TREASURY, FINCEN, ADMIN. RULING, FIN-2013-G001, APPLICATION OF FINCEN'S REGULATIONS TO PERSONS ADMINISTERING, EXCHANGING, OR USING VIRTUAL CURRENCIES 5 (2013) [hereinafter FINCEN, VIRTUAL CURRENCY GUIDANCE], https://www.fincen.gov/statutes_regs/guidance/pdf/FIN-2013-G001.pdf [https://perma.cc/49PB-SU55]. Without assuming its accuracy, this Article adopts FinCEN's definition of decentralized virtual currency.

4. *See generally* VEENA PURESWARAN & PAUL BRODY, IBM INST. FOR BUS. VALUE, DEVICE DEMOCRACY: SAVING THE FUTURE OF THE INTERNET OF THINGS (2015), http://public.dhe.ibm.com/common/ssi/ecm/gb/en/gbe03620usen/GBE03620USEN.pdf [https://perma.cc/HKG9-NPXR].

5. For example, the Open Mustard Seed Framework, being developed by ID3, combines blockchain technology with other decentralized technology with the intent "to provide a powerful new self-deploying and self-administering infrastructure layer for the Internet, which gives individuals control over their identities and their data, and which enables the formation and self-governance of Decentralized Autonomous Organizations, Authorities, and Enterprises for the creation and exchange of 'digital assets.'" *Open Mustard Seed (OMS) Framework*, ID3, https://idcubed.org/open-platform/platform/ [https://perma.cc/R7G9-FA63] (last visited Feb. 28, 2016).

6. *See, e.g.*, CHANGETIP, www.changetip.com [https://perma.cc/XLZ7-MB6D] (last visited Feb. 28, 2016) (providing "a love button for the Internet" through which users can engage in micro-tipping using bitcoin); COINBASE, www.coinbase.com [https://perma.cc/EF2Y-YYPP?type=image] (last visited Feb. 28, 2016) (providing Bitcoin wallet, sales, purchases, and exchange services); COINBEYOND, www.coinbeyond.com [https://perma.cc/GPX3-EU3W] (last visited Feb. 28, 2016) (providing bitcoin merchant services).

7. *See* Marc Andreessen, *Why Bitcoin Matters*, N.Y. TIMES, Jan. 21, 2014, http://dealbook.nytimes.com/2014/01/21/why-bitcoin-matters/?_r=0 [https://perma.cc/5MY8-378P].

> Bitcoin is the first practical solution to a longstanding problem in computer science called the Byzantine Generals Problem. . . .
>
> . . . .
>
> The practical consequence of solving this problem is that Bitcoin gives us, for the first time, a way for one Internet user to transfer a unique piece of digital property to another Internet user, such that the transfer is guaranteed to be safe and secure, everyone knows that the transfer has taken place, and nobody can challenge the legitimacy of the transfer. The consequences of this breakthrough are hard to overstate.

Id.

8. *See* BRIAN KELLY, THE BITCOIN BIG BANG: HOW ALTERNATIVE CURRENCIES ARE ABOUT TO CHANGE THE WORLD 163 (2015) ("Decentralization places the economic power into the hands of the citizens and removes many of the regulations that prevent capitalism from functioning efficiently.").

9. *See* J. ANTHONY MALONE, BITCOIN AND OTHER VIRTUAL CURRENCIES FOR THE 21ST CENTURY 47 (2014) ("Because there is no third party intermediary, Bitcoin transactions are substantially cheaper and quicker than traditional payment methods.").

10. *See id.* ("It has been estimated that half of the adults worldwide are unbanked due to barriers such as high costs, physical distance, and lack of infrastruc-

similar technologies will revolutionize the way people order their affairs and conduct transactions through the evolution of smart contracts,[11] decentralized autonomous organizations,[12] distributed property registries,[13] and distributed and secure data stores.[14] Although similarly captivated by these developing technologies, governments,[15] individual regulators,[16] and various policy makers[17] remain less optimistic that the good contributions of the technology will outweigh the way bad actors use the technology for illicit purposes.

---

ture and documentation. Bitcoin can exist wherever there is Internet or cell phone access and the requisite hardware." (footnote omitted)).

11. *See* Wright & De Filippi, *supra* note 2, at 10–12.

12. *See* William Mougayar, *What Does It Take to Succeed as a Decentralized Autonomous Organization?*, COINDESK (Feb. 21, 2015), http://www.coindesk.com/succeed-as-decentralized-autonomous-organization/ [https://perma.cc/3NJZ-34BY].

13. *See generally* Joshua A.T. Fairfield, *BitProperty*, 88 S. CAL. L. REV. 805 (2015) [hereinafter Fairfield, *BitProperty*].

14. *See* Wright & De Filippi, *supra* note 2, at 12–13.

15. For example, China's central bank completely prohibits financial institutions from handling fiat currency derived from bitcoin transactions. *See* Bloomberg News, *China Bans Financial Companies from Bitcoin Transactions*, BLOOMBERG (Dec. 5, 2013), http://www.bloomberg.com/news/articles/2013-12-05/china-s-pboc-bans-financial-companies-from-bitcoin-transactions [https://perma.cc/V5WD-6BQE]. Bolivia similarly bans the use of bitcoin and other decentralized virtual currencies. *See* Pete Rizzo, *Bolivia's Central Bank Bans Bitcoin*, COINDESK (June 19, 2014), http://www.coindesk.com/bolivias-central-bank-bans-bitcoin-digital-currencies/ [https://perma.cc/6DZY-PV3X]. Russia has considered whether to pass a similar ban on cryptocurrency. *See* Allen Scott, *Russia's Bitcoin Ban Expected in August; Expert Recommends Businesses 'Get Out,'* COINTELEGRAPH (Apr. 2, 2015), http://cointelegraph.com/news/113857/russias-bitcoin-ban-expected-in-august-expert-recommends-businesses-get-out [https://perma.cc/YUU2-HA3K]. Other examples of government skepticism of decentralized virtual currency abound.

16. *See, e.g.*, Jennifer Shasky Calvery, Dir., FinCEN, Prepared Remarks at the Association of Certified Anti-Money Laundering Specialists (ACAMS) 19th Annual International AML and Financial Crime Conference 2 (Mar. 18, 2014), transcript *available at* http://www.fincen.gov/news_room/speech/pdf/20140318.pdf [https://perma.cc/Y5E3-4ZYD] ("Indeed, the idea that illicit actors might exploit the vulnerabilities of virtual currency to launder money is not merely theoretical. We have seen both centralized and decentralized virtual currencies exploited by illicit actors.").

17. *See, e.g.*, CONF. OF STATE BANK SUPERVISORS, POLICY ON STATE VIRTUAL CURRENCY REGULATION 1 (Dec. 16, 2014), *available at* http://www.csbs.org/regulatory/ep/Documents/CSBS%20Policy%20on%20State%20Virtual%20Currency%20Regulation%20—%20Dec.%2016%202014.pdf [https://perma.cc/7SE4-FKVG] ("State regulators have determined that certain virtual currency activities raise concerns in the areas of consumer protection, marketplace stability, and law enforcement.").

Under the weight of various historical indicators[18] and in the wake of significant recent events,[19] regulators adopted an increasingly aggressive approach to enforcing existing regulations against the drastically new, different, and emerging technology.[20] The resulting barriers to entry[21] and climate of legal stigma[22] are stifling the nascent decentralized technology industry and preventing further innovation. In response, the decentralized virtual currency industry and other businesses interested in exploring the potential uses of decentralized technologies in commerce call for self-regulation.[23] Current literature, for its part, suggests a variety of regulatory models with each approach varying in light of the characteristics of the underlying technology that the commentator suggesting the model considers to threaten the most potential harm.[24]

History intimates that the self-regulatory approach is unlikely to sufficiently resolve the market failures that will ultimately allow illicit and fraudulent uses of decentralized technologies to occur. Meanwhile, the regulatory approaches suggested in the literature each impose a new regulatory barrier to entry even while trying to alleviate the inefficiencies of the

18. *See generally* Lawrence Trautman, *Virtual Currencies; Bitcoin & What Now After Liberty Reserve, Silk Road, and Mt. Gox?*, 20 RICH. J.L. & TECH. 13 (2014) (providing detailed historical review of illicit and criminal uses of bitcoin).

19. *See, e.g.*, Application and Affidavit for Seizure Warrant, In the Matter of the Seizure of the Contents of One Dwolla Account, No. 13–1162 SKG (D. Md. May 14, 2013) [hereinafter Application for Seizure Warrant], *available at* http://cdn.arstechnica.net/wp-content/uploads/2013/05/Mt-Gox-Dwolla-Warrant-5-14-13.pdf [http://cdn.arstechnica.net/wp-content/uploads/2013/05/Mt-Gox-Dwolla-Warrant-5-14-13.pdf]; Notice of Finding That Liberty Reserve S.A. Is a Financial Institution of Primary Money Laundering Concern, 78 Fed. Reg. 34169-01 (June 6, 2013) [hereinafter FinCEN, Notice of Finding].

20. *See, e.g.*, FINCEN, VIRTUAL CURRENCY GUIDANCE, *supra* note 3; Kashmir Hill, *Every Important Person in Bitcoin Just Got Subpoenaed by New York's Financial Regulator*, FORBES (Aug. 12, 2013), http://www.forbes.com/sites/kashmirhill/2013/08/12/every-important-person-in-bitcoin-just-got-subpoenaed-by-new-yorks-financial-regulator/.

21. Prior to the announcement of the Virtual Currency Guidance, state regulators remained silent about the potential for their existing laws to regulate decentralized virtual currency. The federal action seemed to spark a wave of activity at the state level as well. In fact, the state regulatory barriers to entry are now so high that they prevent even established players, such as Coinbase Inc., from entering all markets. *See* Jamie Redman, *Coinbase to Stop Service in Wyoming Due to 'Impractical' Regulations*, COINTELEGRAPH (June 4, 2015), http://cointelegraph.com/news/114470/coinbase-to-stop-service-in-wyoming-due-to-impractical-regulations [https://perma.cc/7ZKG-A9GM].

22. *See* Robin Sidel, *Bitcoin Evangelist Is Bound but Not Out*, WALL ST. J., June 30, 2014, http://www.wsj.com/articles/bitcoin-evangelist-is-bound-but-not-out-1404185518 [https://perma.cc/LA7X-UGZT].

23. *See, e.g.*, *Standards*, DIGITAL ASSET TRANSFER AUTHORITY, http://info.dataauthority.org/wordpress/standards/ [https://perma.cc/FG2M-UPS2] (last visited Feb. 28, 2016).

24. *See, e.g.*, Omri Marian, *A Conceptual Framework for the Regulation of Cryptocurrencies*, 8 U. CHI. L. REV. DIALOGUE 53 (2015) (suggesting target anonymity to curb criminal uses); Wright & De Filippi, *supra* note 2 (suggesting do-nothing approach because encouraging innovation is tantamount).

current landscape. This Article suggests a different approach, one designed to encourage organic regulation that both addresses potential market and governance failures and takes into account the unique nature of the technology at issue.

This Article lays the foundation for adopting an endogenous theory of decentralized technology regulation. Drawing on theories of endogenous economic regulation, endogenous development, and functional financial regulation, this Article proposes that decentralized technologies, including the blockchain technology underlying decentralized payment systems such as bitcoin, are robust enough to support a theory of endogenous, technology-assisted regulation. Specifically, when this Article proposes an endogenous theory of regulation, it suggests that regulators undertake the dual task of enacting a law or regulation via statute and then implementing that statute through code by engaging in an iterative and cooperative process with the technologies' core developers and with consensus from the network, so that regulation is endogenously incorporated into the decentralized ledger technology and the applications running on top of the technology.

This Article makes the case for such an approach in five parts. Part I briefly introduces the decentralized ledger technology ecosystem, setting the stage for the rest of the Article by focusing on the protocol layer before addressing applications that might run on the protocol, such as bitcoin payments. Part II examines the current regulatory landscape, describing the "law lag" experienced by the decentralized ledger technology ecosystem and evaluating whether the choice between ex ante and ex post regulation is contributing to the lag. In light of the technology, its present uses, and the current regulatory landscape facing those uses, Part III proposes a set of criteria for constructing a regulatory framework for decentralized ledger technology and evaluates the alternative regulatory approaches that have been considered to date in light of those criteria. Ultimately, Part III identifies a regulatory lacuna common to both the present landscape and the alternative proposals presented in the literature. Part IV synthesizes an endogenous theory of decentralized ledger technology regulation from concepts found in economic regulation, international development, comparative law, and financial regulation literature.

In particular, Part IV argues that the regulatory approach with the potential to fulfill a majority of the criteria to a high degree is an endogenous, or functional, approach that simultaneously governs from within and without, and sidesteps the ex ante/ex post regulatory dichotomy by building compliance into the protocol as regulation-through-code. Linking the endogenous regulatory approach to the academic discourse re-

garding Lawrence Lessig's concept of code-as-law,[25] this Article proposes regulation that is endogenous at two levels: (1) as an iterative and cooperative process requiring participation of both regulators and industry actors approaching regulation design from a functional perspective and (2) as regulation implemented literally from within the decentralized ledger system as part of its operative code. Recognizing certain practical and theoretical challenges to implementing this endogenous theory, this Article concludes by identifying areas for further research and suggesting ways that successful implementation could disrupt core aspects of regulatory theory.

I. THE DECENTRALIZED LEDGER TECHNOLOGY ECOSYSTEM: A BRIEF INTRODUCTION

Commentators often compare the technical development and stages of public adoption of bitcoin to the development of the Internet.[26] The reality, however, is that the technical development and public adoption of bitcoin is better compared to the development and adoption of Internet Explorer or Apple TV (both of which are applications that run on the underlying Internet technology), while the development and adoption of the blockchain is akin to that of the Internet. Bitcoin is simply one application, a payments application, of the blockchain technology on which it runs. Further, the blockchain is just one of a variety of similar technologies often referred to as decentralized public ledgers or trustless public ledgers.[27] Because failure to appreciate these distinctions constitutes a core element in the regulatory difficulty facing entrepreneurs integrating decentralized ledger technology into their products and services, a brief introduction to the varied technology that makes up the decentralized ledger ecosystem, including decentralized public ledgers such as the blockchain, decentralized payments applications such as bitcoin, and other decentralized applications of the technology is warranted.[28] As the

25. *See* Lawrence Lessig, *Open Code and Open Societies: Values of Internet Governance*, 74 CHI.-KENT L. REV. 1405, 1408 (1999) [hereinafter Lessig, *Open Code and Open Societies*].

> The code of cyberspace—whether the Internet, or a net within the Internet—defines that space. It constitutes that space. And as with any constitution, it builds within itself a set of values and possibilities that governs life there. . . . And the design of code is something that people are doing. Engineers make the choices about how the world will be. Engineers in this sense are governors.

Id.

26. *See, e.g.*, Daniel Folkinshteyn, Mark Lennon & Tim Reilly, *A Tale of Twin Tech: Bitcoin and the WWW*, 10 J. STRATEGIC & INT'L STUD. 82 (2015); Clifton B. Parker, *The Promise and Peril of Bitcoin*, STAN. GRADUATE SCH. BUS. (Feb. 25, 2014), http://www.gsb.stanford.edu/news/headlines/promise-peril-bitcoin [https://perma.cc/DX2S-JNLY].

27. *See generally* Fairfield, *BitProperty*, *supra* note 13.

28. An exhaustive explanation of each of these elements is beyond the scope of this Article, and, as will be evident by the discussion that follows, this effort has

ultimate goal of this Article is to flesh out the initial contours of a regulatory approach that operates as organically and fluidly as the technology itself, this Section begins with an examination of decentralized ledgers and then describes various applications of that technology, such as bitcoin. This Section sets the tone for the regulatory approach ultimately proposed (which focuses on regulating the decentralized ledger technology, rather than the applications of that technology) and develops a common language for use throughout the rest of the Article.

A. *Decentralized Ledger Technologies, Including the Blockchain*

Decentralized ledger technologies "combin[e] peer-to-peer networks, cryptographic algorithms, distributed data storage, and [ ] decentralized consensus mechanisms" to enable "people to agree on a particular state of affairs and record that agreement in a secure and verifiable manner."[29] In other words, decentralized ledger technologies create "online lists, maintained by no one and available to everyone, [and] are maintained by a consensus protocol."[30] In the case of bitcoin, the decentralized public ledger is referred to as the blockchain.[31] The blockchain is "a chronological database of transactions recorded by a network of computers,"[32] which is encrypted and broken into smaller sets of aggregated transactions called "blocks."[33] A block is often described as "a container data structure,"[34] that groups transactions, marks them with a timestamp, and connects them to the previous block in the blockchain.[35] A new block of aggre-

already been eloquently undertaken by others. Instead, this Section explains the components of the decentralized ledger technology ecosystem that are important to understand before attempting to undertake the regulatory enterprise.

29. Wright & De Filippi, *supra* note 2, at 4, 5.

30. Joshua Fairfield, *Smart Contracts, Bitcoin Bots, and Consumer Protection*, 71 WASH. & LEE L. REV. ONLINE 35, 36 (2014) [hereinafter Fairfield, *Bitcoin Bots*].

31. *See* MALONE, *supra* note 9, at 35; Paul H. Farmer, Jr., Note & Comment, *Speculative Tech: The Bitcoin Legal Quagmire & the Need for Legal Innovation*, 9 J. BUS. & TECH. L. 85, 88–89 (2014) ("The Bitcoin peer-to-peer network that allows for miners to generate Bitcoins also serves as a public ledger for all Bitcoin transactions. A timestamp server records the time of creation of each Bitcoin and any other Bitcoin transaction within the network. The full record of transactions is called a block chain, a sequence of records composing a virtual ledger." (footnotes omitted)).

32. Wright & De Filippi, *supra* note 2, at 6 (citation omitted); *see also* PAUL VIGNA & MICHAEL J. CASEY, THE AGE OF CRYPTOCURRENCY: HOW BITCOIN AND DIGITAL MONEY ARE CHALLENGING THE GLOBAL ECONOMIC ORDER 124 (2015) ("The blockchain doesn't live on a single computer or server but . . . is shared around that community of computer owners, or *nodes*.").

33. Wright & De Filippi, *supra* note 2, at 6 (quoting *Blockchain*, BITCOIN FOUND. WIKI, https://en.bitcoin.it/wiki/Block_chain (last visited Mar. 1, 2015)) (internal quotation marks omitted); *see also* MALONE, *supra* note 9, at 35.

34. ANDREAS M. ANTONOPOULOS, MASTERING BITCOIN 160 (2015).

35. *See id.* at xix; Wright & De Filippi, *supra* note 2, at 7.

gated transactions will only be added to the ledger after "the computers on the network reach consensus as to the validity of the transaction."[36]

In the case of bitcoin, the method for reaching consensus is referred to as *mining*, a process of solving complex mathematical problems to validate the block.[37] Mining is an example of a proof-of-work consensus model.[38] A proof-of-work consensus model "require[s] the client requesting the service prove that some work has been done" in order to process the request.[39] Other decentralized ledger technologies employ different consensus models. For example, the Ripple protocol, a shared, public, distributed database,[40] validates transactions by creating a candidate list of transactions that is distributed to and voted on by a subset of trusted nodes, called the "unique node list."[41] The candidate set of transactions is validated and becomes part of the permanent, authoritative ledger once the "voting of server nodes reaches a consensus of 80% . . . ."[42] In a third

36. Wright & De Filippi, *supra* note 2, at 7; *see also* Fairfield, *BitProperty*, *supra* note 13, at 814 ("The Bitcoin protocol creates a ledger out of a series of groups of transactions, termed simply 'blocks,' which as a whole form a log of all transfers, termed the 'block chain.' The block chain is not maintained by any single entity, but instead relies on a mathematically innovative consensus model." (footnote omitted)).

37. *See* ANTONOPOULOS, *supra* note 34, at xx (describing miner as "[a] network node that finds valid proof of work for new blocks, by repeated hashing"); MALONE, *supra* note 9, at 36.

38. *See* PEDRO FRANCO, UNDERSTANDING BITCOIN: CRYPTOGRAPHY, ENGINEERING, AND ECONOMICS 101 (2015) ("To secure the blockchain—the distributed transaction database—Bitcoin requires proof-of-work to be performed on blocks of transactions following the Solution-Verification protocol.").

39. *Id.* at 100; *see also* ANTONOPOULOS, *supra* note 34, at xx (defining proof-of-work as "[a] piece of data that requires significant computation to find. In bitcoin, miners must find a numeric solution to the SHA256 algorithm that meets a network-wide target, the difficulty target."); Wright & De Filippi, *supra* note 2, at 7 n.29 (citing Joseph Bonneau et al., *SoK: Research Perspectives and Challenges for Bitcoin and Cryptocurrencies*, 36 SECURITY & PRIVACY (IEEE, San Fran., Cal.), May 18–20, 2015, *available at* www.jbonneau.com/doc/BMCNKF15-IEEESP-bitcoin.pdf.) ("The Proof of Work consensus mechanism requires that certain computers on the network (colloquially referred to as a [sic] 'miners') solve computationally-intensive mathematical puzzles, while others verify that the solution to that puzzle does not correspond to a previous transaction.").

40. *See* Bryant Gehring, *How Ripple Works*, RIPPLE (Oct. 16, 2014), https://ripple.com/knowledge_center/how-ripple-works/ [https://perma.cc/6LRU-E9JZ].

41. *See* Adrian Blundell-Wignall, *The Bitcoin Question: Currency Versus Trust-Less Transfer Technology* 15 (OECD Working Papers on Fin., Ins. & Private Pensions, No. 37, 2014), *available at* http://www.oecd.org/daf/fin/financial-markets/The-Bitcoin-Question-2014.pdf [https://perma.cc/N4D5-ZRZ4]; *see also* DAVID SCHWARTZ, NOAH YOUNGS & ARTHUR BRITTO, RIPPLE LABS, INC., THE RIPPLE PROTOCOL CONSENSUS ALGORITHM 3 (2014), *available at* https://ripple.com/files/ripple_consensus_whitepaper.pdf [https://perma.cc/X4WL-TQLA].

42. Blundell-Wignall, *supra* note 41, at 15; *see also* SCHWARTZ ET AL., *supra* note 41, at 4. At least one commentator has referred to this approach as a "Byzantine agreement system;" however, the creators of the Ripple protocol do not themselves adopt that terminology. *See generally* DAVID MAZIÈRES, STELLAR DEV. FOUND., THE STELLAR CONSENSUS PROTOCOL: A FEDERATED MODEL FOR INTERNET-LEVEL CONSENSUS (2015) (draft), *available at* https://www.stellar.org/papers/stellar-consensus-

consensus model, "voting rights depend on the amount of resources (e.g., a virtual currency) held by every computer connected to the network."[43] Researchers are presently pursuing the development of other consensus models as well.[44]

Regardless of the consensus method used, these decentralized public ledgers all share key qualities that make the technology revolutionary: they are distributed, run on peer-to-peer networks, and offer a public, permanent record management system "that does not require trust in other parties or in a central list authority, and is robustly resistant to falsification," employing known technology.[45] The technologies are also generally open-source and non-proprietary, meaning that no single person or entity controls the decentralized public ledgers.[46] Rather, the technology was developed, and is maintained and updated "by a worldwide collaborative community of volunteer[ ]" programmers.[47] The community can make improvements to the underlying code and alter the function of the blockchain protocol by proposing the code change and obtaining network consensus.[48]

B. *Decentralized Applications, Including Bitcoin and Smart Contracts*

There are a variety of applications for decentralized public ledger technologies such as the blockchain. Currently, the most well-known of those applications is decentralized virtual currency. Bitcoin is the decentralized virtual currency that runs on the blockchain.[49] "Bitcoins are computer files, similar to an mp3 or a text file and can be destroyed or lost just

---

protocol.pdf [https://perma.cc/J2AG-ZDMF]. A similar, but not identical, approach is adopted by the Stellar Consensus Protocol, which it terms a "Federated Byzantine Agreement" consensus model. *See id.*

43. Wright & De Filippi, *supra* note 2, at 7 n.30; *see also* Nicolas Houy, *It Will Cost You Nothing to "Kill" a Proof-of-Stake Crypto-Currency*, 34 ECON. BULL. 1038, 1040 (2014), *available at* http://www.accessecon.com/Pubs/EB/2014/Volume34/EB-14-V34-I2-P96.pdf [https://perma.cc/P6PH-4WZZ] (describing proof-of-stake as consensus mechanism in which "the expected reward for inserting transactions in the blockchain does not depend on the computational power of miners but on the amount of crypto-currency they already own").

44. *See, e.g.*, IDDO BENTOV, CHARLES LEE, ALEX MIZRAHI & MENI ROSENFELD, PROOF OF ACTIVITY: EXTENDING BITCOIN'S PROOF OF WORK VIA PROOF OF STAKE (2014), *available at* http://eprint.iacr.org/2014/452.pdf [https://perma.cc/9FAM-HDJA].

45. Fairfield, *BitProperty*, *supra* note 13, at 808.

46. *See* MALONE, *supra* note 9, at 34.

47. *Id.*

48. *See* Sarah Jeong, The Bitcoin Protocol as Law, and the Politics of a Stateless Currency 31 (May 8, 2013) (unpublished manuscript), *available at* http://www.modernmoneynetwork.org/sites/default/files/biblio/Bitcoin%20Protocol%20as%20Law.pdf [https://perma.cc/43S9-V75G] ("There is evidence that community consensus can result in the resolution of crisis.").

49. *See* MALONE, *supra* note 9, at 35.

like cash."[50] Just as an mp3 file can be stored either locally on the owner's computer or remotely through a cloud service, bitcoins can be stored either on the owner's computer or with an online service, called a wallet provider or an exchange.[51] When bitcoin owners refer to storing their bitcoins in a "wallet," the reference is to the public-key encryption technique used to secure bitcoins and bitcoin transactions.[52]

Specifically, a wallet is made of two mathematically related keys: a private key and a public key.[53] The public key is the outward facing destination address of the wallet, like a bank account number or an email address.[54] The private key functions as a PIN to a bank account or a password to an email address.[55] To execute a transaction, bitcoin owners use their private key to authorize the transfer of bitcoin to the public address representing the recipient's wallet.[56] The total amount of bitcoins is capped at 21 million,[57] and as a scarce resource with no government-affixed price, the value of an individual bitcoin is set by market forces.[58] Other decentralized virtual currencies run on other protocols layered on top of the blockchain[59] or run as payments applications on other protocols.[60]

---

50. Nikolei M. Kaplanov, Student Article, *Nerdy Money: Bitcoin, the Private Digital Currency, and the Case Against Its Regulation*, 25 LOY. CONSUMER L. REV. 111, 116 (2012).

51. *See id.*

52. *See id.* at 117.

53. *See id.*

54. *See id.*

55. *See id.* For a more complete description of how wallets are created, bitcoins are stored, and transactions are signed using the public-private key encryption pair, see Sarah Gruber, Note, *Trust, Identity, and Disclosure: Are Bitcoin Exchanges the Next Virtual Havens for Money Laundering and Tax Evasion?*, 32 QUINNIPIAC L. REV. 135, 141–45 (2013).

56. *See* Danton Bryans, Note, *Bitcoin and Money Laundering: Mining for an Effective Solution*, 89 IND. L.J. 441, 446 (2014).

57. *See id.*

58. *See id.* at 445; *see also* Reuben Grinberg, *Bitcoin: An Innovative Alternative Digital Currency*, 4 HASTINGS SCI. & TECH. L.J. 159, 160 (2012) ("Bitcoin is a digital, decentralized, partially anonymous currency, not backed by any government or other legal entity, and not redeemable for gold or other commodity.").

59. An example of this was Mastercoin, which was "an entirely new network of currencies, commodities and securities on top of Bitcoin itself." Vitalik Buterin, *Mastercoin: A Second-Generation Protocol on the Bitcoin Blockchain*, BITCOIN MAG. (Nov. 4, 2013), https://bitcoinmagazine.com/7961/mastercoin-a-second-generation-protocol-on-the-bitcoin-blockchain/ [http://perma.cc/53D8-MFKD]. Mastercoin sought to use the blockchain "as a protocol layer, on top of which new currency layers with new rules can be built without changing the foundation." *Id.* (quoting J.R. WILLETT, THE SECOND BITCOIN WHITEPAPER (2012) (draft), *available at* https://sites.google.com/site/2ndbtcwpaper/2ndBitcoinWhitepaper.pdf?attredirects=0) (internal quotation marks omitted).

60. The Ripple Protocol, for example, allows users to transfer "Balances," which represent fiat currency deposited with a gateway. Ripple describes it as follows:

Smart contracts represent another application of decentralized public ledger technology that is beginning to garner attention. Smart contracts can be thought of as self-executing transactions, or as "automated programs that transfer digital assets within the block-chain upon certain triggering conditions . . . ."[61] IBM has demoed a working prototype of a washing machine that orders its own detergent using the smart contracting applications of distributed ledger technology.[62] In practice, entrepreneurs rely on decentralized ledger technology, including the smart contracting features of that technology, to create decentralized marketplaces,[63] decentralized crowdfunding applications,[64] and distributed securities.[65] The more theoretical potential applications for distributed ledger technology include independently wealthy software,[66] zero-member LLCs,[67] and decentralized autonomous organizations,[68] among others.

Despite the potentially broad applications of decentralized ledger technology, regulatory efforts predominately center on payments applica-

---

> USD balances traded on the Ripple protocol are redeemable at the specific "gateway" from which the currency was issued. A gateway is the place where fiat money enters and exits the Ripple protocol. In practice, this can look very similar to traditional banks. However, a gateway can be any business that provides access to the Ripple protocol. Gateways can be banks, money service businesses, marketplaces, or any other financial institution.

Gehring, *supra* note 40.

61. Fairfield, *Bitcoin Bots*, *supra* note 30, at 38. Smart contracts have also been defined as "cryptographic 'boxes' that contain value and only unlock it if certain conditions are met." Wright & De Filippi, *supra* note 2, at 10 n.46 (quoting Vitalik Buterin, *A Next Generation Smart Contract & Decentralized Application Platform*, GITHUB (last edited Jan. 5, 2015), https://github.com/ethereum/wiki/wiki/White-Paper) (internal quotation marks omitted).

62. *See* Wright & De Filippi, *supra* note 2, at 15 n.71; *see also* PURESWARAN & BRODY, *supra* note 4.

63. Two examples of this include OpenBazaar and Bitmarkets. *See* Joon Ian Wong, *Bitmarkets Launches Decentralised Bitcoin Marketplace with Tor Support*, COINDESK (Dec. 8, 2014), http://www.coindesk.com/bitmarkets-launches-decentralised-bitcoin-marketplace-tor-support/ [https://perma.cc/5UQC-4U92].

64. An example includes BlockTrust, an "all-inclusive funding platform for Blockchain projects with project certification and ClearingHouse notarization services, along with multi-sig Bitcoin escrow." Diana Ngo, *BlockTrust Launches Crowdfunding Platform for Blockchain-Based Projects*, COINTELEGRAPH (Dec. 19, 2014), http://cointelegraph.com/news/113146/blocktrust-launches-crowdfunding-platform-for-blockchain-based-projects [https://perma.cc/8KUW-FLU6].

65. *See* Cade Metz, *Overstock Files to Offer Stock That Works Like Bitcoin*, WIRED (Apr. 27, 2015), http://www.wired.com/2015/04/overstock-files-offer-stock-works-like-bitcoin/ [https://perma.cc/B2H4-CK8M].

66. *See* Shawn Bayern, *Of Bitcoins, Independently Wealthy Software, and the Zero-Member LLC*, 108 NW. U. L. REV. 1485, 1492–95 (2014).

67. *See id.* at 1496–98.

68. For a description of the possible use case for a democratic autonomous organization, see generally ETHEREUM FRONTIER, https://www.ethereum.org/ [https://perma.cc/GG6Q-36WA] (last visited Feb. 28, 2016); *see also* Wright & De Filippi, *supra* note 2, at 15–17.

tions of decentralized ledger technologies, including bitcoin. Unfortunately, "[t]he danger is that this could imperil innovations built on top of the [blockchain] that do not fit a financial services model."[69] Indeed, such regulation has already made it more difficult for companies integrating decentralized ledger technologies into their products and services to obtain and maintain banking relationships that enable the company to function;[70] enter certain markets within the United States;[71] and develop alternative use cases for the technology without fear of inadvertently violating financial services laws.[72] To understand why the current regulatory landscape is marked by such dedication to taming bitcoin to the exclusion of all other uses of the technology, it is important to know the regulatory history of virtual currency generally.

II. THIS PRESENT DARKNESS: DECENTRALIZED LEDGER TECHNOLOGY REGULATION IN A CENTRALIZED AGE

At its core, the regulatory enterprise involves creating appropriate incentives to coax desired behavior out of market actors to address externalities otherwise naturally caused by the pursuit of maximizing private interests.[73] The ever-present dilemma of regulators involves whether to offer the incentive before (ex ante) or after (ex post) the activity at issue takes place.[74] In the context of the decentralized ledger technology ecosystem, determining which incentives to present and when to present them is further complicated by the "law lag," a term often used in law and technology literature to refer to the circumstances in which "existing legal provisions are inadequate to deal with a social, cultural or commercial context created by rapid advances in information and communication technology . . . ."[75] This Section evaluates the present state of decentral-

69. Fairfield, *BitProperty*, *supra* note 13, at 830 (citation omitted).

70. *See* Evander Smart, *Banks Handcuff Bitcoin Businesses in Opening Bank Accounts*, CRYPTOCOINSNEWS (Apr. 13, 2015), https://www.cryptocoinsnews.com/banks-handcuff-bitcoin-businesses-opening-bank-accounts/ [https://perma.cc/H7ZN-27YR].

71. *See* Redman, *supra* note 21.

72. *See* U.S. DEP'T OF TREASURY, FINCEN., ADMIN. RULING, FIN-2015-R001, APPLICATION OF FINCEN'S REGULATIONS TO PERSONS ISSUING PHYSICAL OR DIGITAL NEGOTIABLE CERTIFICATES OF OWNERSHIP OF PRECIOUS METAL (2015) [hereinafter FINCEN, DIGITAL CERTIFICATES], *available at* http://www.fincen.gov/news_room/rp/rulings/pdf/FIN-2015-R001.pdf [https://perma.cc/7JZ5-WGUL].

73. *See generally* Brian Galle, *In Praise of Ex Ante Regulation*, 68 VAND. L. REV. 1715 (2015).

74. *See generally* Donald Wittman, *Prior Regulation Versus Post Liability: The Choice Between Input and Output Monitoring*, 6 J. LEGAL STUD. 193 (1977) (exploring choice between regulating ex ante and punishing ex post).

75. Jeremy Pitt & Ada Diaconescu, *The Algorithmic Governance of Common-Pool Resources*, *in* FROM BITCOIN TO BURNING MAN AND BEYOND: THE QUEST FOR IDENTITY AND AUTONOMY IN A DIGITAL SOCIETY 130, 137–38 (John H. Clippinger & David Bollier eds., 2014), *available at* https://drive.google.com/file/d/0B2aVIexl9TLZSkNfTGx0U29WcHc/view [https://perma.cc/ZG27-M26S].

ized technology regulation in the United States. Despite the robustness of decentralized public ledger technology and its myriad potential uses, regulatory activity to date has focused on the decentralized virtual currency applications of such technology, with most prominent attention directed at bitcoin. This focus is partially explained by the fact that decentralized virtual currencies are the first and most widely adopted use of the underlying technology, receiving extensive media coverage and venture-capital attention. However, a full understanding of the present regulatory focus on decentralized virtual currency can only be achieved by looking at the recent regulatory history. To that end, this Section offers a brief overview of the regulatory developments in the decentralized ledger technology ecosystem to date.

This Section begins in the same spot in which regulators found themselves when bitcoin and the blockchain were introduced in 2009: addressing anti-money laundering and other criminal activity in the centralized technology context, including centralized virtual currencies. This Section then examines how regulators have attempted to apply the same regulatory lessons and policy priorities prevalent in the centralized context to decentralized ledger technology regulation. At each step, this Section considers the extent to which efforts are proceeding ex ante or ex post and queries whether preferences for one over the other vary in light of industry developments at the time. This Section concludes by examining the impact of the current regulatory landscape on the decentralized ledger technology industry and attempts to identify the regulatory gaps that leave actors in the industry facing regulatory uncertainty and railing against their very real experience with law lag.

A. *The Backdrop: Regulating Centralized Technology*

The largest virtual currency-related legal development before the open-sourced bitcoin protocol was released in 2009 was the prosecution of E-Gold, Ltd. (E-Gold). E-Gold was a centralized virtual currency allegedly backed by physical gold reserves.[76] E-Gold users could register for an account using an email address without verification of any identifying information.[77] As a result, E-Gold accounts existed under names such as "Mickey Mouse," "Anonymous Man," "bud wieser," and "No Name."[78] The E-Gold currency and the E-Gold platform became popular among criminals and money launderers, prompting various law enforcement ac-

76. *See* Catherine Martin Christopher, *Whack-A-Mole: Why Prosecuting Digital Currency Exchanges Won't Stop Online Money Laundering*, 18 LEWIS & CLARK L. REV. 1, 24 (2014); Stephen T. Middlebrook & Sarah Jane Hughes, *Regulating Cryptocurrencies in the United States: Current Issues and Future Directions*, 40 WM. MITCHELL L. REV. 813, 823 (2014).

77. *See* Christopher, *supra* note 76, at 24.

78. *Id.* (internal quotation marks omitted); *see also* Middlebrook & Hughes, *supra* note 76, at 824 (internal quotation marks omitted).

tions between 2005 and 2008.[79] Regulatory and enforcement activity after E-Gold remained publically quiet until 2013, but it is clear that law enforcement did not remain inactive. For example, the FBI authored an intelligence assessment, dated April 24, 2012, assessing the challenges faced in deterring illicit activity undertaken through the use of bitcoin.[80] The assessment evidences an initial shift in enforcement, from sole focus on centralized virtual currencies to a growing awareness of the unique regulatory and enforcement challenges posed by decentralized virtual currencies.

Then, nearly one year later, the federal government publicly unleashed the full weight of the quiet regulatory consideration it had been directing at decentralized virtual currencies. In March 2013, the Financial Crimes Enforcement Network of the United States Department of the Treasury (FinCEN) issued guidance on the application of the Bank Secrecy Act and its implementing regulations to virtual currencies (the Virtual Currency Guidance).[81] The Virtual Currency Guidance outlines the applicability of the existing federal anti-money laundering (AML) regime to convertible virtual currencies, including decentralized virtual currencies, and concludes that administrators and exchangers of such currencies are subject to the AML requirements to the extent that they transmit decentralized virtual currency or legal tender from one user to another, or from one location to another.[82] Shortly after FinCEN issued the Virtual Currency Guidance, the federal government announced two significant enforcement actions. First, on May 14, 2013, the Department of Homeland Security (DHS) seized a Dwolla account belonging to Mt. Gox, a leading Japan-based bitcoin exchange.[83] Second, a mere fourteen days later, FinCEN exercised its powers under Section 311 of the U.S. PATRIOT Act by designating the Costa Rican company Liberty Reserve a financial insti-

79. *See* Christopher, *supra* note 76, at 24. For details on the charges and guilty pleas entered, see United States v. e-Gold, Ltd., 550 F. Supp. 2d 82, 90 (D.D.C. 2008).

80. *See* FBI, INTELLIGENCE ASSESSMENT, (U) BITCOIN VIRTUAL CURRENCY: UNIQUE FEATURES PRESENT DISTINCT CHALLENGES FOR DETERRING ILLICIT ACTIVITY (2012), *available at* http://wired.com/images_blogs/threatlevel/2012/05/Bitcoin-FBI.pdf [https://perma.cc/3Q9C-9T3P].

81. *See* FINCEN, VIRTUAL CURRENCY GUIDANCE, *supra* note 3.

82. *See id.* at 4. For detailed descriptions of the Virtual Currency Guidance, see generally J. Dax Hansen, Carla L. Reyes & Joseph P. Cutler, *New FinCEN Guidance Changes Regulatory Landscape for Virtual Currencies and Some Prepaid Programs*, CYBERSPACE LAW. (Thomson/Legalworks, New York, N.Y.), Apr. 2013, at 12; Stephen T. Middlebrook & Sarah Jane Hughes, *Virtual Uncertainty: Developments in the Law of Electronic Payments and Financial Services*, 69 BUS. LAW. 263, 264–69 (2013).

83. *See* Application for Seizure Warrant, *supra* note 19. DHS alleged that Mt. Gox's U.S. subsidiary, Mutum Sigillum, LLC, operated an unlicensed money transmitting business in violation of 18 U.S.C. § 1960 (2012). *See id.*

tution of primary money laundering concern[84] and proposing the imposition of special measures against Liberty Reserve.[85]

The Virtual Currency Guidance and the Mt. Gox seizure paved the way for further regulation of decentralized technology. Key themes from each of these actions dating back to the beginning of the E-Gold prosecution in 2005 persist. In particular, the regulatory and law enforcement agencies active in the decentralized ledger technology industry continue to focus on centralized actors: companies with traditional centralized structures that just happen to offer products and services linked to a decentralized ledger technology. Further, like E-Gold, Mt. Gox, and Liberty Reserve, each of which processed very high volumes of transactions, regulators continue to target large-scale operations that offer the potential for high-impact regulatory or enforcement measures. Finally, and perhaps more importantly, the focus remains entirely on virtual currency applications of decentralized ledger technology—the decentralized versions of E-Gold and Liberty Reserve. Notably, this period of regulatory activity evidenced an intent to apply traditional AML and terrorist financing controls, a form of ex ante regulation in the payments space,[86] to virtual currencies, including decentralized virtual currencies. This intent was made most clear by the Virtual Currency Guidance and Liberty Reserve special measures, and continues to permeate the current regulatory landscape, as evidenced by the regulatory activity from 2013 to the present.

B. *The Current Landscape: Applying Centralized Themes to Decentralized Technology*

Although state regulators had not yet voiced an opinion on decentralized virtual currency regulation, shortly after the federal Mt. Gox and Liberty Reserve actions, the California Department of Business Oversight (DBO) sent letters to industry participants in order to gather information to help the DBO decide how to regulate decentralized virtual currencies and related activities.[87] The New York Department of Financial Services (NYDFS) quickly followed suit, issuing subpoenas to twenty-two companies

84. *See* FinCEN, Notice of Finding, *supra* note 19.

85. *See* FinCEN, Imposition of Special Measure Against Liberty Reserve S.A. as a Financial Institution of Primary Money Laundering Concern, 78 Fed. Reg. 34008 (proposed June 6, 2013) (to be codified at 31 C.F.R. pt. 1010); *see also* Jean-Jacques Cabou, J. Dax Hansen, Carla L. Reyes, Ashley A. Locke & Kieth Miller, *Legal Landscape for E-Currency Is Getting More Complicated*, LAW 360 (June 3, 2013), http://www.law360.com/articles/446907/legal-landscape-for-e-currency-is-getting-more-complicated [https://perma.cc/MN2R-6ECQ].

86. *See* Terri Bradford, Fumiko Hayashi, Christian Hung, Simonetta Rosati, Richard J. Sullivan, Zhu Wang & Stuart E. Weiner, *Nonbanks and Risk in Retail Payments: EU and U.S.*, *in* MANAGING INFORMATION RISK AND THE ECONOMICS OF SECURITY 17, 35 (M. Eric Johnson ed., 2009).

87. *See, e.g.*, Letter from Paul T. Crayton, Senior Counsel, Cal. Dep't of Fin. Inst., to BitCoin Found. (May 30, 2013), *available at* http://www.scribd.com/doc/149335233/ca-state-cease-and-desist-may-30 [https://perma.cc/U5PK-G2BY].

in the decentralized technology ecosystem in August 2013.[88] The NYDFS issued the subpoenas as part of "an inquiry into the appropriate regulatory guidelines that it should put in place for virtual currencies."[89] Not to be outdone, the federal government also continued to apply regulatory pressure to the decentralized technology ecosystem. In October 2013, federal law enforcement agents shut down the Silk Road website and arrested its founder and administrators, who were charged with a wide range of crimes, including money laundering, drug trafficking, and computer hacking.[90]

The negative publicity surrounding bitcoin from the Silk Road events prompted the U.S. Senate to hold public hearings on virtual currencies in November 2013.[91] In her testimony during the Senate hearings, Jennifer Shasky Calvery, the Director of FinCEN, noted the "attributes that make virtual currency vulnerable to illicit use" but also recognized the "innovation virtual currencies provide."[92] Early 2014 brought additional federal criminal prosecutorial activity,[93] and the first state prosecutions related to decentralized virtual currency.[94] Furthermore, states continued to evaluate regulation: in January 2014, the NYDFS held a series of hearings on virtual currencies,[95] and U.S. state financial services regulators issued warnings on the risks of virtual currencies, either individually or in collab-

88. *See* Greg Farrell, *N.Y. Subpoenas Bitcoin Firms in Probe on Criminal Risk*, BLOOMBERG (Aug. 12, 2013), http://www.bloomberg.com/news/2013-08-12/n-y-regulator-subpoenas-firms-over-bitcoin-crime-risks.html [https://perma.cc/28L5-C38K].

89. N.Y. Dep't of Fin. Servs., Notice of Inquiry on Virtual Currencies (Aug. 12, 2013), *available at* http://www.dfs.ny.gov/about/letters/ltr130812_virtual_currency.pdf [https://perma.cc/BZ8J-EFMC].

90. *See* Kim Zetter, *How the Feds Took Down the Silk Road Drug Wonderland*, WIRED (Nov. 18, 2013), http://www.wired.com/2013/11/silk-road/ [https://perma.cc/UDN5-CFQ9].

91. *See Beyond Silk Road: Potential Risks, Threats, and Promises of Virtual Currencies Before the S. Comm. on Homeland Sec. & Governmental Affairs*, 113th Cong. (2013), video *available at* http://www.hsgac.senate.gov/hearings/beyond-silk-road-potential-risks-threats-and-promises-of-virtual-currencies [https://perma.cc/3WHN-YN7V].

92. *Id.* (statement of Jennifer Shasky Calvery, Dir., FinCEN).

93. In January 2014, Charlie Shrem, a bitcoin exchange CEO, was arrested and charged with illegal money transmission and money laundering under federal laws. *See* Sidel, *supra* note 22.

94. In February 2014, two Florida-based users of a bitcoin local trading site were arrested and charged with illegal money transmission and money laundering under state laws. *See* United States v. Faiella, 39 F. Supp. 3d 544 (S.D.N.Y. 2014); Florida v. Reid, No. 14-002935 (Fla. Miami-Dade Cnty. Ct., Sept. 16, 2015); Florida v. Espinoza, No. 14-002923 (Fla. Miami-Dade Cnty. Ct., filed Feb. 7, 2014).

95. For more information, see generally N.Y. State Dep't of Fin. Servs., NYDFS Outlines Additional Details on Witnesses and Panels for Virtual Currency Hearing on January 28 and 29 in New York City (Jan. 23, 2014), *available at* http://www.dfs.ny.gov/about/panels_witnesses_virtual_currency_hearing.pdf [https://perma.cc/SP2Z-MNQH].

oration with other state regulators.[96] Other federal regulatory agencies, including the Internal Revenue Service[97] and the Federal Reserve, also waded into the decentralized technology morass.[98] Finally, FinCEN issued

96. *See generally* CONF. OF STATE BANK SUPERVISORS, MODEL STATE CONSUMER AND INVESTOR GUIDANCE ON VIRTUAL CURRENCY (Apr. 23, 2014), http://www.csbs.org/legislative/testimony/Documents/ModelConsumerGuidance—Virtual%20Currencies.pdf [https://perma.cc/K63Y-TEU4]. To date, ten states have issued consumer guidance based on the CSBS model. *See* Press Release, Susan Bell, Comm'r, Alaska Dep't of Commerce, Cmty. & Econ. Dev., No. 14-014, Virtual Currency Investor Advisory Alert: What's in Your e-Wallet? (Apr. 30, 2014), *available at* https://www.commerce.alaska.gov/web/portals/3/pub/pr-14-014-virtua-currency-investor-advisory-alert-043014.pdf [https://perma.cc/S89T-MY4W]; Media Release, Jan Lynn Owen, Comm'r, Cal. Dep't of Bus. Oversight, California Department of Business Oversight Issues Advisory on Virtual Currencies (Apr. 30, 2014), *available at* http://www.dbo.ca.gov/Press/press_releases/VC_Advisory_PR_043014.pdf [https://perma.cc/M9QR-MJ36]; Advisory, Idaho Dep't of Fin., What's in Your e-Wallet? (Apr. 29, 2014), *available at* http://finance.idaho.gov/Securities/Documents/Virtual_Currency_Advisory.pdf [https://perma.cc/4VRL-EWQS]; Investor Alert, Ind. Sec'y of State Secs. Div., What's in Your e-Wallet? (May 12, 2014), *available at* http://www.in.gov/sos/files/Virtual_Currency_IN.pdf [https://perma.cc/M9ZP-KRBE]; Advisory Notice, Md. Comm'r of Fin. Regulation, Virtual Currencies: Risks for Buying, Selling, Transacting, and Investing, No. 14-01 (Apr. 24, 2014), *available at* http://www.dllr.state.md.us/finance/advisories/advisoryvirtual.pdf [https://perma.cc/U8XZ-3GCG]; News Release, Mo. Sec'y of State, Investor Alert: Kander Cautions Missouri Investors on Bitcoin (Apr. 24, 2014), *available at* http://www.sos.mo.gov/news.asp?id=1383 [https://perma.cc/AU9Y-RFLY]; Press Release, Nev. Dep't of Bus. & Indus., Nevada Financial Institutions Division Issues Consumer and Investor Guidance on Virtual Currency (Apr. 25, 2014), *available at* http://www.fid.state.nv.us/GuidanceVirtualCurrency.pdf [https://perma.cc/NGQ8-5XP6]; Press Release, N.M. Regulation & Licensing Dep't, State Regulations Alert Consumers About Risks Involved with Investing in Virtual Currencies (Apr. 30, 2014), *available at* http://www.rld.state.nm.us/uploads/PressRelease/28b4bcdf4 f8d46899c723b2b76f16 b5b/Virtual_Currency_Warning.pdf [https://perma.cc/8PYK-J6KE]; Press Release, Pa. Dep't of Banking & Secs., Pennsylvania Banking and Securities Department Urges Consumers, Businesses and Investors to Be Cautious with New Virtual Currencies (May 19, 2014), *available at* http://www.prnewswire.com/news-releases/pennsylvania-banking-and-securities-department-urges-consumers-businesses-and-investors-to-be-cautious-with-new-virtual-currencies-259822731.html [https://perma.cc/PH8M-XWFT]; Press Release, George Althoff, Commc'ns Dir., Wis. Dep't of Fin. Insts., State Agency Warns Consumers to Be Cautious with Virtual Currencies (Apr. 30, 2014), *available at* https://www.wdfi.org/newsroom/press/2014/DFIVirtualCurrencyAdvisory.pdf [https://perma.cc/5LKC-C6PS].

97. In May 2014, the Internal Revenue Service (IRS) of the Department of Treasury issued a notice classifying bitcoin and similar virtual currencies as property. *See* I.R.S. Notice 21-16, 2014-21 C.B. 938 (May 19, 2014), *available at* https://www.irs.gov/pub/irs-irbs/irb14-21.pdf [perma.cc/3FDT-56DT].

98. The Federal Reserve, for its part, used 2014 to evolve its thinking regarding bitcoin and other decentralized virtual currencies. On February 27, 2014, Federal Reserve Chair Janet Yellen, in testimony before the Senate Banking Committee, opined that the Federal Reserve had no role in regulating bitcoin because it is developing outside of the banks that the Federal Reserve has the authority to regulate. *See Semiannual Monetary Policy Report to the Cong.: Before the H. Comm. on Fin. Servs.*, 113th Cong. (2014) (testimony of Janet Yellen, Chair, Bd. of Governors of the Fed. Reserve Sys.), *available at* http://www.federalreserve.gov/newsevents/testimony/yellen20140211a.htm [https://perma.cc/RD87-VKDG]. At its

a series of administrative letter rulings in 2014 intended to clarify the application of the Virtual Currency Guidance to various business models used in the decentralized technology ecosystem.[99] By the end of 2014, FinCEN had addressed the status of miners,[100] software development,[101] investment activity,[102] virtual currency trading platforms,[103] and a virtual currency payment system.[104]

The year 2015 brought similar developments. At the state level, the NYDFS finalized its BitLicense regime,[105] several other states took a wait-

May 9, 2014, quarterly meeting, however, the Federal Reserve concluded that bitcoin did not presently pose a threat to the system, but that "regulation is advisable" to address consumer protection and illicit use. *See* Fed. Advisory Council & Bd. of Governors, Record of Meeting 11 (May 9, 2014), *available at* http://www.federalreserve.gov/aboutthefed/fac-20140513.pdf. The Federal Reserve also noted that "one area of focus should be [b]itcoin's circumvention of currency controls." *Id.* at 10.

99. *See generally* Joseph Cutler, J. Dax Hansen & Carla L. Reyes, *Admin Rulings: FinCEN Clarifies Money Transmitter Exemptions for Virtual Currency and Payment-Related Services*, JD SUPRA BUS. ADVISOR (June 10, 2014), http://www.jdsupra.com/legalnews/admin-rulings-fincen-clarifies-money-tr-92506/ [https://perma.cc/XF7C-4UBC]; Joseph Cutler, J. Dax Hansen & Carla L. Reyes, *New FinCEN Guidance on Virtual Currency Transactions*, JD SUPRA BUS. ADVISOR (Feb. 12, 2014), http://www.jdsupra.com/legalnews/new-fincen-guidance-on-virtual-currency-14922/ [https://perma.cc/L7GC-RFE7]; Carla L. Reyes, *FinCEN Issues New Rulings Covering Virtual Currency Exchanges and Payment Processors*, JD SUPRA BUS. ADVISOR (Oct. 30, 2014), http://www.jdsupra.com/legalnews/fincen-issues-new-rulings-covering-virtu-44222/ [https://perma.cc/HT3U-YB7F].

100. *See* U.S. DEP'T OF TREASURY, FINCEN, ADMIN. RULING, FIN-2014-R007, APPLICATION OF MONEY SERVICES BUSINESS REGULATIONS TO THE RENTAL OF COMPUTER SYSTEMS FOR MINING VIRTUAL CURRENCY (Apr. 29, 2014), *available at* http://www.fincen.gov/news_room/rp/rulings/pdf/FIN-2014-R007.pdf [https://perma.cc/J6CG-U2DD]; U.S. DEP'T OF TREASURY, FINCEN, ADMIN. RULING, FIN-2014-R001, APPLICATION OF FINCEN'S REGULATIONS TO VIRTUAL CURRENCY MINING OPERATIONS (Jan. 30, 2014), *available at* http://www.fincen.gov/news_room/rp/rulings/pdf/FIN-2014-R001.pdf [https://perma.cc/4XNA-7R3L].

101. *See* U.S. DEP'T OF TREASURY, FINCEN, ADMIN. RULING, FIN-2014-R002, APPLICATION OF FINCEN'S REGULATIONS TO VIRTUAL CURRENCY SOFTWARE DEVELOPMENT AND CERTAIN INVESTMENT ACTIVITY (Jan. 30, 2014), *available at* http://www.fincen.gov/news_room/rp/rulings/pdf/FIN-2014-R002.pdf [https://perma.cc/AB7K-22AW].

102. *See id.*

103. *See* U.S. DEP'T OF TREASURY, FINCEN, ADMIN. RULING, FIN-2014-R011, REQUEST FOR ADMINISTRATIVE RULING ON THE APPLICATION OF FINCEN'S REGULATIONS TO A VIRTUAL CURRENCY TRADING PLATFORM (Oct. 27, 2014), *available at* http://www.fincen.gov/news_room/rp/rulings/pdf/FIN-2014-R011.pdf [https://perma.cc/KPH2-TMSA].

104. *See* U.S. DEP'T OF TREASURY, FINCEN, ADMIN. RULING, FIN-2014-R012, REQUEST FOR ADMINISTRATIVE RULING ON THE APPLICATION OF FINCEN'S REGULATIONS TO A VIRTUAL CURRENCY PAYMENT SYSTEM (Oct. 27, 2014), *available at* http://www.fincen.gov/news_room/rp/rulings/pdf/FIN-2014-R012.pdf [https://perma.cc/XC62-KEMF].

105. *See* N.Y. COMP. CODES R. & REGS. tit. 23, §§ 200.1–200.22 (2015), *available at* http://www.dfs.ny.gov/legal/regulations/adoptions/dfsp200t.pdf [https://perma.cc/L58E-QPQP].

and-see approach,[106] and state legislatures,[107] the Uniform Law Commission,[108] and the Conference of State Banking Supervisors[109] undertook legislative drafting efforts with a best practices approach in mind. FinCEN issued yet another administrative ruling, this time examining the ways in which digitally issued certificates representing ownership in commodities (such as gold) intersect with money transmission regulation.[110] The Commodity Futures Trading Commission (CFTC) concluded that bitcoin is a commodity[111] and took enforcement action against two bitcoin-related businesses for various violations of the Commodity Exchange Act.[112] The CFTC also issued an order of temporary registration as a swap exchange facility to a third bitcoin-related business, indicating that the CFTC is actively considering and acting upon applications.[113] The Security and Exchange Commission (SEC) refrained from conclusively ruling how it will

106. *See, e.g.*, *Sellers of Checks*, WIS. DEP'T FIN. INSTS., https://www.wdfi.org/fi/lfs/soc/ [https://perma.cc/P4RW-FE3M] (last visited Mar. 1, 2016) ("The division is unwilling, at this time, to license companies to transmit virtual currency.").

107. *See, e.g.*, *Bitcoin Week in Review 06.27.15 - 07.10.15*, PERKINS COIE (July 10, 2015), http://www.virtualcurrencyreport.com/2015/07/bitcoin-week-in-review-06-27-15-07-10-15/ [https://perma.cc/URB8-UAQX] (discussing California's proposed bill AB-1326).

108. *See generally* NAT'L CONF. OF COMM'RS ON UNIF. STATE LAWS, REGULATION OF VIRTUAL CURRENCIES ACT (2015) (draft), *available at* http://www.uniformlaws.org/shared/docs/regulation%20of%20virtual%20currencies/2015oct_RVCA_Mtg%20Draft.pdf [https://perma.cc/MH24-SHJ9]; *Regulation of Virtual Currencies*, UNIF. L. COMM'N, http://www.uniformlawcommission.com/Committee.aspx?title=Regulation%20of%20Virtual%20Currencies [https://perma.cc/3VLA-ZHTS] (last visited Mar. 1, 2016).

109. *See generally* CONF. OF STATE BANK SUPERVISORS, STATE REGULATORY REQUIREMENTS FOR VIRTUAL CURRENCY ACTIVITIES: CSBS MODEL REGULATORY FRAMEWORK (2015), *available at* https://www.csbs.org/regulatory/ep/Documents/CSBS-Model-Regulatory-Framework(September%2015%202015).pdf [https://perma.cc/AV3R-ZZA8].

110. *See* FINCEN, DIGITAL CERTIFICATES, *supra* note 72. The recent CFTC Complaint against MintCo LLC indicates that the CFTC may also consider itself to have jurisdiction over such digital commodity certificates, identified by the Virtual Currency Guidance as a form of convertible virtual currency. *See* U.S. Commodity Futures Trading Comm'n v. MintCo LLC, 15-cv-61960-BB (S.D. Fla. filed Sept. 16, 2015), *available at* http://www.cftc.gov/idc/groups/public/ @lrenforcementactions/documents/legalpleading/enfmintcocomplaint091615.pdf [https://perma.cc/Z39L-4W3Q].

111. *See* Coinflip, Inc., CFTC, Docket No. 15-29, at 3 (Sept. 17, 2015) (order), *available at* http://www.cftc.gov/idc/groups/public/@lrenforcementactions/documents/legalpleading/enfcoinfliprorder09172015.pdf [https://perma.cc/WA4W-ZCUJ].

112. *See id.*; TeraExchange LLC, CFTC Docket No. 15-33 (Sept. 24, 2015) (order), *available at* http://www.cftc.gov/idc/groups/public/@lrenforcementactions/documents/legalpleading/enfteraexchangeorder92415.pdf [https://perma.cc/PW6U-ZN3C].

113. *See* LedgerX LLC, CFTC Staff Letter, [Current Decisions] Comm. Fut. L. Rep. (CCH) ¶33,537 (Sept. 8, 2015), *available at* http://www.cftc.gov/idc/groups/public/@lrlettergeneral/documents/letter/15-49.pdf [https://perma.cc/PD9Y-FDM9].

treat bitcoin, despite efforts from entrepreneurs to force the SEC's hand by filing shelf registrations for offerings that integrate blockchain technology.[114] Meanwhile, prosecutions for criminal activity perpetrated to some degree through the use of bitcoin moved forward,[115] and several consent orders were entered against decentralized technology companies for failure to properly comply with the Bank Secrecy Act regulations.[116]

Although federal regulatory agencies, including FinCEN, have carried out their intent to impose ex ante anti-money laundering regulations on decentralized virtual currency systems, industry developments have revealed that compliance with those regulations through the mechanics of the decentralized ledger technology is not always intuitive. As a result, where practical difficulties or other technology mismatches arise, regulators also used ex post criminal prosecutions to heighten compliance incentives. Even as federal authorities expanded the tools in their regulatory toolbox, they also expanded the policy priorities away from a singular focus on money-laundering, terrorist financing, and identity verification towards a more comprehensive set of payments-related issues, including privacy and security, tax compliance, and the potential for use of unfair and deceptive businesses practices in the industry. State regulatory activity also added new policy concerns to the mix, with a primary focus on consumer protection. Although other agencies are clearly apprised of the possibility that decentralized ledger technology may touch on areas within their regulatory purview, they have remained silent.

---

114. *See* Romain Dillet, *Winklevoss Twins Eat, Sleep, Breathe Bitcoin*, TECHCRUNCH (May 6, 2015), http://techcrunch.com/2015/05/06/winklevoss-twins-eat-sleep-breathe-bitcoin/ [https://perma.cc/22DT-2FAA] (discussing Winklevoss's efforts to build exchange traded fund to allow trading of bitcoins on NASDAQ OMX); Cade Metz, *Overstock Will Issue a Private Bond Powered by Bitcoin Tech*, WIRED (June 5, 2015) http://www.wired.com/2015/06/overstock-will-issue-private-bond-powered-bitcoin-tech/ [https://perma.cc/6G6E-KLF3] (discussing Overstock .com's intention to offer $25 million private bond using blockchain). Although the *Shavers* case involved bitcoin, the ruling did not determine whether or how bitcoin would be regulated by the SEC and focused instead on the criminal Ponzi scheme Shavers operated. The fact that Shavers used bitcoin to operate the Ponzi scheme did not change the underlying nature of the criminal activity. *See* SEC v. Shavers, No. 4:13–CV–416, 2013 WL 4028182 (E.D. Tex. Aug. 6, 2013). For arguments that bitcoin should be considered an investment contract or a security, see Derek A. Dion, Note, *I'll Gladly Trade You Two Bits on Tuesday for a Byte Today: Bitcoin, Regulating Fraud in the E-Conomy of Hacker-Cash*, 2013 J.L. TECH. & POL'Y 165, 193–94; Farmer, *supra* note 31, at 98–104.

115. *See* Joel Rosenblatt, *Second U.S. Agent Agrees to Plead Guilty to Bitcoin Theft*, BLOOMBERG (June 22, 2015), http://www.bloomberg.com/news/articles/2015-06-23/second-u-s-agent-agrees-to-plead-guilty-to-bitcoin-theft [https://perma.cc/K9U9-BEV9]; Sam Thielman, *Silk Road Operator Ross Ulbricht Sentenced to Life in Prison*, GUARDIAN (May 29, 2015), http://www.theguardian.com/technology/2015/may/29/silk-road-ross-ulbricht-sentenced [https://perma.cc/99MH-TPE8].

116. *See* U.S. DEP'T OF JUSTICE, SETTLEMENT AGREEMENT BETWEEN U.S. ATT'Y N. DIST. OF CAL. AND RIPPLE LABS, INC. (2015) [hereinafter DOJ, RIPPLE SETTLEMENT AGREEMENT], *available at* http://www.justice.gov/file/421626/download [https://perma.cc/DHF4-AE39].

The collective impact of this regulatory history is that new entrants into the decentralized ledger technology industry must tread carefully, for fear of triggering one or more known or unknown regulatory priorities by introducing a new and innovative application of the underlying technology. The 2015 FinCEN ruling and the SEC's silence on the Winkelvoss endeavor is a clear example of the regulatory lacuna and its effects. Even when given the opportunity to comment on regulation of the underlying technology, the SEC has not done so, and when presented with a novel application of the technology, FinCEN shoehorned it into the payments regulatory landscape. In other words, the lacuna in the present regulatory landscape is characterized by the lack of regulation addressing distributed ledger technology, and the result is that, when a new use emerges, the application may be subject to payments laws that are ill-suited to the issues presented by the technology.

C. *The Impact of the Current Landscape: Confusion, High Risk, and Disincentives to Innovation*

The policy priorities related to bitcoin and other decentralized virtual currencies are now relatively clear. The implementation of those policies through existing law remains a mystery in several areas, however. As a result, a common critique leveled at the regulatory efforts related to decentralized ledger technologies described above is that it evidences what appears to be development and implementation absent a master plan. To date, the United States has made great efforts to understand the unique characteristics and potential risks of virtual currency. Nonetheless, virtual currency hearings have not yielded any formal recommendations or guidance. As a result, regulatory bodies, courts and state legislatures have acted independently resulting in a regulatory mishmash of guidance, clarification, extension and ongoing discussion.[117]

The reality, however, is that the present regulatory approach to decentralized virtual currencies reflects mainstream approaches to financial regulation generally, using a combination of ex ante and ex post regulation to mitigate systemic risk in the financial system.[118] Leading literature on approaches to financial regulation offers this insight:

> Complete ex ante financial regulation, whereby regulators prevent every failure, is [ ] a futile goal. And even if it were feasible, it would not necessarily be desirable. Ex ante regulation can provide an incentive for regulatory arbitrage. Furthermore, any ex ante regulation that attempts to prevent all financial failures may end up being too chilling, thereby dampening economic growth. Ex post remedies will therefore always be needed to try

117. Kevin V. Tu & Michael W. Meredith, *Rethinking Virtual Currency Regulation in the Bitcoin Age*, 90 WASH. L. REV. 271, 304 (2015).

118. *See generally* Steven L. Schwarcz, *Systemic Risk*, 97 GEO. L.J. 193 (2008) [hereinafter Schwarcz, *Systemic Risk*].

> to prevent financial failures—when they inevitably occur—from spreading and becoming systemic.[119]

The regulatory history of decentralized virtual currency to date reads like a textbook example of this commentary: a heavy emphasis on ex ante attempts to prevent financial harm in the decentralized virtual currency industry, complemented by ex post prosecutions of harmful activity when failures nevertheless occurred.

Nontheless, the heavy emphasis on ex ante efforts to prevent decentralized virtual currency-related market failures when coupled with the innovative nature of the underlying technology has led to confusion and uncertainty, while the ex post efforts to punish and correct failures highlight the high risk faced by anyone connected to the decentralized ledger technology industry, whether working with a payments applications like virtual currency or not. Even a cursory review of the state of the industry supports this position. There presently exists no fully licensed, U.S.-based decentralized virtual currency exchange.[120] Any entity offering a product or service connected in any way to decentralized public ledger technology finds difficulty obtaining and maintaining banking relationships to enable the operation of its business.[121] Furthermore, the regulatory history is replete with evidence of the practical difficulties resulting from shoehorning decentralized ledger technologies, related applications, and the businesses that offer products and services related to them into a regulatory scheme first designed for centralized technologies. Compliance with the Funds

---

119. Steven L. Schwarcz, Keynote Address at Chapman Law Review Symposium: Ex Ante Versus Ex Post Approaches to Financial Regulation (Jan. 28, 2011), *in* 15 CHAP. L. REV. 257, 260 (2011) (footnotes omitted).

120. Coinbase launched its exchange to claims of being the first licensed bitcoin exchange in the United States. *See* Davey Alba, *Coinbase Opens First Licensed Bitcoin Exchange in the US*, WIRED (Jan. 26, 2015), http://www.wired.com/2015/01/coinbase-opens-first-licensed-bitcoin-exchange-u-s/ [https://perma.cc/3HME-UXLY]. However, in reality, Coinbase remains unable to obtain the requisite licenses in all states, and even pulled out of certain states where the licensure process proved too burdensome. *See* Redman, *supra* note 21. Similarly, itBit initially claimed that the New York trust charter it obtained from the New York Department of Financial Institutions enabled it to lawfully operate an exchange service in all fifty states. *See* Cade Metz, *NY Backs Bitcoin Exchange. But It May Not Fly in California*, WIRED (May 8, 2015), http://www.wired.com/2015/05/new-york-backs-bitcoin-exchange-may-not-fly-california [https://perma.cc/LG49-FA85]. However, the analyses of practitioners and academics alike have failed to prove out itBit's theory and instead openly call it into question. *See id.* (quoting Carol Van Cleef, Partner, Manatt, Phelps & Phillips, as saying that charter "is not necessarily going to be a blank pass to offer services in all states"); Houman Shadab, *What itBit's Banking Law Charter Really Means*, COINDESK (May 17, 2015), http://www.coindesk.com/in-itbit-we-trust/ [https://perma.cc/8FL5-PQ9R] ("Nonetheless, there seems to be some uncertainty about whether itBit—a banking law trust—automatically qualifies to do business without a money transmitter license in certain states.").

121. *See* Smart, *supra* note 70.

Transfer and Funds Travel Rules[122] and the valuation of virtual currency assets when applying for money transmission licenses under statutes that contemplate only fiat currency[123] offer two examples of such difficulties. If the regulatory approach to decentralized ledger technologies to date is a clear example of traditional financial regulation, and the result is confusion, uncertainty, and disincentive for innovation, the urgent question facing regulators, consumers, and entrepreneurs alike is whether an alternative approach that nevertheless remains consistent with leading legal regulatory theory is possible.

III. EVALUATION OF CURRENT ALTERNATIVE REGULATORY PROPOSALS ECHOES THE GAP IN THE CURRENT APPROACH

Recognizing the inadequacy of the current regulatory approach to the decentralized technology industry,[124] the current literature suggests several alternative proposals. The proposals can be grouped into three categories. First, various proposals attempt to apply existing law to bitcoin and other decentralized virtual currencies by shoehorning the decentralized payment applications into a specific type of asset or property category. Second, many commentators argue that federal financial services law should apply to all decentralized virtual currencies in order to address the money laundering risk, but that the remaining policy issues should be left to the states to address. Third, a variety of proposals call for various methods and levels of self-regulation.

Notably, most of the proposals in each category focus on building a regulatory approach to bitcoin and other decentralized virtual currencies, and do not address regulation of the underlying decentralized ledger technology. When the literature does turn its attention to the legal implications of decentralized ledger technology, it tends to skip the question of how to regulate the blockchain and moves straight to jurisprudential questions of how the blockchain might disrupt or alter known legal structures such as contract law,[125] property law,[126] and judicial decision making.[127]

122. *See* DOJ, RIPPLE SETTLEMENT AGREEMENT, *supra* note 116, at Attachment A, paras. 13–14.

123. *See* WASH. DEP'T OF FIN. INSTS., DIV. OF CONSUMER SERVS., INTERIM REGULATORY GUIDANCE ON VIRTUAL CURRENCY ACTIVITIES (Dec. 8, 2014), *available at* http://www.dfi.wa.gov/documents/money-transmitters/virtual-currency-interim-guidance.pdf [https://perma.cc/TL2S-LQNK] (explaining how minimum tangible net worth and permissible investment statutory requirements can be applied to virtual currency-related businesses).

124. Some of the literature is solely dedicated to proving out the extensiveness of this inadequacy. *See, e.g.*, Grinberg, *supra* note 58; Tu & Meredith, *supra* note 117.

125. *See generally* Fairfield, *Bitcoin Bots*, *supra* note 30.

126. *See generally* Fairfield, *BitProperty*, *supra* note 13.

127. *See generally* Michael Abramowicz, *Cryptocurrency-Based Law* (George Wash. Law Sch., Research Paper No. 2015-9, 2015), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2573788 [https://perma.cc/NHL7-G3MA].

The literature leaves a significant gap, which will have a substantial impact on both current entrepreneurial efforts to build regulatory-compliant businesses and the ability of decentralized ledger technology to actually impact the other jurisprudential questions raised by the literature. The blockchain and other similar technologies will never revolutionize property law, for example, if the regulatory environment is so hostile that no software developer can risk developing the product that will spark the revolution. To develop a regulatory approach robust enough to account for the many uniquely beneficial aspects of decentralized ledger technology, the various market and governance failures that have historically plagued such technologies, and the variety of forms taken by decentralized ledger technology, and to allow for continued innovation, this Section first develops certain criteria for evaluating alternative regulatory approaches. This Section then weighs existing alternative regulatory proposals against these criteria, finding that none of the current proposals meet all of the criteria to a high degree.[128] This Section concludes by attempting to define the boundaries of the regulatory lacuna left by both the current regulatory landscape and the academic literature, thereby setting the stage for developing a gap-filling alternative approach in Part IV.

A. *Criteria for Evaluating Alternative Regulatory Proposals*

To objectively consider whether any of the presently proposed alternative regulatory approaches adequately fill the lacunae in the current regulatory landscape, this Article proposes the use of the following seven standards: (1) minimize compliance risk; (2) minimize risk of illicit use; (3) minimize malfunctions and related problems; (4) minimize data security risk; (5) minimize systemic risk; (6) promote innovation and adaptability, and (7) maximize political feasibility. These criteria are drawn from the policy priorities reflected in the current state of decentralized ledger technology regulation and from financial regulatory theory.

Compliance risk refers to "the risk of loss associated with non-compliance with laws, rules, regulations, prescribed practices, or ethical standards."[129] This criterion aims to capture the policy priorities that underlie many of the ex ante regulatory measures presently applied to the decentralized ledger technology industry, including anti-money laundering and terrorist financing controls,[130] and minimum net worth and bond require-

128. This approach is patterned after a common analytical tool used in public policy literature. For an overview of the approach, see EUGENE BARDACH, A PRACTICAL GUIDE FOR POLICY ANALYSIS: THE EIGHTFOLD PATH TO MORE EFFECTIVE PROBLEM SOLVING 79–82 (4th ed. 2012). For examples of applications of this approach in the legal literature more broadly, see generally Carla L. Reyes, *Access to Counsel in Removal Proceedings: A Case Study for Exploring the Legal and Societal Imperative to Expand the Civil Right to Counsel*, 17 UDC/DCSL L. REV. 131 (2014); Schwarcz, *Systemic Risk*, *supra* note 118.

129. Bradford et al., *supra* note 86, at 35.

130. *See id.*

ments found in state money transmission laws. *Risk of illicit* use refers to "the risk of penalties if the failure to comply with required guidelines to curb illicit use . . . is discovered."[131] This criterion reflects ex post punishments for criminal behavior using decentralized ledger technology. *Malfunctions and related problems* refers to "malfunctions that are the result of unintentional circumstances or events . . . or intentional circumstances or events . . . ."[132] This criterion reflects the history of malfunctions resulting from unintentional circumstances in the decentralized ledger technology industry, including, for example, the fork of the blockchain in March 2013,[133] theft of consumer bitcoins held in trust by industry actors (such as the case of the Mt. Gox failure),[134] and the potential for an intentional 51% attack on the blockchain[135] or similar attacks on other decentralized ledger technologies.[136]

Data-security risk refers to "unauthorized modification, destruction, or disclosure of data . . . ."[137] Although this criterion may seem counterintuitive in the context of decentralized ledger technology, which sports encryption and cryptographic security features, the security of all applications that interact with decentralized ledger technologies are not created equal. This criterion is designed to ensure that any remaining data-security risk not intrinsically addressed by the underlying technology is addressed by consumer-facing uses of the technology. *Systemic risk* refers to

> [t]he risk that (i) an economic shock such as market or institutional failure triggers (through a panic or otherwise) either (X) the failure of a chain of markets or institutions or (Y) a chain of significant losses to financial institutions, (ii) resulting in increases in the cost of capital or decreases in its availability, often evidenced by substantial financial-market price volatility.[138]

---

131. *Id.*

132. *Id.* at 34.

133. *See* Jeong, *supra* note 48, at 5.

134. *See* Yoshifumi Takemoto & Sophie Knight, *Mt. Gox Files for Bankruptcy, Hit with Lawsuit*, REUTERS (Feb. 28, 2014), http://www.reuters.com/article/2014/02/28/us-bitcoin-mtgox-bankruptcy-idUSBREA1R0FX20140228 [https://perma.cc/WYV3-FDUW].

135. *See* Daniel Cawrey, *Are 51% Attacks a Real Threat to Bitcoin?*, COINDESK (June 20, 2014), http://www.coindesk.com/51-attacks-real-threat-bitcoin/ [https://perma.cc/NQ9Z-ZT8J].

136. *See, e.g.*, Vitalik Buterin, *Long-Range Attacks: The Serious Problem with Adaptive Proof of Work*, ETHEREUM BLOG (May 15, 2014), https://blog.ethereum.org/2014/05/15/long-range-attacks-the-serious-problem-with-adaptive-proof-of-work/ [https://perma.cc/K7FB-TG73] (describing potential for long-range attack on Ethereum protocol).

137. Bradford et al., *supra* note 86, at 34.

138. Iman Anabtawi & Steven Schwarcz, *Regulating Systemic Risk: Towards an Analytical Framework*, 86 NOTRE DAME L. REV. 1349, 1353 (2011) (quoting Schwarcz, *Systemic Risk*, *supra* note 118, at 204).

Although this criterion relies on a definition from financial regulatory literature, here, it is not intended to be used only with reference to the payments applications of decentralized ledger technologies. Rather, as each decentralized ledger protocol represents a system, albeit not necessarily a financial system, systemic shocks may result in parallel effects. This criterion is intended to be used by way of extrapolation, drawing parallels between the complexities and interrelatedness of the financial system and those of decentralized ledger technologies.[139]

Promoting innovation and adaptability refers to the ability to reduce the lag between the law and the technology it regulates through mechanisms designed to promote innovation and enable relatively fast regulatory adaptation to those innovations. This criterion reflects both the recognition that decentralized ledger technology has quickly evolved and that it will likely continue to do so. It also captures the complexity of the technology, which like the financial system it frequently interacts with, traditionally "innovate[s] more quickly than regulators can adapt."[140] *Political feasibility* refers to the variety and number of actors that will support the regulatory approach.[141] Given the decentralized nature of the technology to be regulated, wide stakeholder buy-in will be crucial to the effectiveness of any alternative regulatory proposal.[142]

B. *Categorizing Decentralized Virtual Currencies as a Recognized Legal Asset*

The first group of alternative proposals presented by the academic literature focuses on the payments application of decentralized technologies and argues that bitcoin and related decentralized virtual currencies should be regulated as a specific type of asset, such as intangible prop-

139. Indeed, this Article has drawn such parallels throughout, including with reference to the ex ante/ex post regulatory dichotomy and with regard to elements of the endogenous approach proposed below. This is in no way intended to suggest that the payments applications of decentralized ledger technologies are the focus of the analysis presented here. In fact, the opposite is intended. However, the complexity of issues, the speed of innovation, the potential for system-wide impact (both good and bad), and the number of points-of-entry for consumers are all parallels that make financial regulatory literature a useful point of reference. Notably, the analysis in this Article does not end with financial regulatory literature. Rather, the diffuse nature of the inquiry, incorporating elements of technology law, financial law, comparative law, and international development law, reflects the depth of the technology and related points of regulatory inflection at issue.

140. Schwarcz, *Systemic Risk*, *supra* note 118, at 260.

141. *See* BARDACH, *supra* note 128, at 41–42 (referring to this criterion as *political acceptability* and defining it as "a combination of two conditions: too much opposition (which may be wide or intense or both) and/or too little support (which may be insufficiently broad or insufficiently intense or both)").

142. *See* Wright & De Filippi, *supra* note 2, at 57 (arguing that if decentralized ledger community does not buy-in to regulatory proposal, it could defeat it by refusing to adopt new rules).

erty,[143] money,[144] securities,[145] uncertificated securities,[146] or some other presently recognized form of legal asset.[147] One of the goals of these proposals appears to be reducing uncertainty as to which legal regimes apply to bitcoins. If bitcoins are categorically money, property, or some other form of recognized legal asset, the path to regulatory compliance becomes clearer: follow the traditional rules applicable to that asset. Various practical difficulties plague this approach. First, not all decentralized virtual currencies behave in precisely the same way and therefore may not all fit within the definition of the traditional legal asset at issue. Second, implementation issues may arise that leave the sufficiency of compliance efforts uncertain. For example, issues of adequate implementation have plagued even the most well-meaning industry actors with regard to compliance with federal money service business regulations and state money transmitter laws.

Two significant theoretical difficulties face these approaches as well. First, these approaches only consider the regulation of the payments application of decentralized ledger technologies, ignoring the underlying technology and its other potential use cases entirely. In other words, if the primary criteria for these approaches is to provide regulatory clarity, to the extent it does so at all, it only achieves that criteria for one application of

143. *See, e.g.*, Rhys Bollen, *The Legal Status of Online Currencies: Are Bitcoins the Future?*, 24 J. BANK. & FIN. L. & PRAC. 272, 279 (2013) (arguing that "Bitcoins are a form of intangible private property, a valuable digital artefact" and are therefore "analogous with other forms of intangible private property, such as digital music, shares, licenses, trademarks, copyright, goodwill, domain names, frequent flier points and brands"); Nelson DaCunha, *Virtual Property, Real Concerns*, 4 AKRON INTELL. PROP. J. 35, 41 (2010) (noting that if decentralized virtual currencies are form of intangible property, tort law offers one way to protect interests of both users and service providers).

144. *See* Bryans, *supra* note 56, at 441; Nicholas A. Plassaras, Comment, *Regulating Digital Currencies: Bringing Bitcoin Within the Reach of the IMF*, 14 CHI. J. INT'L L. 377, 403 (2013).

145. *See* J. Scott Colesanti, *Trotting Out the White Horse: How the S.E.C. Can Handle Bitcoin's Threat to American Investors*, 65 SYRACUSE L. REV. 1, 38 (2014); Ruoke Yang, *When Is Bitcoin a Security Under U.S. Securities Law?*, 18 J. TECH L. & POL'Y 99, 108 (2013).

146. *See generally* Jeanne L. Schroeder, Bitcoin and the Uniform Commercial Code (Benjamin N. Cardozo Sch. Law Research Paper No. 458, 2015), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2649441 [https://perma.cc/LS6G-EVF2].

147. *See, e.g.*, Houman B. Shadab, *Regulating Bitcoin and Block Chain Derivatives* (2014), *available at* http://www.cftc.gov/ucm/groups/public/@aboutcftc/documents/file/gmac_100914_bitcoin.pdf [https://perma.cc/F7PD-42PG] (arguing that bitcoins fall into definition of commodity under Commodity Exchange Act and that derivative contracts that reference bitcoins are subject to regulation by Commodity Futures Trading Commission); George K. Fogg, *Perkins Coie: The UCC and Bitcoins—Solution to Existing Fatal Flaw*, COINDESK (Jan. 29, 2015), http://www.coindesk.com/perkins-coie-bitcoin-can-learn-real-estate-law/ [https://perma.cc/72M7-XRR8] (arguing that bitcoins would presently be considered general intangibles under UCC, and presenting solution for changing that classification to one of investment property).

the technology, leaving the rest of the industry either in unchartered waters or, perhaps worse, attempting to comply with a regime that is ill-suited to the technology use at issue. Second, these approaches do nothing to resolve the underlying tension of a combined ex ante and ex post approach to regulating decentralized ledger technologies. In sum, although these approaches address the criteria of compliance risk and illicit use to a high degree, they do not promote innovation and adaptability, minimize systemic risk, or solicit broad stakeholder buy-in.

C. *Applying Federal Financial Service Laws and Otherwise Deferring to State Regulation*

The second group of proposals argues that decentralized ledger technology service providers, and especially those offering a service related to decentralized virtual currency, should remain subject to existing "customer-identification program and AML compliance program requirements of Sections 326 and 352 of the USA PATRIOT Act, and with the economic sanctions regulations enforced by OFAC" and FinCEN regulations as appropriate, and that the remaining regulatory functions should be left to state governments.[148] Within this second group, the proposals for state approaches to regulation vary widely and include a recommendation to require exchanges to pay premiums to a third-party insurer of the exchange's choice[149] and an elective tax on anonymity,[150] among others.[151] The wide variety of specific recommendations within this sec-

148. Trautman, *supra* note 18, at 43 (quoting *The Present and Future Impact of Virtual Currency: Joint Hearing Before the Subcomms. on Econ. Pol'y & on Nat'l Sec. & Int'l Trade & Fin. of the S. Banking Comm.*, 113th Cong. 2–3 (2013), *available at* http://www.banking.senate.gov/public/index.cfm/hearings?ID=955322CC-D648-4A00-A41F-C23BE8FF4CA (statement of Sarah Jane Hughes, Univ. Scholar & Fellow in Commercial Law, Ind. Univ. Maurer Sch. of Law)); *see also* Middlebrook & Hughes, *supra* note 76, at 840 (noting that regulating cryptocurrencies by analogy to existing regulatory schemes may have higher likelihood of success because "[t]he law has a tendency to address new products and technologies by analogizing to existing regulatory schemes"); Joshua J. Doguet, Comment, *The Nature of the Form: Legal and Regulatory Issues Surrounding the Bitcoin Digital Currency System*, 73 LA. L. REV. 1119, 1147–49 (2013) (examining three regulatory approaches and arguing that compliance with existing anti-money laundering regulations offers existing opportunity to curb illicit uses of bitcoin payment system).

149. *See* David Groshoff, *Kickstarter My Heart: Extraordinary Popular Delusions and the Madness of Crowdfunding Constraints and Bitcoin Bubbles*, 5 WM. & MARY BUS. L. REV. 489, 554 (2014).

150. *See* Marian, *supra* note 24, at 54.

151. *See, e.g.*, Gruber, *supra* note 55, at 204–08 (arguing for compliance with existing BSA and tax law and for additional prohibition of mixing technologies and use of Tor network to enhance anonymity); Misha Tsukerman, Note, *The Block Is Hot: A Survey of the State of Bitcoin Regulation and Suggestions for the Future*, 30 BERKELEY TECH. L.J. 1127 (2015) (arguing for registry linking bitcoin wallet public keys to user's identity). Notably, both of these proposals focus on the anonymous nature of bitcoin transactions as the primary policy problem to be addressed. *See* Kaplanov, *supra* note 50, at 113–14 (arguing that bitcoin should be regulated as community currency).

ond group stems from the emphasis each proposal places on specific characteristics of decentralized virtual currency. For example, the third-party insurance solution emphasizes the price volatility that characterizes bitcoin and uses economic theory to suggest a way to minimize investor risk and protect consumers against the price volatility with minimal government intervention.[152] Meanwhile, the elective tax on anonymity seeks to reduce what is commonly perceived as a core benefit that decentralized virtual currencies offer to criminal masterminds: anonymity.[153]

Despite the variety of approaches, each of the proposals in this group attempts to bridge the gap between the policy concerns presently voiced by regulators and the frustration of many decentralized industry participants. In particular, many of the proposals start from the premise that the payments applications of decentralized technologies present a real risk of money laundering and facilitation of other criminal activity.[154] Further, the proposals recognize that users of decentralized payments systems face real risk of loss of funds and other assets.[155] These proposals, however, face difficulties similar to the first group of proposals: practical difficulties to implementation, a singular focus on bitcoin and other payments applications of decentralized ledger technology, and proposals for regulatory frameworks that emphasize one perceived characteristic of decentralized virtual currencies at the expense of others. In other words, these proposals, like both the first group of proposals and current regulation, minimize compliance risk and illicit use at the expense of innovation and adaptability. Further, these proposals lack structured consideration of issues related to minimizing malfunctions, data security, or systemic risks. Finally these approaches will likely not garner broad stakeholder support, especially among industry stakeholders. As a result this group of proposals generally only upholds two of the criteria to a high degree.

D. *Proposals for Self-Regulation*

The third and most prominent group of proposals calls for various levels of industry self-regulation.[156] One such proposal argues for a three-tiered self-regulatory approach. The three tiers would include: (1) the code itself acting as law to restrain activity; (2) contractual obligations self-

152. *See* Groshoff, *supra* note 149, at 554.

153. *See* Marian, *supra* note 24, at 53.

154. *See, e.g.*, *id.*

155. *See, e.g.*, Middlebrook & Hughes, *supra* note 76, at 823; Christopher, *supra* note 76, at 24.

156. *See, e.g.*, Primavera De Filippi, *Bitcoin: A Regulatory Nightmare to a Libertarian Dream*, 3 INTERNET POL'Y REV. 1, 10 (2014) [hereinafter De Filippi, *Regulatory Nightmare*] ("[R]egulation of the protocol will most probably arise 'organically' as bitcoin adoption increases. Accordingly, before turning to regulation, it might be wise to first look at whether the solutions forthcoming from the market could actually provide a satisfactory answer to these aforementioned problems." (citation omitted) (citing Henrik Karlstrøm, *Do Libertarians Dream of Electronic Coins? The Material Embeddedness of Bitcoin*, 15 SCANDINAVIAN J. SOC. THEORY 23 (2014))).

imposed through a service provider's terms of service, privacy policy, and other consumer facing documents; and (3) private lawsuits to hold service providers "liable for all losses due to their negligence, recklessness, or disregard for" users' rights.[157] Other commentators suggest that a new body of law, which they term "*Lex Cryptographia*," will emerge as "a set of rules administered through self-executing smart contracts and decentralized (and potentially autonomous) organizations."[158] Recognizing *Lex Cryptographia* as a form of self-regulation in the vein of its predecessors, *Lex Mercatoria* and *Lex Informatica*, Wright and De Filippi argue that "[o]ne of the key consequences of the blockchain could be a rapid expansion of what Lawrence Lessig referred to as 'architecture'—the code, hardware, and structures that constrain how we behave—or at a minimum a redefinition of how laws and regulations are designed, implemented, and enforced."[159]

Although this Article contends that promoting innovation and adaptability will be a key aspect of regulating decentralized ledger technology, these self-regulatory proposals elevate this criterion over all others. Doing so discounts the actual market failures that have occurred since the introduction of decentralized ledger technologies, including massive loss of consumer funds caused by the failure of large industry players, such as Mt. Gox.[160] The self-regulatory proposals do not, however, limit their scope to the decentralized virtual currency applications of the underlying decentralized ledger technology. Rather, it is the very recognition of the vast and complex potential use cases for the underlying technology that causes these writers to counsel self-regulation. Proposals for self-regulation of decentralized ledger technologies face several challenges. First, the threat of ex post incentives for compliance has proved important to the regulatory history of decentralized virtual currencies to date. Without the power to impose ex post regulation, whether through enforcement activity or some other form of ex post incentive, it is unclear how proposals for self-regulation intend to address the compliance, illicit use, and malfunction risk criteria. Second, *Lex Mercatoria* and *Lex Informatica* largely provide rules for the private sphere, while many of the core policy concerns facing the decentralized ledger technology industry implicate matters of public law as well. As a result, a self-regulatory approach, including a *Lex Cryptographia* that follows the pattern of its predecessors and focuses on rules for the private sphere, will be ill-suited to address systemic risk.

---

157. DaCunha, *supra* note 143, at 45, 58, 71.

158. Wright & De Filippi, *supra* note 2, at 48.

159. *Id.* at 50 (footnote omitted) (citing LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE VERSION 2.0, at 24 (2d ed. 2006) [hereinafter LESSIG, CODE AND OTHER LAWS]).

160. *See* Takemoto & Knight, *supra* note 134.

E. *Crystalizing the Problem and Defining the Boundaries of the Regulatory Lacuna*

Taken as a whole, the present alternative regulatory proposals focus on the same policy priorities as the current regulatory approach: focusing overwhelmingly on the payments applications of decentralized ledger technologies, curbing illicit uses of such payments applications, reducing the perceived extreme level of anonymity afforded to use of such payments applications, protecting consumers from financial loss, and predominately focusing on ex ante measures followed by ex post supplemental enforcement actions as necessary. Furthermore, both the current regulatory landscape and the alternative proposals focus their efforts on the centralized actors in the ecosystem. Although this approach arguably worked well with regard to regulating the Internet,[161] it appears to be experiencing higher levels of inefficiency and ineffectiveness in the context of decentralized ledger technologies. As regulation of the Internet experienced in the 1990s, so regulation of decentralized ledger technologies is experiencing now: a lacuna in the regulatory approach that results in law lag. Regulation that focuses on the centralized actors in a decentralized ecosystem simply will not be able to keep pace. There is some level of urgency related to addressing the law lag, as the level of decentralization in the ecosystem is only expected to grow.[162]

The above discussion reveals four core elements of the gap between law and decentralized ledger technology that is causing the law lag. First, the complete failure to regulate at the decentralized ledger level rather than the payments application level occupies a large place in the regulatory gap. This failure implicates two of the criteria: promoting innovation and adaptability and minimizing systemic risk. Second, the current and alternative approaches are overly reactive to the past bitcoin market failures. The heavy emphasis on anti-money laundering and curbing other illicit uses are directly reactive to the Mt. Gox failure, and the E-Gold, Liberty Reserve, and Silk Road enforcement actions. Similar to the pattern of overreacting to past crises that characterizes most existing financial regulation,[163] this reactive approach implicates the criteria of compliance, illicit use, malfunction, and data security risks. Third, the present and proposed alternative regulatory approaches are grounded in the characteristics of bitcoin and decentralized virtual currencies as they appear at present. This artificially ties effective regulation to a specific moment in time and a specific market context. Again, this flaw echoes that of existing financial regulation more generally[164] and implicates the innovation and

161. *See* Wright & De Filippi, *supra* note 2, at 55.

162. *See id.* at 56–58; *see also* Abramowicz, *supra* note 127; Fairfield, *Bitcoin Bots*, *supra* note 30.

163. *See* Anabtawi & Schwarcz, *supra* note 138, at 1351.

164. *See id.* at 1369 ("It is our view, however, that additional measures are, and will continue to be, needed to protect the financial system from unforeseen economic shocks. In part, this is because the measures that have been adopted re-

adaptability and systemic risk criteria. Finally, it remains unclear whether the mishmash of ex ante and ex post regulation is purposeful or simply the result of various regulators applying existing laws to an emerging technology. When viewed in this light, the regulatory gap crystalizes and may be problematized in the following manner: what regulatory approach (ex ante, ex post, a combination of both, or neither) will treat decentralized ledger technology holistically, including taking a balanced approach to rectifying past crises, without tying regulation to specific implementations or applications of the technology, while maximizing the seven criteria to a high degree?

IV. FILLING THE GAP WITH AN ENDOGENOUS THEORY OF DECENTRALIZED TECHNOLOGY REGULATION: AN INITIAL PROPOSAL

Current regulation of decentralized virtual currencies and the existing literature assume that the form of regulation is limited to the following dichotomy: "[S]elf-regulation (i.e. through market-based mechanisms, or with the support of a private regulatory body like the Bitcoin Foundation) or by means of state regulation."[165] This Article, however, has demonstrated that neither choice effectively incentivizes decentralized technology ecosystem participants to prevent the market and governance failures that primarily concern regulators. This Article therefore challenges the conventional dichotomy and proposes a third alternative: an endogenous model of regulation that simultaneously governs from within and without, and sidesteps the ex ante/ex post regulatory choice by building compliance into the protocol and thereby eliminating the need for incentives. In so doing, this Article investigates the impact that decentralized technologies will have on the regulatory exercise itself.

A. *An Endogenous Theory of Regulation for Decentralized Ledger Technologies*

The concept of endogenous regulation can be found in various branches of academic literature, including economics, development, comparative law, and financial regulation. This Article suggests an approach to endogenous regulation that relies on insights from each of these areas in order to meet the criteria for decentralized ledger technology regulation identified above in Part III(A) and fill the regulatory lacuna identified in Parts II and III above. Synthesizing the various commentaries regarding endogenous regulation leads to an approach that is iterative, cooperative, focused on the functional purposes for enacting regulation, and implemented from within the market requiring regulation.

---

spond to practices specific to the recent global financial crisis, rather than addressing its fundamental causes.").

165. De Filippi, *Regulatory Nightmare*, *supra* note 156, at 10.

Generally speaking, the term *endogenous* refers to the concept of "[h]aving an internal cause or origin."[166] For economists, "[t]he theory of endogenous policy describes how self-interested agents influence the choices made regarding government policies."[167] In particular economic theory considers the endogenous evolution of regulation as one that is "incremental, and continuous, producing small effects at each individual step but cumulatively resulting in ever deeper levels of cooperation."[168] Economic development literature similarly conceptualizes an endogenous approach as an iterative and cooperative one, in which "the distinctiveness of individual cultures and societies should be at the center of determining the goals to be pursued."[169] This approach links culture to development and argues that because the other system possesses a unique cultural identity, it should be "entitled to freely choose [its] own method[ ] for achieving full political and economic independence."[170] The contribution of endogenous development theory relevant to the present regulatory inquiry is the premise that when promoting development in another system, whether through the imposition of new regulations[171] or otherwise, it is

166. *Endogenous*, OXFORD DICTIONARY, http://www.oxforddictionaries.com/us/definition/american_english/endogenous [https://perma.cc/DZ7D-A9RC] (last visited Mar. 1, 2016).

167. ISIDORO ADOLFO MAZZA, *An Endogenous Policy Model of Hierarchical Government*, *in* ESSAYS ON ENDOGENOUS ECONOMIC POLICY 11, 11 (2009).

168. Laurence R. Helfer, *Understanding Change in International Organizations: Globalization and Innovation in the ILO*, 59 VAND. L. REV. 649, 665 (2006); *see also* Stanley Reiter, *On Endogenous Economic Regulation*, 2 ECON. DESIGN 211, 211–14 (1996) (setting forth economic game theory underlying endogenous economic regulatory approach and describing it as iterative game process in which interactions between regulators and economic actors they regulate in one phase construct rules and regulations that govern next phase).

169. Ruth E. Gordon & Jon H. Sylvester, *Deconstructing Development*, 22 WIS. INT'L L.J. 1, 35 n.153 (2004).

170. Edmund H. Chiang, Note, *The UNESCO Convention on the Protection and Promotion of the Diversity of Cultural Expressions: A Look at the Convention and Its Potential Impact on the American Movie Industry*, 6 WASH. U. GLOBAL STUD. L. REV. 379, 392 n. 81 (2007) (citing Ivan Bernier, *A UNESCO International Convention on Cultural Diversity*, *in* FREE TRADE VERSUS CULTURAL DIVERSITY: WTO NEGOTIATIONS IN THE FIELD OF AUDIOVISUAL SERVICES 65, 72 (Cristoph Beat Graver, Michael Girsberger & Mira Nenova eds., 2004)).

171. Modernizing legal norms (by patterning them off of Western institutions) has long been considered a method for promoting economic development. For a brief history and description of the law and development movement, see Gordon & Sylvester, *supra* note 169, at 18–23; *see also* Amanda J. Perry, *International Economic Organizations and the Modern Law and Development Movement*, *in* MAKING DEVELOPMENT WORK: LEGISLATIVE REFORM FOR INSTITUTIONAL TRANSFORMATION AND GOOD GOVERNANCE 19 (Ann Seidman, Robert B. Seidman & Thomas W. Wälde eds., 1999); David M. Trubek, *The "Rule of Law" in Development Assistance: Past, Present, and Future*, *in* THE NEW LAW AND ECONOMIC DEVELOPMENT: A CRITICAL APPRAISAL 74 (David M. Trubek & Alvaro Santos eds., 2006).

necessary to understand "the ways in which local innovations and gains can be preserved as part of local economic and cultural power."[172]

The financial regulatory literature also explores an endogenous or functional approach to regulation.[173] The functional approach to financial regulation argues that in order to regulate "a dynamically changing financial system," which rapidly changes in unexpected ways, "it may be more effective—or at least instructive—to focus on the system's underlying, and thus less time-dependent, economic functions than to tie regulation to any specific financial architecture."[174] A functional approach is desirable, the theory argues, because it is well-suited to "analysis of a highly complex or unknown structure" and it "facilitates the analysis of a rapidly changing structure," both of which are qualities of the financial system.[175]

Comparative legal theory describes a similar approach to understanding regulation and, in particular, a methodology for determining the relevant functions of a system to be regulated, and the appropriate institution with which to achieve that regulation through the concept of the functional method.[176] The central idea of the comparative functional method is that of functional equivalence, which suggests that "similar functional needs [of society] can be fulfilled by different institutions . . . ."[177] Functional equivalence posits that social problems are generally universal, but the legal and institutional response to universal social problems need not be.[178] As a result, the functional method

---

172. Natsu Taylor Saito, *Decolonization, Development, and Denial*, 6 FLA. A & M U. L. REV. 1, 45 (2010) (quoting ARTURO ESCOBAR, ENCOUNTERING DEVELOPMENT: THE MAKING AND UNMAKING OF THE THIRD WORLD 98 (1995)) (internal quotation marks omitted).

173. *See generally* Steven L. Schwarcz, *Regulating Financial Change: A Functional Approach*, 100 MINN. L. REV. (forthcoming 2016) [hereinafter Schwarcz, *Functional Approach*], *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2469467 [perma.cc/V2DH-HUDM].

174. *Id.* at 5–6.

175. *Id.* at 6.

176. The functional method as used in the comparative legal enterprise is designed to help a comparative legal scholar understand the way that a foreign legal system approaches a particular problem through regulation. This Article suggests that this same approach can be used to consider how to approach a particular problem in a foreign system, with decentralized ledger technology being the foreign system. On the idea of code-as-law, which leads to the conception of decentralized ledger technology as a foreign legal system, see Lessig, *Open Code and Open Societies*, *supra* note 25.

177. Ralf Michaels, *The Functional Method of Comparative Law*, *in* THE OXFORD HANDBOOK OF COMPARATIVE LAW 339, 357 (Mathias Reimann & Reinhard Zimmermann eds., 2006); *see also* KONRAD ZWEIGERT & HEIN KÖTZ, INTRODUCTION TO COMPARATIVE LAW 34 (Tony Weir trans., Oxford Univ. Press 3d rev. ed. 1998) (1977).

178. *See* Esin Örücü, *Developing Comparative Law*, *in* COMPARATIVE LAW: A HANDBOOK 43, 51 (Esin Örücü & David Nelken eds., 2007). Stated another way, "if a society has a certain problem *a*, it must have a legal institution *y*, and different solutions to *a* are functionally equivalent." Michaels, *supra* note 177, at 371.

> aims at explaining the effects of legal institutions as functions . . . and it promises to look at non-legal responses to societal requisites, too. The functional method asks us to understand legal institutions not as doctrinal constructs but as societal responses to problems—not as isolated instances but in their relation to the whole legal system, and beyond, to the whole of society.[179]

The functional method forces comparative legal scholars to shed the assumption that the absence of a certain legal structure means that the society does not address the social problem the structure is designed to resolve.[180] Instead, comparative theorists look at the legal and social context of the foreign system as a whole, with the goal of uncovering a functional equivalent—another institution that, although different in structure, serves the same purpose.[181]

Comparative legal scholars have developed a methodology for uncovering functional equivalents in foreign legal systems.[182] The first step in functional equivalence analysis is to ask what social problem a certain legal institution seeks to resolve.[183] In framing this question, comparative theorists seek to eliminate any reference to concepts in their own legal system, but rather state the question in "purely functional terms."[184] The next step in the functional method is to search the foreign system for the legal institution responding to the social problem posed. Comparative theorists undertaking this research are obligated to explore all aspects of the foreign system and not expect the legal construct to appear in the same form and context as in the native legal system.[185]

---

179. Michaels, *supra* note 177, at 364.

180. *See id.*

181. *See id.*

182. Comparative legal scholarship has debated the relative importance of the functional method as opposed to other approaches to comparative law. *See generally* Jaakko Husa, *Farewell to Functionalism or Methodological Tolerance?*, 67 RABELS ZEITSCHRIFT 419 (2003) [hereinafter Husa, *Farewell to Functionalism*] (providing review of debate and arguing for "moderate version of functionalism"). To clarify, the functional method is one of several approaches to micro-comparison, including the study of legal transplants. *See* Michele Graziadei, *The Functionalist Heritage*, *in* COMPARATIVE LEGAL STUDIES: TRADITIONS AND TRANSITIONS 100, 100 (Pierre Legrand & Roderick Munday eds., 2003). The functional method and legal transplants, however, are of particular value to the rule of law development enterprise, and for that reason, are discussed in more detail than other approaches.

183. *See* Michaels, *supra* note 177, at 366.

184. ZWEIGERT & KÖTZ, *supra* note 177, at 34 (demonstrating, through example, that question should not be "What formal requirements are there for sales contacts in foreign law?" but rather, "How does foreign law protect parties from surprise, or from being held to an agreement not seriously intended?" (internal quotation marks omitted)).

185. *Id.* at 35 ("Even experienced comparatists sometimes look for the rule they want only in the particular place in the foreign system where their experience of their own system leads them to expect it: they are unconsciously looking at the problem with the eyes of their own system.").

In the event that a search of the foreign legal system fails to produce an institution designed to address the problem, the next step for comparative theorists is to ask why the legal system does not provide such an institution.[186] This step in functional methodology forces comparative theorists to search the entire foreign system, rather than narrowly focusing on the legal system.[187] In particular, comparative theorists investigate the foreign system's cultural and customary norms in search of an institution that addresses the problem.[188] By the end of the comparative endeavor, comparative theorists have either discovered a functionally equivalent institution, or have discovered the reason for the absence of one.[189]

As a result of the functional method, comparative theorists "know that law, just like culture, is not monolithic."[190] Instead of prescribing which laws work best, the comparative functional method "sets out to understand what makes law work."[191] By beginning the inquiry with the social function of law,[192] the comparative functional method creates a framework in which it is possible to avoid "the problem that one perceives the foreign systems mainly through the mind-set of one's own legal system."[193] In doing so, the functional method enables the comparative theorists to conceive of possible reasonable substitutes, rather than assume that one set of institutions is essential for meeting a certain set of regulatory criteria.

Ultimately, then, in undertaking the micro-comparison enterprise through the functional method, the first question is not, *How can this specific institution be successfully transplanted?* but rather, *Which institution can be transplanted that would successfully address the problem?* If decentralized ledger technology is considered a "foreign system," with protocol rules that govern its usage and a coding language all its own, the comparative functional method becomes a core element of an endogenous approach to decentralized ledger technology development. Essentially, when combined with foundational concepts from functional financial regulation, endogenous economic regulation, and endogenous development, the comparative functional method offers regulators a tool for engaging in a two-way regulation design process that requires the participation of core developers in the decentralized ledger technology ecosystem. By doing so, the construct of an endogenous or functional approach to regulating de-

186. *See id.*

187. *See id.*

188. *See id.*

189. *See id.*

190. Graziadei, *supra* note 182, at 115.

191. *Id.*

192. *See* Husa, *Farewell to Functionalism*, *supra* note 182, at 423; Jaakko Husa, *About the Methodology of Comparative Law – Some Comments Concerning the Wonderland. . .* 8 (Univ. of Maastricht Faculty of Law, Working Paper No. 2007/5, 2007) [hereinafter Husa, *Wonderland*] ("The point of departure for comparison ought to be . . . the socio-legal function.").

193. Husa, *Farewell to Functionalism*, *supra* note 182, at 423; *see also* Husa, *Wonderland*, *supra* note 192, at 8.

centralized ledger technology has the potential to meet a majority of the criteria set forth in Part III above to a high degree and therefore offers a potential avenue for filling the gap in the current regulatory landscape and academic literature. Because it is difficult to assess the fulfillment of the criteria in the abstract, this Article next offers one possible implementation and uses it to demonstrate the capacity for endogenous regulation to offer flexible, adaptable, and feasible regulation that minimizes a variety of risks to a high degree.

B. *Technology-Assisted Regulation: A Proposed Implementation of Endogenous Regulation in the Decentralized Ledger Technology Ecosystem*

Taking the various strands of endogenous and functional regulation together reveals a synthesized approach that is iterative, cooperative, focused on the functional purposes for enacting regulation, and implemented from within the market requiring regulation. These are the core elements of the endogenous theory of decentralized ledger technology proposed here. Taking the last element first, this Article proposes that regulation of decentralized ledger technology should build on the body of literature, most prominently led by Lawrence Lessig, that argues for the use of code-as-law.[194] The proposal here is not for allowing the industry to self-regulate through rules created by use of the blockchain or other similar technologies.[195] Nor is this a proposal for using smart contracts to create a code of law that enables the regulation of private actors and decentralized autonomous organizations.[196] Finally, this is not a proposal for layering law on top of technology architecture in order to form a com-

194. *See, e.g.*, LESSIG, CODE AND OTHER LAWS, *supra* note 159, at 24; Lawrence Lessig, *Foreword*, 52 STAN. L. REV. 987, 990 (2000) (explaining that phrase "*[c]ode is law*" was meant "[m]etaphorically, in that the code controls behavior as law might control behavior" (internal quotation marks omitted)). In Lessig's conception of code-as-law, the idea is that writers of code, private actors, constrain behavior as they write rules into the code. *See* Lessig, *Open Code and Open Societies*, *supra* note 25, at 1408.

> The code of cyberspace—whether the Internet, or a net within the Internet—defines that space. It constitutes that space. And as with any constitution, it builds within itself a set of values and possibilities that governs life there. . . . And the design of code is something that people are doing. Engineers make the choices about how the world will be. Engineers in this sense are governors.

Id.

The proposal here builds Lessig's conception of code-as-law into law-through-code, or technology-assisted regulation, something that Lessig doubted could be achieved in an open source environment. *See infra* note 219 and accompanying text.

195. *See generally* De Filippi, *Regulatory Nightmare*, *supra* note 156; David R. Johnson & David Post, *Law and Borders—The Rise of Law in Cyberspace*, 48 STAN. L. REV. 1367, 1391–95 (1996).

196. In other words, this is not a proposal in the same vein as Wright & De Filippi's *Lex Cryptographia*. *See generally* Wright & De Filippi, *supra* note 2.

plete regulatory picture.[197] Rather, this is a proposal that regulators undertake the dual task of enacting a law or regulation via statute, and then implementing that statute through code, so that it is endogenously incorporated into the decentralized ledger technology or applications running on top of the technology. In other words, while several commentators have suggested that increasingly complex systems of smart contracts can be used to create new rules and constructs for organizations,[198] corporate entities,[199] property,[200] and government bodies,[201] this proposal contests that the first and primary target for regulation-through-code is the technology itself. In this way, the endogenous theory of regulation advanced here reflects Lessig's suggestion that

> [r]egulation in cyberspace is, or can be, different. If the regulator wants to induce a certain behavior, she need not threaten, or cajole, to inspire the change. She need only change the code—the software that defines the terms upon which the individual gains access to the system, or uses assets on the system.[202]

Achieving such implementation of regulation-through-code, which this Article will refer to as technology-assisted regulation, will organically require that regulators adopt the other elements of the endogenous approach. Namely, because the writing of code is limited by certain properties of the protocol, regulators will be unable to craft the requisite rules without cooperating with members of the decentralized ledger technology ecosystem. Further, only an iterative process of incorporation and feedback will lead both the drafters of statute and the writers of code to a place of thoughtful and meaningful regulation. Finally, cooperation between regulators and industry members in an iterative process will inevitably lead to discussions about the functional purpose of current regulation and how to translate those purposes into mechanisms that serve as a functional equivalent within the code. If such a level of cooperation could be achieved, the criteria of political feasibility would be met to a high degree, as buy-in would be required of regulators and industry members alike.

---

197. *See* LESSIG, CODE AND OTHER LAWS, *supra* note 159, at 123 (arguing that regulation is composed of various levels of constraints, including laws, market, social norms, and architecture (including code)); *see also* DaCunha, *supra* note 143, at 58, 64, 68 (arguing for three layers of bitcoin regulation); Andy Yee, *Internet Architecture and the Layers Principle: A Conceptual Framework for Regulating Bitcoin*, 3 INTERNET POL'Y REV. 1 (2014).

198. *See* Wright & De Filippi, *supra* note 2, at 50.

199. *See* Mihaela Ulieru, *Organic Governance Through the Logic of Holonic Systems*, *in* FROM BITCOIN TO BURNING MAN AND BEYOND: THE QUEST FOR IDENTITY AND AUTONOMY IN A DIGITAL SOCIETY, *supra* note 75, at 113, 128.

200. *See generally* Fairfield, *BitProperty*, *supra* note 13.

201. *See generally* Abramowicz, *supra* note 127.

202. Lawrence Lessig, *The Zones of Cyberspace*, 48 STAN. L. REV. 1403, 1408 (1996).

Writing regulation into the code is not only possible, but is organic to the system. It is possible that an interaction between the decentralized ledger technology industry and regulators could be coordinated through a centralized entity representing the community, such as the Bitcoin Foundation,[203] the Digital Asset Transfer Authority (DATA),[204] or a similar organization created specifically for this purpose. However, the chosen organization may dissolve while the need for regulation would remain constant. As a result, coordinating the cooperative, iterative endogenous regulation process through such a centralized entity, while familiar to regulators, may not be the most beneficial in the long run. In any event, such efforts need not be implemented through a centralized organization. "There is evidence that community consensus can result in the resolution of" issues related to decentralized public ledger maintenance.[205] As such, "if the [decentralized ledger technology] network came to a consensus about modifying the rules," the rules of the system could change.[206] In fact, it is likely that much decentralized public ledger maintenance is conducted by a small group of core developers and a handful of additional volunteers recruited by the core team.[207] Moreover, many of the prominent decentralized ledgers have adopted such a structure,[208] and evidence shows that "large successful open source projects typically have a benevolent dictator who makes decisions."[209] Furthermore, decentralized ledger technologies and, in particular, the payments applications that run on them, arguably already contain "a number of economic rules that serve as monetary policy enacted in code."[210] In fact, the very issues of who can conduct transactions, under what circumstances and when, are all determined by rules built into the protocol.[211]

By leveraging smart contracts and other features of decentralized ledger technologies, regulation can be implemented at a systemic, decentralized ledger technology level, as opposed to an application-specific level (e.g., focusing solely on payments). In doing so, this proposal fulfills two criteria to a high degree: minimizing systemic risk and promoting innovation and adaptability. Implementing regulation from within the code it-

203. *See* BITCOIN FOUNDATION, http://bitcoinfoundation.org/ [https://perma.cc/2SJZ-SQUS] (last visited Mar. 1, 2016).

204. *See* DATA ASSET TRANSFER AUTHORITY, http://info.datauthority.org/wordpress/ [https://perma.cc/QG8R-T7DR] (last visited Mar. 1, 2016).

205. Jeong, *supra* note 48, at 31.

206. *Id.* at 5.

207. *See* David S. Evans, *Economic Aspects of Bitcoin and Other Decentralized Public-Ledger Currency Platforms* 15 (Coase-Sandor Inst. for Law & Econ., Working Paper No. 685, 2014), *available at* http://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=2349&context=law_and_economics [https://perma.cc/2T2D-X6SA].

208. *See id.* at 16.

209. *Id.* at 15 (citing CHARLES M. SCHWEIK & ROBERT C. ENGLISH, INTERNET SUCCESS: A STUDY OF OPEN-SOURCE SOFTWARE COMMONS (2012)).

210. Jeong, *supra* note 48, at 5.

211. *See* De Filippi, *Regulatory Nightmare*, *supra* note 156, at 1.

self promises an opportunity to create system-wide mechanisms for absorbing shocks such as market or institutional failure triggers. Further, like the financial system, "technology evolves in an unpredictable way"[212] and at a rapid pace. This is particularly true of decentralized ledger technologies, which only first emerged in 2009 and are already disrupting traditional markets and legal structures. Regulation at the decentralized ledger technology level will help avoid "[t]he danger [ ] that [blockchain] technologies as a whole may be cabined to one use case by the development of a specific legal regime, say, payments and money transmission services, and not left open to other potential uses."[213] Further, a functional approach to regulation, once built-in at a code-as-law level, and once supplemented by a formal decentralized consensus mechanism for updating regulation to reflect protocol and software changes in real time,[214] promises to keep pace with the changes in technology and decrease the length of the law lag that presently plagues the decentralized ledger technology industry. Fulfilling these criteria to a high degree is among the key contributions of this regulatory approach, as neither the current landscape nor current alternative proposals feature these characteristics.

A third key contribution of this approach regards minimizing compliance risk and the risk of illicit use.[215] Here, the heart of the regulatory exercise comes into motion: Will regulation seek to minimize such risks via ex ante or ex post measures? What if this dichotomy could be eliminated? If the system incorporates regulation-through-code, self-executing code will be regulatory-compliant, and the choice presented to individual actors will no longer be whether to comply or not, but will merely be whether or not to use the system.[216] When viewed in this light, the prospect of regulating decentralized ledger technology from within raises is-

212. ANTONIO VÁZQUEZ-BARQUERO, ENDOGENOUS DEVELOPMENT: NETWORKING, INNOVATION, INSTITUTIONS AND CITIES 77 (2002).

213. Fairfield, *BitProperty*, *supra* note 13, at 869.

214. I note here that the economic literature occasionally makes reference to a slow pace of endogenous changes. This appears to be a general reference to the time required for the endogenous regulatory effort to take root. I recognize this potential difficulty to the proposed approach and discuss it more fully in *infra* note 219 and accompanying text.

215. It is not presently clear that endogenous regulation will make any further contribution to minimizing data security risk, malfunctions, or related unintended problems other than that which is already present in the protocols. One issue that might be addressed through the functional method inquiry is the issue of privacy of financial information on a public ledger, especially as adoption becomes more widespread, or if mainstream banks adopt use of decentralized ledger technology. For now, however, these criteria are considered a wash—neither enhancing nor detracting from the suitability of the proposed endogenous regulatory approach.

216. See LESSIG, CODE AND OTHER LAWS, *supra* note 159, at 125 ("The code or software or architecture or protocols set these features, which are selected by code writers. They constrain some behavior by making other behavior possible or impossible. The code embeds certain values or makes certain values impossible.").

sues more important to regulatory theory than simply how to approach the regulation of decentralized ledger technology, or the subset of related applications that includes bitcoin. Rather, the possibility of endogenous regulation of decentralized ledger technology raises the possibility of disrupting the regulatory exercise as we know it. This is a particularly distinct possibility in the financial regulation realm for several reasons.

First, as this Article has noted throughout, regulation of decentralized ledger technology poses many of the same challenges as regulation of the financial system. Second, significant financial industry actors are moving to incorporate decentralized ledger technology into the mainstream financial system.[217] If decentralized ledger technology can make an endogenous theory of financial regulation or a functional approach to financial regulation[218] a practical reality and, if it can go a step further to enhance innovation and the ability of regulators to keep pace with such innovation, solving the riddle of how to regulate the blockchain and similar technologies will have far more significant consequences than alleviating the immediate regulatory quagmire facing the businesses in the decentralized ledger technology ecosystem.

C. *Challenges to Implementation and a Call for Further Research*

The above proposal lays out the foundation for pursuing endogenous regulation of decentralized ledger technologies, through a cooperative, iterative process that focuses on the functional purposes for enacting regulation, implemented from within the system requiring regulation. The proposal may, however, face various practical and theoretical challenges to adoption and implementation. First, it is not clear the extent to which endogenous regulation meets the criteria of political feasibility. It may be impossible to know the extent of stakeholder buy-in to the approach until after initial regulatory proposals are presented to the development team for integration into the code. This could pose a powerful practical obstacle to the endogenous regulatory enterprise. As Wright and Filippi explain:

> [T]he open nature of blockchain-based architecture means that most, if not all of the applications deployed on the blockchain could be reproduced and adjusted by anyone, in order to fulfill different functions and satisfy the needs of different groups and communities. As a result, dictating the manner in which software developers design a particular application protocol, or forcing software developers to introduce a particular feature into the code will only work to the extent that the user-base actually

217. *See* Yessi Bello Perez, *8 Banking Giants Embracing Bitcoin and Blockchain Tech*, COINDESK (July 27, 2015), http://www.coindesk.com/8-banking-giants-bitcoin-blockchain/ [https://perma.cc/Z4UK-GPS3].

218. *See generally* Schwarcz, *Functional Approach*, *supra* note 173.

> agrees to switch to the new protocol. Failure to reach consensus amongst users means that software will remain in use.[219]

Another practical challenge to adopting endogenous regulation is the time that it may take to get the cooperative, iterative process up and running, and to put a consensus building mechanism into place that will allow regulators and the core development teams to gauge the political feasibility of any specific regulation being considered for inclusion as regulation-through-code. The economic and development literature both hint at a view that the endogenous approach is a slow method.[220] Such delays may temporarily increase the law lag, but not more so than if no new regulatory approach is taken.

A third challenge to adopting and implementing endogenous regulation of decentralized ledger technology is a theoretical one. Assuming the regulator determines to adopt this proposal for technology-assisted regulation and assuming the regulator uses the functional method to determine that the decentralized ledger technology already contains a mechanism approximating the same function as the real-world regulation intended to be imposed through code-as-law, "how should law regulate" under such circumstances?[221] Should the law change in response to the differences found in the code, "[o]r should the law try to change the features of cyberspace, to make them conform to the law? And if the latter, then what constraints should there be on the law's effort to change cyberspace's 'nature'?"[222]

Each of these challenges makes clear that further research into the practical, technical, and theoretical viability of wide-scale endogenous regulation of decentralized ledger technology is necessary. Further research into the implications of a successful implementation of this approach would also be useful. In particular, further exploration of the impact of technology-assisted regulation, or regulation-through-code, on the ex

---

219. Wright & De Filippi, *supra* note 2, at 57; *see also* Lawrence Lessig, *The Limits in Open Code: Regulatory Standards and the Future of the Net*, 14 BERKELEY TECH. L.J. 759, 764 (1999) ("Whether government can regulate code depends in part upon who controls that code. If the code is closed—controlled by private for-profit organizations—then government's power is assured. But if the code is open—outside of the control of any particular private for-profit organization—then the government's power is threatened."). While evidence suggests that the issue is no longer as black and white as Lessig would lead readers to believe, the point is well taken that the open source nature of decentralized ledger technologies may pose a practical challenge to implementing technology-assisted regulation.

220. *See* Helfer, *supra* note 168, at 665 (describing iterative process proposed here as "endogenous, incremental, and continuous, producing small effects at each individual step but cumulatively resulting in ever deeper levels of cooperation"); *see also* Reiter, *supra* note 168, at 211–14 (describing iterative process as one that occurs over time).

221. Lawrence Lessig, *The Law of the Horse: What Cyberlaw Might Teach*, 113 HARV. L. REV. 501, 505 (1999).

222. *Id.*

ante/ex post dichotomy is warranted in light of industry moves to integrate decentralized ledger technology into the mainstream financial system. Finally, examining whether comparative law's functional method offers some insight into the limits to be imposed upon regulators who elect to use technology-assisted regulation as a policy tool will be critical to ensuring that an endogenous approach to regulation remains cooperative, iterative, and properly focused on function and regulation from within.

V. CONCLUSION

This Article presents a framework for regulating decentralized technology in a holistic, organic, and functional way—an endogenous way. The current patchwork of regulations applied to businesses using decentralized ledger technology is compromised by its inability to adapt to the technology, its inefficient mechanisms for responding to market and governance failures, and its overwhelming tendency to quash innovation in the name of preventing crime and protecting consumers. Alternative regulatory methods proposed to date often fall victim to the same shortcomings. Most such alternative proposals center on regulating payments applications of decentralized technology, such as bitcoin, without regard to the collateral damage caused to other innovative uses of blockchain technology. Proposals that attempt to focus on the novel characteristics of the technology similarly focus on only a subset of novel characteristics, at the expense of the others. To the extent that the present literature discusses decentralized technology through a holistic lens, its inquiry centers on ways new applications (other than payments applications) of decentralized technology may evolve and disrupt the established order. Such literature often bypasses the most pressing current question facing the very innovators who hope to disrupt technology use as we know it: What regulatory approach to the decentralized ledger technology itself can keep pace with innovation while still addressing common market and governance failures? The endogenous theory of regulation proposed in this Article attempts to fill that lacuna.

Importantly, an endogenous approach to regulation will only be effective if each of the relevant stakeholders actively participates. The current regulatory nightmare facing decentralized virtual currencies and decentralized ledger technologies is a result of more than just the mismatch resulting from the application of antiquated laws to revolutionary technology. It also stems from a long history of boisterous, bad industry actors, high volumes of monetary losses suffered by consumers, and unsubstantiated myths regarding the level of anonymity and impunity afforded to criminals using the technology. Dispelling such myths and charting a new industry course will require a collaborative effort between industry actors and regulators. By working together and leveraging the consensus properties of decentralized technologies, industry actors and regulators are well-placed to make technology-assisted regulation, which this Article

submits should be viewed as a practical application of architecture-as-law or code-as-law, a reality. Such endogenous regulation offers unique compliance incentives and stakeholder buy-in that should enable more efficient ex ante regulation while simultaneously reducing the need for expensive coercive enforcement action. Finally, if the endogenous regulation of decentralized ledger technology such as the blockchain proposed in this Article could be achieved, it might pave the way for an entirely new approach to financial regulation: technology-assisted regulation, or regulation-through-code, that bypasses the ex ante/ex post dichotomy and influences actions in real time.