In Code We Trust: Blockchain's Decentralization Paradox

Sangita F. Gazi[*]

ABSTRACT

This Article explores blockchain technology's decentralization and governance challenges. It interrogates the tension between the idea of a trustless, decentralized economy at the core of blockchain's promise and the realities of power concentration and information asymmetry. Examining the ramifications of the Crypto Winter of 2022 on trust and governance within the blockchain ecosystem, the Article also underscores a critical paradox within blockchain ecosystems. It argues that despite the foundational ethos of decentralization and open participation, the governance structures of major blockchain networks manifest significant centralization, challenging the narrative of an egalitarian, user-driven evolution. The current state of blockchain's centralities fundamentally incentivize participants to be opportunistic. In light of the collapse of several blockchain organizations in 2022, this Article highlights the danger of blockchain's centralities. It posits that, without an effective governance regime established by network participants, blockchain's tragedy will continue to destroy the network's valuable resources. Finally, this Article stresses the need to design a fully polycentric blockchain system, from both operational and governance aspects, to incentivize network participants and stakeholders to act in the interest of the community rather than in their own interests.

[*] Postdoctoral Research Fellow, the Wharton School, University of Pennsylvania; Transatlantic Technology Law Fellow, Stanford Law School. Email: sgazi123@wharton.upenn.edu. The Article revises and expands on the paper *Blockchain as Commons: Applying Ostrom's Polycentric Approach to Blockchain Governance*, funded by the Algorand Foundation. I am grateful to Professors Angie Raymond and Madelyn Rose Sanfilippo, the Digital Economist, and the participants, reviewers, and commentators of the 2023 Annual Conference of the Society of Law and Economics (SIDE) conference and the WINIR Young Scholar Workshop 2023 for their insights, comments, and critiques. I thank the editorial team of the Vanderbilt Journal of Entertainment and Technology Law for their exceptional work. All errors are mine.

TABLE OF CONTENTS

Blockchain turned out to be the most rapid recentralization of a decentralized technology that I've seen in my lifetime.[1]

I. INTRODUCTION

In the realm of financial innovation, the advent of Bitcoin—a type of cryptocurrency[2]—has catapulted blockchain technology into the

1. Dan Patterson, *Internet Guru Tim O'Reilly on Web3: "Get Ready for the Crash,"* CBS NEWS (Feb. 22, 2022, 11:09 AM), https://www.cbsnews.com/news/web3-cryptocurrency-nft-tim-oreilly/ [https://perma.cc/74M3-7DXN]; Hillary J. Allen, *DeFi: Shadow Banking 2.0?*, 64 WM. & MARY L. REV. 919, 951 (2023).

2. Professor Kevin Werbach defines cryptocurrency as "digital money secured not through the backing of a state or financial institutions, but through cryptography." Kevin Werbach, *Trust, But Verify: Why the Blockchain Needs Law*, 33 BERKELEY TECH. L.J. 487, 489 (2018) [hereinafter Werbach, *Trust, But Verify*]. For an economic analysis of cryptocurrencies, *see*

forefront of academic and policy discussions.[3] Blockchain technology, while lacking a singular, precise definition,[4] is often characterized as peer-to-peer technology, where data is replicated on an immutable digital ledger and disseminated across the entire network of computer systems.[5] Various scholars define it as a novel "institutional

David Yermack, *Is Bitcoin a Real Currency? An Economic Appraisal*, 2 (Nat'l Bureau of Econ. Rsch., Working Paper No.19747, 2013), https://www.nber.org/system/files/working_papers/w19747/w19747.pdf [https://perma.cc/59JN-3BDS]. For the genesis of cryptocurrency, *see generally* Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, BITCOIN.ORG, https://bitcoin.org/bitcoin.pdf [https://perma.cc/CWH5-B6F8] (last visited Jan. 9, 2025). For a historical context on the cryptography, *see* Stuart Haber & W. Scott Stronetta, *How to Time-Stamp a Digital Document*, *in* ADVANCES IN CRYPTOLOGY 437 (A.J. Menezes & S.A. Vanstone eds., 1991) (providing the very first architecture of blockchain technology that consisted of a cryptographically secured chain of blocks that time-stamped digital documents to ensure that digital documents were immutable and temper-resistant); *see also* Ralph C. Merkle, *A Digital Signature Based on a Conventional Encryption Function*, *in* ADVANCES IN CRYPTOLOGY 369, 370 (Carl Pomerance ed., 1988) (providing the fundamentals of digital signature, which became instrumental in designing the architecture of a cryptography hash); Scott Shackelford & Steve Myers, *Block-by-Block: Leveraging the Power of Blockchain Technology to Build Trust and Promote Cyber Peace*, 19 YALE J.L. & TECH. 334, 338 (2017) (describing how Bitcoin works).

3. *See, e.g.*, Anjee Gorkhali, Ling Li & Asim Shrestha, *Blockchain: A Literature Review*, 7 J. MGT. ANALYTICS 321, 321 (2020). For an overview of the technology and a systematic literature review, *see* T. M. Fernández-Caramés & P. Fraga-Lamas, *A Review on the Use of Blockchain for the Internet of Things*, 6 IEEE ACCESS 32979, 32981 (2018); Matthew P. Ponsford, *A Comparative Analysis of Bitcoin and other Decentralized Virtual Currencies: Legal Regulation in the People's Republic of China, Canada, and the United States*, JOLT DIG. (Nov. 14, 2015), https://jolt.law.harvard.edu/digest/a-comparative-analysis-of-bitcoin-and-other-decentralized-virtual-currencies-legal-regulation-in-the-peoples-republic-of-china-canada-and-the-united-states [https://perma.cc/M3HT-YMFA]; Peter Yeoh, *Regulatory Issues in Blockchain Technology*, 25 J. FIN. REGUL. & COMPLIANCE 196, 196 (2017); Matthias Lehman, *National Blockchain Laws as a Threat to Capital Market Integration*, 26 UNIF. L. REV. 148, 149 (2021); PAUL VIGNA & MICHAEL J. CASEY, THE AGE OF CRYPTOCURRENCY: HOW BITCOIN AND DIGITAL MONEY ARE CHALLENGING THE GLOBAL ECONOMIC ORDER 16 (St. Martin's Press, Inc. ed., 2015) (differentiating blockchain from distributed ledger technology).

4. *See, e.g.*, ARIZ. REV. STAT. ANN. § 44-7061 (2006) (added by 2017 Ariz. Sess. Laws 2417) (defining blockchain technology as "distributed ledger technology that uses a distributed, decentralized, shared and replicated ledger, which may be public or private, permissioned or permissionless, or driven by tokenized crypto economics or tokenless"); Primavera De Filippi, Morshed Mannan & Wessel Reijers, *The Alegality of Blockchain Technology*, 41 POLICY & SOC'Y 358, 359 (2022) (defining blockchain through its characteristics, such as "(a) decentralization, (b) transnationality, (c) tamper-resistance, (d) pseudonymity, (e) lack of coercion, (f) trustlessness, and (g) operational autonomy").

5. PRIMAVERA DE FILIPPI & AARON WRIGHT, BLOCKCHAIN AND THE LAW 2 (Harv. Univ. Press ed., 2018); Douglas Arner, Ross P. Buckley, Dirk Zetzsche, Bo Zhao, Anton N. Didenko, Cyn-Young Park & Emilija Pashoska, *Policy and Regulatory Challenges of Distributed Ledger Technology and Digital Assets in Asia*, *in* CRYPTOASSETS: LEGAL, REGULATORY, AND MONETARY PERSPECTIVES 263, 274 (Chris Brummer ed., 2019); CHRIS JAIKARAN, CONG. RSCH. SERV. R45116, BLOCKCHAIN: BACKGROUND AND POLICY ISSUES (2018); Primavera De Filippi & Samer Hassam, *Blockchain Technology as a Regulatory Technology: From Code is Law to Law is Code*, CORNELL UNIV. COMPUT. & SOC'Y (Jan. 8, 2018, 3:33 PM), https://arxiv.org/pdf/1801.02507 [https://perma.cc/5QVT-W6Y4]; Georgios Dimitropoulos, *The Law of Blockchain*, 95 WASH. L. REV.

technology"[6] that has redesigned the "architecture of trust."[7] Other scholars described the technology based on its technical features, such as a "distributed data structure,"[8] an "encrypted digital database,"[9] or a "decentralized transaction management technology" that stores information into a block.[10] Depending on the access and control, blockchain can be permissioned (i.e., private blockchain)[11] or permissionless (i.e., public blockchain).[12]

1117, 1119 (2020); Thibault Schrepel, *Is Blockchain the Death of Antitrust Law? The Blockchain Antitrust Paradox*, 3 GEO. L. TECH. REV. 281, 287 (2019); Marco Lansiti & Karim Lakhani, *The Truth about Blockchain*, HARV. BUS. REV. (2017), https://hbr.org/2017/01/the-truth-about-blockchain [https://perma.cc/48ZA-9B53].

6. Chris Berg, Sinclair Davidson & Jason Potts, *Capitalism After Satoshi: Blockchains, Dehierarchicalisation, Innovation Policy, and the Regulatory State*, 9 J. ENTREPRENEURSHIP & PUB. POL. 152, 156 (2020); Sinclair Davidson, Primavera De Filippi & Jason Potts, *Blockchain and the Economic Institutions of Capitalism*, 14 J. INST'L ECON. 639, 640 (2017).

7. Werbach, *Trust, But Verify*, *supra* note 2, at 491; *see also* KEVIN WERBACH, THE BLOCKCHAIN AND THE NEW ARCHITECTURE OF TRUST 28 (MIT Press ed., 2023) [hereinafter WERBACH, THE BLOCKCHAIN] (noting the blockchain creates a "trustless trust," citing LinkedIn founder Reid Hoffman).

8. Konstantinos Christidis & Michael Devetsikiotis, *Blockchain and Smart Contracts for the Internet of Things*, 4 IEEE ACCESS 2292, 2293 (2016).

9. Grace Dillon & Hannah Dillon, *Blockchain, the Metaverse, NFTs: Making Web3 Work*, EXCHANGEWIRE (Feb. 1, 2023), https://www.exchangewire.com/blog/2023/02/01/blockchain-the-metaverse-nfts-making-web3-work/#:~:text=Blockchain%20is%20a%20type%20of,a%20permanent%20record%20of%20transactions [https://perma.cc/8F5U-3QU9].

10. Jesse Yli-Hummo, Deokyoon Ko, Sujin Choi, Sooyong Park & Kari Smolander, *Where Is Current Research on Blockchain Technology: A Systemic Review*, PLOS ONE 1, 1 (2016), https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0163477&type=printable [https://perma.cc/S7AC-R7PQ].

11. In a permissioned blockchain, the access and role for each node have to be granted by a central authority. Julien Polge, Jérémy Robert & Yves Le Traon, 7 ICT EXPRESS 229, 229 (2020). Another form of permissioned blockchain is called consortium, which has a controlled access point (example: Hyperledger Fabric). *Id.*; Werbach, *Trust, But Verify*, *supra* note 2, at 498; *see* Vittorio Capocasale, Danilo Gotta & Guido Perboli, *Comparative Analysis of Permissioned Blockchain Frameworks for Industrial Applications*, 4 BLOCKCHAIN: RSCH. & APPLICATIONS 100113, 100113 (2023) (providing a comparative study focusing on the critical aspects, including governance, maturity, support, latency, privacy, interoperability, flexibility, efficiency, resiliency, and scalability, of some of the most commonly utilized permissioned blockchain platforms).

12. Amber Seira, Jeffrey Allen, Cy Watsky & Richard Alley, *Governance of Permissionless Blockchain Networks*, FED. RSRV. (Feb. 9, 2024), https://www.federalreserve.gov/econres/notes/feds-notes/governance-of-permissionless-blockchain-networks-20240209.html [https://perma.cc/PE6E-D3XM] (defining a permissionless blockchain as "a system of the physically distributed computer running a copy of a shared ledger"). For the contrast with permissioned, *see* Roman Beck, Christoph Müller-Bloch & John L. King, *Governance in the Blockchain Economy: A Framework and Research Agenda*, 19 J. ASS'N FOR INFO. SYS. 1020, 1022 (distinguishing blockchain governance mechanisms); Joshua Gans, *Permissioned Versus Permissionless*, *in* THE ECONOMICS OF BLOCKCHAIN CONSENSUS: EXPLORING THE KEY TRADEOFFS IN BLOCKCHAIN DESIGN 51, 51–67 (Palgrave Macmillan ed., 2023) (comparing permissioned and permissionless networks); Andrew Miller, *Permissioned and Permissionless Blockchains*, *in* BLOCKCHAIN FOR DISTRIBUTED SYSTEMS SECURITY, 193, 193 (Sachin Shetty et al. eds., 2019).

Following the global financial crisis of 2008—a period marked by a pervasive erosion of traditional banking systems[13]—blockchain positioned itself as a potent alternative in the financial sector.[14] Since then, it has been heralded as "[t]he technology most likely to change the next decade in business."[15] The various offshoots of this technology, such as smart contracts,[16] decentralized applications (dApps),[17] and decentralized autonomous organizations (DAOs),[18] cumulatively

13. For an overview of the global financial crisis, *see* Steven L. Schwartz, *Protecting Financial Markets: Lessons from the Subprime Mortgage Crisis*, 93 MINN. L. REV. 373, 375 (2008); Timothy C. Earle, *Trust, Confidence, and the 2008 Global Financial Crisis*, 29 RISK ANALYSIS 785, 785 (2009) (analyzing the loss of trust and confidence in the context of the global financial crisis and risk management); Zuzana Fungáčová, Eeva Kerola & Laurent Weill, *Does Experience of Banking Crises Affect Trust in Banks*, 62 J. FIN. SERV. RSCH. 61, 61 (2022); Catherine R. Schenk, *The Global Financial Crisis and Banking Regulation: Another Turn of the Wheel*, 19 J. MOD. EUR. HIST. 8, 8 (2021) (drawing on the historical context to analyze the effect of trust in banks following financial crises).

14. Douglas W. Arner, Dirk A. Zetzshe, Ross P. Buckley & Jaimieson L. Kirkwood, *The Financialization of Crypto* 1, 2 (2023) (manuscript, https://www.sciencedirect.com/science/article/pii/S0267364924000372 [https://perma.cc/4VBE-8N6T]; Vitalik Buterin, *Forward* to WILLIAM MOUGAYAR, THE BUSINESS BLOCKCHAIN: PROMISE, PRACTICE, AND THE APPLICATION OF THE NEXT INTERNET TECHNOLOGY (John Wiley & Sons, Inc. eds., 2016).

15. Don Tapscott & Alex Tapscott, *The Impact of the Blockchain Goes Beyond Financial Services*, HARV. BUS. REV. (May 10, 2016), https://hbr.org/2016/05/the-impact-of-the-blockchain-goes-beyond-financial-services [https://perma.cc/NL3N-YGBA]; *cf.* Kevin Werbach, *Why Blockchain Isn't a Revolution*, KNOWLEDGE WHARTON (June 20, 2018), https://knowledge.wharton.upenn.edu/article/blockchain-isnt-revolution/ [https://perma.cc/B56X-TR9U] (arguing that there are costs and catches for blockchain to be "true" revolutionary and "the costs involve a very slow network with limited functionality that wastes massive amount electricity," while the original mechanisms work only for a small group of people preventing them from "climb[ing] to the mainstream").

16. A smart contract is a digital protocol that automatically executes and enforces the terms of a contract, based on predefined rules, on a blockchain network. *See generally* Max Raskin, *The Law and Legality of Smart Contracts*, 1 GEO. L. TECH. REV. 305, 319 (2017). The term "smart contract" was coined by cryptographer Nick Szabo in the 1990s. *See* Nick Szabo, *Formalizing and Securing Relationships on Public Networks*, FIRST MONDAY (Sept. 1, 1997), https://firstmonday.org/ojs/index.php/fm/article/view/548/ [https://perma.cc/6WNM-MWRS]; Kevin Werbach, *Contracts Ex Machina*, 67 DUKE L.J. 313, 314 n.2 (2017); Chris Brummer, *Disclosure, Dapps, and DeFi*, 5 STAN. J. BLOCKCHAIN & POL'Y 137, 141 (2022) (illustrating that smart contracts can operate outside the crypto market).

17. *See generally* Brummer, *supra* note 16 ("[dApps] enable[] new forms of control for consumers insofar as they do not have to hand over personal data to the company providing the service.").

18. There is no uniform definition of DAOs. DAOs are described as "blockchain-based applications for the automated execution of governance process." Olivier Rikken, Marjin Janssen & Zenlin Kwee, *The Ins and Outs of Decentralized Autonomous Organizations (DAOs) Unraveling the Definitions, Characteristics, and Emerging Developments of DAOs*, 4 BLOCKCHAIN: RSCH. & APPLICATIONS 100143, 100143 (2023); *see* Alyssa Hertig, *What is a DAO?*, COINDESK (Jan. 17, 2023, 5:36 AM), https://www.coindesk.com/learn/what-is-a-dao/ [https://perma.cc/SMP3-TRE9] (describing DAO as a "blockchain-based form of organization or company"); Madhusudan Singh & Shiho Kim, *Blockchain Technology for Decentralized Autonomous Organizations*, 115 ADVANCES

contributed to building a new alternative financial system popularly known as Decentralized Finance (DeFi).[19]

With its popularization through Bitcoin, blockchain has drawn the attention of both enthusiasts and skeptics. Enthusiasts argue that blockchain brought a "technological revolution," disrupting the current state of market-based capitalism.[20] Indeed, blockchain supports the creation of a trustless economy[21] where transactions and interactions

IN COMPUTS. 117, 119 (2019) (explaining, as opposed to centralized autonomous organization, "with only an elite group of best managers," DAOs operate in a coded environment "without human involvement"); Gail Weinstein, *A Primer on DAOs*, HARV. L. SCH. F. ON CORP. GOVERNANCE (Sept. 17, 2022), https://corpgov.law.harvard.edu/2022/09/17/a-primer-on-daos/ [https://perma.cc/TEQ6-PAWY] (explaining DAOs are the "digital universe" founded on the principles of "decentralization, autonomous functioning, transparency, and bottom-up principles"); Ying-Ying Hsieh, Jean-Philippe Vergne, Philip Anderson, Karim Lakhani & Markus Reitzig, *Bitcoin and the Rise of Decentralized Autonomous Organizations*, 7 J. ORG. DESIGN 1 (2018) (describing Bitcoin as a first DAO).

19. For a general definition of Decentralized Finance, *see* Fabian Schär, *Decentralized Finance: On Blockchain and Smart Contract-Based Financial Markets*, 103 FED. RESERVE BANK ST. LOUIS REV. 153, 153 (2021) (explaining DeFi usually refers to "an open, permissionless, and highly interoperable protocol stack built on public smart contract platforms"); *see also* Dirk A. Zetzsche, Douglas W. Arner & Ross P. Buckley, *Decentralized Finance*, 6 J. FIN. REG. 172, 173–74 (2020) (explaining DeFi is an overarching term used to suggest the "decentralized provision of financial services through a mix of infrastructure, markets, technology, methods, and applications."). The underpinning technologies concerning DeFi are artificial intelligence, blockchain, data, and cloud computing. *Zetsche et al.,* supra. For a general overview of DeFi, *see* Igor Makarov & Antoinette Schoar, *Cryptocurrencies and Decentralized Finance (DeFi)*, (NAT'L BUREAU ECON. RSCH., Working Paper No. 30006, 2022) (discussing potential benefits and challenges of the DeFi system, which has the potential to reduce transaction costs and at the same time, can impose challenges to enforce "tax compliance, anti-money laundering laws, and preventing financial malfeasance"); *cf.* Nic Carter & Linda Jeng, DeFi Protocol Risk: The Paradox of DeFi 1 (June 14, 2021) (unpublished manuscript) (on file with the Social Science Research Network) (highlighting the risks of DeFi). The Carter and Jeng paper argues that DeFi demonstrates novel financial risks, such as interconnections with the traditional system, operational risks, governance, and regulatory risks, etc. *Carter & Jeng, supra.* It is argued that "[t]he growth of DeFi will depend on its ability to navigate and build with traditional finance and on how laws and regulations respond." *Id.*

20. Berg et al., *supra* note 6.

21. Generally, "trustless" means the absence of a central authority in validating and approving a transaction. Dominik Harz & Magnus Boman, *The Scalability of Trustless Trust*, *in* FIN. CRYPTOGRAPHY & DATA SEC. 279, 279 (Aviv Zohar et al., eds., 2018). For an examination of "trustlessness" in different contexts, *see* Vanessa Bracamonte & Hitoshi Okada, *The Issue of User Trust in Decentralized Applications Running on Blockchain Platforms*, IEEE INT'L SYMP. ON TECH. & SOC'Y 1, 3 (2017) (analyzing trustlessness from a user's perspective and positing that while decentralized applications' websites like Bitcoin and Ethereum refer to trustlessness, oftentimes the developers have significant control in the characterization of such an element in their systems)*; see also* Usman W. Cohan, *Are Cryptocurrencies Truly Trustless?*, *in* CRYPTOFINANCE AND MECHANISMS OF EXCHANGE 77, 77 (Stéphane Goutte, Khaled Guesmi & Samir Saadi eds., 2020) (positing that trustlessness in the field of cryptocurrencies is nuanced, as it demonstrates human intervention in a variant degree; arguing—through drawing on the examples of hard forks, cryptocurrency exchanges, the distribution of Initial Coin Offerings (ICOs), and investors' participation—that the alleged

are not dependent on centralized authorities or middlemen, thus creating a more equitable and decentralized framework for economic activities.[22] Further, the evolution of DeFi has challenged the orthodox concept of fiat money, banking, and the established notion of a third-party intermediated capital market system.[23] DeFi has radically altered our perception of how we exchange value, transfer ownership, and verify transactions.[24] Enthusiasts also argue that blockchain is a tool to break ties from tyranny[25] and liberate individuals from conventional legal systems, which often disproportionately benefit corporations and governments.[26]

On the other hand, critics argue that the blockchain network is just another form of market capitalism disguised as a means for private profit generation.[27] Blockchain's anarcho-capitalist political structure "encourages scarcity and competition," gives rise to "oligarchy and

trustlessness, in reality, requires "both direct human intervention and direct human participation"). Reid Hoffman coined the term "trustless trust." *See* Charlotte Ducuing, *How to Make Sure My Cryptokitties Are Here Forever? The Complementary Roles of Blockchain and the Law to Bring Trust*, 10 EUR. J. RISK REG. 315, 316 n.5 (2019). Alternatively, on human involvement in a trustless system, *see* Gili Vidan & Vili Lehdonvirta, *Mine the Gap: Behind and the Maintenance of Trustlessness*, 21 SAGEPUB J. 42, 45 (2019) (delving into the nuances of "trustlessness" and describing the "discursive" nature of the code involving the apparent indivisible human actors). These discursive moves, such as "conflating people with devices, assuming subjects to be self-interested rational individuals, appealing to technical expertise, and explaining contradiction as temporary bugs," often undermine the intensity of human intervention required in a blockchain protocol. *Id.*

22. Nakamoto, *supra* note 2.

23. *E.g.*, Salue Omarova, *The People's Ledger: How to Democratize Money and Finance the Economy*, 74 VAND. L. REV. 1231, 1234–45 (2021) (arguing on the concept of democratization of finance using the case of central bank digital currency).

24. *See generally* DON TAPSCOTT & ALEX TAPSCOTT, BLOCKCHAIN REVOLUTION: HOW THE TECHNOLOGY BEHIND BITCOIN AND OTHER CRYPTOCURRENCIES IS CHANGING THE WORLD (Penguin Random House ed., 2018) (providing a comprehensive exploration of blockchain's transformative potential across various sectors of the economy and society); Jei Young Lee, *A Decentralized Token Economy: How Blockchain and Cryptocurrency can Revolutionize Business*, 62 BUS. HORIZONS 773, 774 (2019) (discussing the creation, valuation, and application of blockchain-generated tokens and highlighting their benefits, such as increased liquidity and automated transactions).

25. Chelsea Gohd, *Why a Respected CEO Believes "Bitcoin is a tool for Freeing Humanity,"* FUTURISM (July 12, 2017), https://futurism.com/why-a-respected-ceo-believes-bitcoin-is-a-tool-for-freeing-humanity [https://perma.cc/V9X8-JQZS].

26. WERBACH, THE BLOCKCHAIN, *supra* note 7, at 3.

27. Berg et al., *supra* note 6, at 160; Boris Korneychuk, *The Political Economy of the Blockchain Society*, *in* DIGITAL TRANSFORMATION AND GLOBAL SOCIETY 317, 318 (Daniel A. Alexandrov et al. eds., 2018); *cf.* Vasilis Kostakis & Chris Giutitsas, *The (A)Political Economy of Bitcoin*, 12 TRIPLEC: COMMC'N, CAPITALISM & CRITIQUE 432, 436 (2014) (challenging the view of blockchain as a means to create a distributed capitalism and instead indicating thatit has given rise to "capitalist opportunism" among the early Bitcoin adopters).

crises," and facilitates "excessive capital accumulation."[28] Such a dynamic can only intensify social inequalities, particularly by providing disproportionate advantages to early adopters and manipulators who leverage the novel architecture of the technology to devise a "get-rich-quick scheme."[29]

The integration of blockchain technology into the cryptocurrency market has not been without its share of controversies. Cryptocurrencies' notorious price volatility and speculative use have led to cryptocurrencies being labeled as a "Ponzi scheme,"[30] "criminal,"[31] and "overhyped"[32] in various circles. This reputation further complicates the perception of blockchain technology as its most famous application; cryptocurrency has become a subject of intense debate and scrutiny.[33] Ironically, cryptocurrency exchanges[34] have ended up

28. John Flood & Lachlan Robb, Trust, Anarcho-Capitalism, Blockchain, and Initial Coin Offerings 4 (Research Paper No. 17–23, 2017, Griffith Law School), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3074263 [https://perma.cc/8PCU-6X65]; VASILIS KOSTAKIS & MICHEL BAUWENS, NETWORK SOCIETY AND FUTURE SCENARIOS FOR A COLLABORATIVE ECONOMY 33–34 (Palgrave McMillan ed., 2014).

29. Naval Ravikant (@naval), TWITTER (Jan. 23, 2018), https://twitter.com/naval/status/955998687670411264?lang=en [https://perma.cc/5UYS-N5JE] (cited in WERBACH, THE BLOCKCHAIN , *supra* note 7, at 3).

30. Chlore Taylor, *Jamie Dimon Calls 'Dangerous' Crypto a 'Decentralized Ponzi Scheme' That's not 'Good for Anybody',* FORTUNE (Sept. 22, 2022), https://fortune.com/2022/09/22/jpmorgan-jamie-dimon-dangerous-crypto-decentralized-ponzi-scheme-not-good-for-anybody/ [https://perma.cc/EN7B-VBC5].

31. Sen. Elizabeth Warren (D-MA), during a Senate Banking Committee hearing, stated: "The only true use case for it is criminals, drug traffickers . . . money laundering, tax avoidance." Jeff Cox, *Jamie Dimon Lashes Out against Crypto: "If I was the Government, I'd Close it Down*," CNBC (Dec. 6, 2023), https://www.cnbc.com/2023/12/06/jamie-dimon-lashes-out-on-crypto-if-i-was-the-government-id-close-it-down.html [https://perma.cc/CNT7-2V88]; Nolan D. McCaskill, *'Financial Criminals Love Crypto' and Other Takeaways from a Senate Hearing on Cryptocurrency*, L.A. TIMES (Feb. 14, 2023), https://www.latimes.com/politics/story/2023-02-14/financial-criminals-love-crypto-and-other-takeaways-from-a-senate-hearing-on-cryptocurrency [https://perma.cc/688R-T9CU].

32. Aino Nordgren, Ellen Weckstrom, Minna Martikainen & Othmar M. Lehner, *Blockchain in the Fields of Finance and Accounting: A Disruptive Technology or an Overhyped Phenomenon*, 8 ACRN J. FIN. & RISK PERSP. SPECIAL ISSUE DIG. ACCT. 47, 47 (2019).

33. *See* Rebecca M. Bratpies, *Cryptocurrency and the Myth of the Trustless Transaction*, 25 MICH. TECH. L. REV. 1, 6, 50 (2018) (analyzing the DAO hack and thefts, testing cryptocurrencies' trustless claim, and concluding that cryptocurrency compels users to trust "less transparent, less reliable, and less accountable parties"); *see also* David Z. Morris, *CoinDesk Turns 10: 2016 – How The DAO Hack Changed Ethereum and Crypto*, COINDESK (May 15, 2023, 11:22 AM), https://www.coindesk.com/consensus-magazine/2023/05/09/coindesk-turns-10-how-the-dao-hack-changed-ethereum-and-crypto/ [https://perma.cc/SG9S-6PU9]; Steve Stecklow, Alexandra Harney, Anna Irrera & Jemima Kelly, *Chaos and Hackers Stalk Investors on Cryptocurrency Exchanges*, REUTERS (Sept. 29, 2017, 10:00 AM), https://www.reuters.com/investigates/special-report/bitcoin-exchanges-risks/ [https://perma.cc/59PS-EMSE].

34. A cryptocurrency exchange is a "kind[] of platform[]" designed to facilitate the opening of cryptocurrency accounts, trading between wallets, and conversion to fiat

functioning as a new type of intermediary[35] as opposed to the original vision of disintermediation.[36] The lack of disintermediation in blockchain leads to centralization risks, with power concentrating in a few dominant nodes or entities.[37] This creates a paradox of trustlessness: while aiming to eliminate intermediaries, users often end up trusting specific nodes or mining pools, inadvertently creating new centralized points of trust.[38] As a result, the system is susceptible to security breaches, selfish behavior, and manipulation.[39] Even within the DAOs, "decentralization" has become a hype[40] or "incomplete ambition"[41] that suffers from "significant collective action problems" and "expos[es] investors to catastrophic regulatory and governance risks."[42] The centralization of blockchain goes against blockchain's promise of democratization of finance and equal access, which could create inefficiencies and inequalities within the blockchain ecosystem.[43]

The paradox of public blockchain's decentralization has garnered significant interest in academic literature.[44] This discussion

currencies. Rashi Maheshwari, *What are Crypto Exchanges and How Do They Work*, FORBES (Jan. 10, 2024, 2:54 PM), https://www.forbes.com/advisor/in/investing/cryptocurrency/what-is-a-crypto-exchange/ [https://perma.cc/ZQ5Z-WECF].

35. Bratpies, *supra* note 33, at 19.

36. Nakamoto, *supra* note 2.

37. Bratpies, *supra* note 33, at 26.

38. *Id.*

39. Werbach, *Trust, But Verify*, *supra* note 2, at 494.; *See generally* Stefan Scharnowski & Yanghua Shi, Bitcoin Blackout: Proof-of-Work and the Centralization of Mining (Nov. 10, 2022) (unpublished manuscript) (on file with the Social Science Research Network) (analyzing centralization of mining activities on cryptocurrency exchanges and identifying "higher exchange rate volatility, lower liquidity, and larger price differences between exchanges").

40. Justin Sherman, *Those Hyping Blockchain Need to Learn Internet History*, TECH POL'Y PRESS (Jan. 11, 2023), https://www.techpolicy.press/those-hyping-blockchain-need-to-learn-internet-history/ [https://perma.cc/54K4-BJU6].

41. Nathan Schneider, *Decentralization: An Incomplete Ambition*, 12 J. CULTURAL ECON. 265, 265 (2019).

42. Carla L. Reyes, Nizan G. Packin & Ben Edwards, *Distributed Governance*, 59 WM & MARY L. REV. ONLINE 1, 1 (2017).

43. *See* Schneider, *supra* note 41, at 279.

44. For an overview of the mainstream discussion on decentralization in permissionless blockchains, *see* Angela Walch, *Deconstructing "Decentralization": Exploring the Core Claim of Crypto Systems*, *in* CRYPTOASSETS: LEGAL, REGULATORY, AND MONETARY PERSPECTIVES 39, 41–47 (Chris Brummer ed., 2019) [hereinafter Walch, *Deconstructing Decentralization*]. For an overview of different elements of blockchain's purported decentralization, *see* Arati Baliga, *Understanding Blockchain Consensus Models*, PERSISTENT (Apr. 2017), http://phd.artsedighi.com/wp-content/uploads/2017/09/WP-Understanding-Blockchain-Consensus-Models.pdf [https://perma.cc/8JRW-6EYP] (providing an overview of the consensus model); Juri Mattila, *The Blockchain Phenomenon – The Disruptive Potential of Distributed Consensus Architectures* 19 (The Rsch. Inst. of the Finnish Econ., ELTA Working Paper No. 38, 2016) (providing an overview of technology stacks underlying permissioned and

primarily revolves around the inherent centralization found within the protocol design, system architecture, and consensus model.[45] Often, these centralities emerge inadvertently[46] in the governance and the decision-making process, culminating in the disproportionate accumulation of wealth and power among a select few individuals or entities.[47] Scholars emphasize the importance of following legal frameworks and accountability principles in blockchain systems, as these systems need robust trust.[48] Any breach of trust may potentially jeopardize the sustainability of a blockchain system. This hypothesis manifested in several shutdowns of cryptocurrency exchanges in recent years.[49]

---

permissionless blockchain architectures); Sinclair Davidson, Primavera De Filippi & Jason Potts, Economics of Blockchain 5, 10 (2016) (unpublished manuscript) (on file with the Social Science Research Network) (arguing that blockchain's decentralization may resemble a traditional market economy; however, it can facilitate smart contracts and automated execution, which help mitigate market "opportunism" by "eliminating the need for trust"); *see generally* Primavera De Filippi, The Interplay Between Decentralization and Privacy: The Case of Blockchain Technologies 4 (2016) (unpublished manuscript) (on file with the Social Science Research Network) (arguing that blockchain's decentralized infrastructure does not necessarily promote more robust privacy and autonomy and, if not designed properly, blockchain could be dangerous to entities using the technology).

45. *E.g.*, Arthur Geravis, Ghassan O. Karame, Vedran Capkun & Srdjan Capkun, *Is Bitcoin a Decentralized Currency?*, 12 IEEE SEC. & PRIV. 54, 60 (2014) (discussing the centralization tendencies in bitcoin protocol design and mining ecosystem); Primavera De Filippi & Benjamin Loveluck, *The Invisible Politics of Bitcoin: Governance Crisis of a Decentralized Infrastructure*, 5 INTERNET POL'Y REV. 3, 3 (2016) (examining the centralization in Bitcoin's governance system); Yujin Kwon, Hyoungshick Kim, Jinwoo Shin & Yongdae Kimet, *Bitcoin vs. Bitcoin Cash: Coexistence or Downfall of Bitcoin Cash?,* IEEE SYMP. ON SEC. & PRIV. 935–51 (2019) (discussing centralization risks in consensus models of Bitcoin and Bitcoin Cash).

46. For an overview of blockchain's unintended centralities in the design architecture, *see* Evan Sultanik, Alexander Remie, Felipe Manzano, Trent Brunson, Sam Moelius, Eric Kilmer, Mike Myers, Talley Amir & Sonya Schriner, *Are Blockchains Decentralized? Unintended Centralities in Distributed Ledgers, Defense Technical Information Center*, TRAIL BITS 1, 3–4 (2022) (providing an analytical overview of DLT's centralities in governance, consensus, incentive-structure, topology, network distribution, and software architecture, and arguing "[e]very blockchain has a privileged set of entities that can modify the semantics of the blockchain to potentially change past transaction").

47. *See* Sami Ben Mariem, Pedro Casas, Matteo Romiti, Benoit Donnet, Rainer Stütz & Bernhard Haslhofer, *All that Glitters is Not Bitcoin – Unveiling the Centralized Nature of the BTC (IP) Network*, ARXIV ONLINE (Feb. 19, 2020), https://arxiv.org/abs/2001.09105 [https://perma.cc/NYX8-PTGL] (showing 4.5% of Bitcoin holders control 85% of Bitcoin).

48. WERBACH, THE BLOCKCHAIN, *supra* note 7, at 116, 173.

49. *See* Taylor Moore & Nicolas Christin, *Beware the Middleman: Empirical Analysis of Bitcoin-Exchange Risk*, *in* FIN. CRYPTOGRAPHY AND DATA SEC., 25 (Springer ed., 2013). Given centralization in the Bitcoin ecosystem, counterparty risk has become substantial. Rainer Böhme, Nicolas Christin, Benjamin Edelman & Tyler Moore, *Bitcoin: Economics, Technology, and Governance*, 29 J. ECON. PERSP. 213, 226 (2015). These exchanges, often acting as quasi-banks, pose risks to users who convert their currency to Bitcoin and leave it within the exchange. *Id.*

The latest debacles are the events of the Crypto Winter of 2022,[50] where major cryptocurrency entities like Futures Exchange Trading Ltd. (FTX), Terraform Labs (Terra), Celsius Network LLC (Celsius), and Genesis Global Trading, Inc. (Genesis) met their downfall.[51] Amidst many irregularities, the shocking revelation was crypto executives' reckless gamble and risky behavior, leaving billions of dollars in community resources shattered and damaging blockchain's reputation and reliability.[52] However, this fiasco was not just a financial disaster—it was a betrayal of trust to crypto communities and consumers. This sequence of events eventually prompted intervention from the United States Congress, thereby exposing the fallacy embedded in the perceived decentralization of blockchain systems.[53]

The crisis also demonstrated the risk of opportunism[54]—a governance hazard that usually refers to untrustworthy management behavior contrary to shareholder interests.[55] In the context of blockchain, opportunism arises when a blockchain network's centralized power structure has the intent and ability to exploit trust or centralities in the protocol's design and disregards the community's interest.[56] In the FTX and Terra collapses, the founding teams and

---

50. For a general analysis of the cause and impacts of the crypto winter, *see* Arner et al., *supra* note 14.

51. *See* discussion *infra* Section III.B.2.

52. Trisha Ray, *The Crypto Winter: FTX and the Crisis of Trust*, OBSERVER RSCH. FOUND. (Dec. 4, 2022), https://www.orfonline.org/expert-speak/the-crypto-winter-ftx-and-the-crisis-of-trust [https://perma.cc/FUU5-6PZL]; David McCabe & Ephrat Livni, *FTX Chief: Company Appeared to Use 'Old-Fashioned Embezzlement'*, N.Y. TIMES (Dec. 15, 2022), https://www.nytimes.com/2022/12/13/technology/ftx-crypto-hearing.html [https://perma.cc/CF78-6P58].

53. H.R. Comm. on Fin. Serv's, *Notice of Hearing*, CONGRESS.GOV (Dec. 6, 2022), https://www.congress.gov/117/meeting/house/115246/documents/HHRG-117-BA00-20221213-SD001.pdf [https://perma.cc/U5VZ-HNEJ]. For the full testimony on the FTX collapse, *see* John Ray III, *Investigating the Collapse of FTX, Part I*, YOUTUBE (Dec. 13, 2022), https://www.youtube.com/watch?v=rWAnrigAO3I [https://perma.cc/S7S2-3D4Y]; David Streitfeld, *Sam Bankman-Fried's Wild Rise and Abrupt Crash*, N.Y. TIMES (Nov. 2, 2023), https://www.nytimes.com/2023/11/02/technology/sam-bankman-fried-rise-crash.html [https://perma.cc/TPK8-QJGN]; *see also Crypto Crash: Why the FTX Bubble Burst and the Harm to Consumers*: *Hearing on Examining the Failure of the Non-U.S. and U.S. Based FTX Crypto Exchanges and the Fallout Affecting Other Crypto and Financial Firms Before the S. Comm. on Banking, Hous., & Urban Affairs*, 117th Cong. 4 (2022).

54. In the words of Professor Werbach, "'opportunism' means violating the spirit, but not necessarily the letter, of an agreement by taking advantage of asymmetric information." WERBACH, THE BLOCKCHAIN, *supra* note 7, at 24.

55. *Id.*; Axel V. Werder, *Corporate Governance and Stakeholder Opportunism*, 22 ORG. SCI. 1345, 1345 (2011).

56. *Cf.* Davidson et al., *supra* note 44, at 10 (drawing on Williamson's model of opportunism and arguing blockchains could be "a mechanism to control opportunism by eliminating the need for trust by using crypto-enforced execution of an agreed contract through consensus and transparency").

senior management demonstrated opportunistic behaviors by capitalizing on information asymmetry and exploiting consumer trust.[57] For example, in the complaint lodged before the US District Court for the Southern District of New York, the Security Exchange Commission (SEC) alleged that, before the collapse of Terra's blockchain protocol, its CEO moved over 10,000 Bitcoin from Terra's platform to a Swiss bank account and converted them to fiat currency.[58] In a similar vein, FTX clandestinely lent billions of dollars from customers' funds to its sister company, Alameda Research, without a whisper of disclosure to the very customers entrusting FTX with their assets.[59]

A fundamental issue underpinning the tumultuous landscape of the cryptocurrency market is the decentralization dilemma.[60] Decentralization is often associated with blockchain's resilience and ability to operate without the "concentration of power."[61] It is also represented in blockchain's "trustless" nature.[62] Blockchain relies on automated, code-driven operation and decision-making processes in which various actors[63] are organized in a distributed manner and able to act without trusting one another.[64]

However, reality reveals the opposite—the governance of blockchain networks falls into the hands of a select few, thereby concentrating power, exacerbating centralization, and jeopardizing the

---

57. Usman Chohan, FTX, Sam Bankman-Fried, and the Cryptoexchange Problem 2–3 (Jan. 19, 2023) (unpublished manuscript) (on file with the Social Science Research Network), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4326161 [https://perma.cc/2B8U-VDS3].

58. Turner Wright, *Do Kwon Removed 10K Bitcoin from Terra After Collapse – Takeaways from SEC Complaint*, COINTELEGRAPH (Feb. 17, 2023), https://cointelegraph.com/news/do-kwon-removed-10k-bitcoin-from-terra-after-collapse-takeaways-from-sec-complaint [https://perma.cc/WBW3-CW3D]. For the full complaint, *see* Complaint, S.E.C. v. Terraform Labs PTE Ltd. & Do Hyeong Kwon, No. 1:23-cv-1346 (S.D.N.Y 2023).

59. For example, in the declaration filed in the FTX bankruptcy proceedings, John J. Ray III states: "The FTX Group did not maintain centralized control of its cash. Cash management procedural failures included the absence of an accurate list of bank accounts and account signatories, as well as insufficient attention to the creditworthiness of banking partners. Under my direction, the Debtors are establishing a centralized cash management system with proper controls and reporting mechanisms . . . The Debtors have also been unable to locate many of Alameda's assets, and it is not clear what Alameda did with the billions of dollars that FTX lent to it." John J. Ray, Declaration of John J. Ray III in Support of Chapter 11 Petitions and First Day Pleadings at 18, 24, *In re* FTX Trading Ltd., et al., No. 22-11068-JTD (U.S. Bankr. D. Del. 2022).

60. *See* Walch, *Deconstructing Decentralization*, *supra* note 44, at 47 ("[N]o one knows what 'decentralization' means.").

61. *Id.* at 41.

62. *See* De Filippi & Loveluck, *supra* note 45.

63. Various actors include core developers, node-runners or mining-pool operators, foundations or investors, and users.

64. Harz & Boman, *supra* note 21.

sustainability and integrity of these networks.[65] The Crypto Winter of 2022 underscored the need for a more robust and accountable governance framework in blockchain and cryptocurrency.[66] The event challenged the previously unassailable notion of inherent decentralization within the blockchain paradigm.[67] Thus, solving blockchain's centralization issues is critical to its continued success.

In Section III, this Article argues for an application of Nobel laureate Elinor Ostrom's polycentric[68] approach to resolving blockchain's centralities and governance problems.[69] Originally propounded by the economist Vincent Ostrom and his peers, who studied the realization of decentralization in public administration, polycentricity in their work refers to a "system-wide coordination" of multiple decision centers" that "constitute[s] a collective good of a value."[70] Vincent Ostrom's three-prong polycentricity comprises: (1) multiple autonomous decision-making centers; (2) a coherent system where participants choose to act in ways to take account of others through the process of cooperation, competition, and conflict; and (3) the presence of a conflict resolution mechanism.[71] Drawing on Vincent

---

65. De Filippi & Loveluck, *supra* note 45, at 7.

66. *See generally* Douglas Arner, Dirk A. Zetzshe, Ross P. Buckley & Jamieson M. Kirkwood, The Financialization of Crypto: Lessons from FTX and the Crypto Winter of 2022-2023 1 (2023) (unpublished manuscript) (on file with the Social Science Research Network), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4372516 [https://perma.cc/4KNQ-7VDN] ("[I]n many so-called DeFi business models crucial elements of the set-up and governance are centralized.").

67. *See, e.g.*, Nakamoto, *supra* note 2.

68. According to the Oxford English Dictionary, "polycentric" refers to "having several or many centres." *Polycentric*, OXFORD ENG. DICTIONARY (July 2023), https://doi.org/10.1093/OED/7730574142 [https://perma.cc/8AEF-4EAA].

69. *Infra* Part III.

70. Vincent Ostrom, Charles M. Tiebout & Robert Warren, *The Organization of Government in Metropolitan Areas: A Theoretical Inquiry*, 55 AM. POL. SCI. REV. 831, 832 (1961). *See generally* Michael McGinnis & Elinor Ostrom, *Reflections on Vincent Ostrom, Public Administration, and Polycentricity*, 72 PUB. ADMIN. REV. 15, 15 (2012) (reflecting on Vincent Ostrom's early works and tracing into the origin of "polycentricity" as a concept). Vincent Ostrom suggests that polycentric governance was first introduced by Michael Polanyi in his book *The Logic of Liberty* in 1951. *See* Vincent Ostrom, *Annual Meeting of the American Political Science Association, Sept. 5-9, 1972*, 6, *in* POLYCENTRICITY AND LOCAL PUBLIC ECONOMIES 52, 57, 59 (Michael McGinnis ed., 1999).

71. Ostrom et al., *supra* note 70, at 831; McGinnis & Ostrom, *supra* note 70, at 15; Krister P. Andersson & Elinor Ostrom, *Analyzing Decentralized Resource Regimes from a Polycentric Approach*, 4 POL'Y SCI. 71, 73 (2008); Elinor Ostrom, *Beyond Markets and States: Polycentric Governance of Complex Economic Systems*, 100 AM. ECON. REV. 641, 643 (2010) [hereinafter Ostrom, *Beyond Markets and States*]; *see also* Andrea Gatto, *Polycentric and Resilient Perspectives for Governing the Commons: Strategic and Law and Economic Insights for Sustainable Development*, 51 AMBIO 1921, 1921–22 (2022) (proposing a framework for the governance of the commons, where resilience and polycentricity are detected as principal assets to ensure sustainable natural resource users). For polycentricity in the context of blockchain, *see generally*

Ostrom's work, Elinor Ostrom later applied the polycentricity framework to natural resources management, which highlighted the idea's flexibility and applicability beyond its original use in public administration.[72] Ostrom reformulates the theory by defining polycentricity as "a complex system of powers, incentives, rules, values, and individual attitudes combined in a complex system of relationships at different levels."[73] It embodies a "bottom-up approach" that allows members to self-govern and manage common resources in a shared community.[74] After years of research and experimentation, Ostrom provided a set of design principles and strategies (known as Ostrom's design principles)[75] that members can use to curate rules, responsibilities, enforcement, and conflict-mitigating mechanisms in a polycentric system.[76] The underpinning rationale is to encourage members to act cooperatively and foster sustainable use and management of common resources.[77]

In the context of blockchain, a polycentric governance structure would bring together diverse stakeholders.[78] Polycentricity suggests that sustainable management of blockchain's shared resources can be

---

Scott J. Shackleford & Steve Myers, *Block-by-Block: Leveraging the Power of Blockchain Technology to Build Trust and Promote Cyber Peace*, 19 YALE J.L. & TECH. 334, 336 (2017).

72. Elinor Ostrom, *Polycentric Systems for Coping with Collective Action and Global Environmental Change*, 20 GLOB. ENV'T CHANGE 550, 552 (2010); Marcel J. Dorsch & Christian Flachsland, *A Polycentric Approach to Global Climate Governance*, 17 GLOB. ENV'T POL. 45, 47 (2017).

73. Paul D. Aligica & Vlad Tarko, *Polycentricity: From Polanyi to Ostrom, and Beyond*, 25 GOVERNANCE 237, 247 (2011).

74. Ostrom, *Beyond Markets and States*, *supra* note 71, at 650. For a definition of the bottom-up approach, *see* Mark Pennington, *Elinor Ostrom and the Robust Political Economy of Common-Pool Resources*, 9 J. INST. ECON. 449, 455 (2013) (providing an analysis of Ostrom's bottom-up governance approach); William Easterly, *Institutions: Top Down or Bottom Up?*, 98 AM. ECON. REV. 95, 95–96 (2008) (showing a top-down governance approach refers to a direct regulation enforced by government or private markets).

75. Ostrom mentioned eight design principles as user boundaries, resource boundaries, congruence with local conditions, appropriation and provision, collective choice arrangements, monitoring users, monitoring the resources, graduated sanctions, conflict resolution mechanisms, recognition of rights, nested enterprise ("[G]overnance activities are organized in multiple nested layers."). Ostrom, *Beyond Markets and States*, *supra* note 71, at 653.

76. *Id.*

77. *Id.*; Brett Frischmann, *The Tragedy of the Commons, Revisited*, SCI. AM. (Nov. 19, 2018), https://blogs.scientificamerican.com/observations/the-tragedy-of-the-commons-revisited/#:~:text=Hardin%20described%20a%20social%20dilemma,even%20destruction%20of%20the%20resource [https://perma.cc/EGQ9-TW3L].

78. For blockchain's key stakeholders, *see* Yue Liu, Qinghua Lu, Liming Zhu, Hye-Young Paik & Mark Staples, *A Systematic Literature Review on Blockchain Governance*, 197 J. SYS. & SOFTWARE 1, 13 (2023).

achieved when every participant in the network collaborates towards a common objective rather than indulging in self-interested actions.[79]

Although Ostrom's governance theory has focused on the physical world's common-pool resources, such as forests, fisheries, and water systems,[80] with the advancement of technology, the discourse of the commons is now finding relevance in the digital realm.[81] Accordingly, contemporary scholars have discussed new and nontraditional forms of commons, such as digital resources created and maintained online.[82] Similar to physical world commons, these digital

79. For a general analysis of the blockchain's shared resources, *see* David Rozas, Antonio Tenorio-Fornés, Silvia Díaz-Molina & Samer Hassan, *When Ostrom Meets Blockchain: Exploring the Potentials of Blockchain for Commons Governance*, 11 SAGE OPEN 1, 5–11 (2021).

80. *See* Roy Gardner, Elinor Ostrom & James M. Walker, *The Nature of Common-Pool Resource Problems*, 2 RATIONALITY & SOC'Y 336, 336 (1990) (outlining the pre-conditions that make common-pool resources distinguishable from the commons). First, the resources are subtractable, meaning a resource unit consumed or withdrawn by one individual is not fully available to another individual. *Id.* Therefore, "[w]hen a resource has no natural replacement (*exhaustible* resource), then any withdrawal rate maintained over time will lead to exhaustion." *Id.* Second, there are multiple individuals who are appropriating the resource units. *Id.*

81. *See* CHARLOTTE HESS & ELINOR OSTROM, UNDERSTANDING KNOWLEDGE AS A COMMONS 4 (MIT Press ed., 2011) (analyzing knowledge as a commons in the digital world from an interdisciplinary perspective); Jennifer Shkabatur, *The Global Commons of Data*, 22 STAN. TECH. L. REV. 354, 354 (2019) (positing that data generated on private platforms, such as Facebook, Twitter, and Instagram, should be recognized as global commons and arguing that a data commons regime can protect both commercial interests and data privacy); *see also* Mélanie Dulong de Rosnay & Felix Stalder, *Digital Commons*, INTERNET POL'Y REV. 1 (2020), https://policyreview.info/concepts/digital-commons [https://perma.cc/BWW7-UM2W] (describing a historical evolution of "the digital commons, from free software, free culture, and public domain works, to open data and open access to science"). Dulong de Rosnay and Stalder analyze the digital commons' "foundational dimensions (licensing, authorship, peer production, governance) and finally study newer forms of the digital commons, urban democratic participation and data commons." Dulong De Rosnay & Stalder, *supra*. *See also* Mayo Fuster Morell, *Governance of Online Creation Communities for the Building of Digital Commons: Viewed Through the Framework of the Institutional Analysis and Development*, *in* GOVERNING KNOWLEDGE COMMONS (Brett M. Frischmann, Michael J. Madison & Katherine J. Strandburg eds., 2016); *cf.* Christian Fuchs, *The Digital Commons and the Digital Public Sphere: How to Advance Digital Democracy Today*, 16 WESTMINSTER PAPERS COMMC'N & CULTURE 9, 9 (2021) (drawing on an analysis of big tech companies, the author argues the open-access model is not necessarily a characteristic of a digital commons). In fact, per Fuchs, digital commons can be subsumed by digital capitalism in which corporations tend to adopt a model for profits out of commons. *Id.* Therefore, the discourse of digital commons should focus on the commons with non-capitalistic character. *Id.*

82. Examples of such commons may include the internet, data, electromagnetic spectrum, etc. *E.g.*, Kevin Werbach, *Supercommons: Toward a Unified Theory of Wireless Communication*, 82 TEX. L. REV. 863, 864 (2004). These common digital resources are also known as "knowledge commons," "digital commons," or "information goods." *See generally* Herminio Bodon, Pedro Bustamante, Marcela Gomez, Prashabnt Krishnamurthy, Michael J. Madison, Ilia Murtazashvili, Jennifer Brick Murtazashvili, Tymofiy Mylovanov & Martin B. H. Weiss, *Ostrom Amongst the Machines: Blockchain as a Knowledge Commons* (Univ. of Pitt. Sch. of L., Working Paper, 2019),

shared resources are susceptible to social dilemmas in which individuals make selfish decisions that jeopardize the other members' access to blockchain resources.[83]

Academics have rightly argued that the foundation of blockchain protocol is polycentric.[84] Particularly from a design perspective, blockchain has multiple decision-making centers ("nodes") and other external competing blockchain networks.[85] This feature of blockchain fulfills the definition of a polycentric system theorized by Vincent Ostrom.[86] From an access perspective, the blockchain system allows anyone to participate in the governance process as long as they possess a governance token.[87] Indeed, the very essence of a blockchain network represents a collective, bottom-up effort as opposed to a top-down one.[88]

This Article argues that the polycentricity of a permissionless blockchain is not inherent in its design alone but rather hinges upon its capacity to circumvent the concentration of power and asymmetry of information.[89] As such, this Article exposes a critical paradox within blockchain ecosystems: despite the foundational ethos of decentralization and open participation, the governance structures of

---

https://scholarship.law.pitt.edu/fac_articles/402 [https://perma.cc/BWW7-UM2W]; De Rosnay & Stalder, *supra* note 68 (providing a detailed account of "the history of the movement of the digital commons, from free software, free culture, and public domain works, to open data and open access to science"); Lawrence B. Solum, *Questioning Cultural Commons*, 95 CORNELL L. REV. 817, 818 (2010).

83. The best example of a social dilemma is the Prisoner's Dilemma—a fundamental problem in game theory that demonstrates why two rational individuals might not cooperate, even if it appears that it is in their best interest to do so. *See generally* ANATOL RAPOPORT & ALBERT M. CHAMMAH, PRISONER'S DILEMMA: A STUDY IN CONFLICT AND COOPERATION, 35–36, 48 (1965) (examining the conditions under which trust can emerge in a competitive environment); *see also* Ilia Murtazashvili, Jennifer Brick Murtazashvili, Martin B. H. Weiss & Michael J. Madison, *Blockchain Networks as Knowledge Commons*, 16 INT'L J. COMMC'N 108, 112 (2022) (providing an inventory of social dilemmas in the context of blockchain-based shared knowledge).

84. *See* Eric Alston, Wilson Law, Ilia Murtazashvili & Martin Weiss, *Blockchain Networks as Constitutional and Competitive Polycentric Orders*, 18 J. INSTITUTIONAL ECON. 1, 1 (2022).

85. *Id.*

86. For the definition of a polycentric system, *see* Ostrom, *supra* note 72.

87. *See* Primavera De Filippi, Morshed Mannan & Wessel Reijers, *Blockchain as a Confidence Machine: The Problem of Trust and Challenges of Governance*, 62 TECH. SOC'Y 1, 8 (2020).

88. *See* Murtazashvili et al., *supra* note 83, at 112. For a definition of the bottom-up approach, *see* Mark Pennington, *Elinor Ostrom and the Robust Political Economy of Common-Pool Resources*, 9 J. INSTITUTIONAL ECON. 449, 449 (2013) (providing an analysis of Ostrom's bottom-up governance approach); William Easterly, *Institutions: Top Down or Bottom Up?*, 98 AM. ECON. REV. 95, 95 (2008) (explaining a top-down governance approach refers to a direct regulation enforced by government or private markets).

89. *See* discussion *infra* Part II.B.2.

major blockchain networks manifest severe centralization.[90] These centralized realities of blockchain directly challenge the narrative of an egalitarian, user-driven evolution.[91]

This Article also underscores the danger of blockchain's centralities, as evidenced by the collapse of several blockchain organizations during the Crypto Winter of 2022.[92] It posits that, without an effective governance regime established by network participants, blockchain's tragedy[93] will continue to cause the destruction of the network's valuable resources.[94]

The current state of blockchain's centralities fundamentally incentivizes participants in the ecosystem to be opportunistic.[95] One way to minimize opportunistic behavior is to implement a fully polycentric blockchain system in both operation and governance, which would incentivize the network participants and stakeholders to act in the community's interest rather than their own.

This Article has two novel contributions. First, it contributes to understanding the embedded centralities (both intended and unintended) in a public blockchain's governance structure. It argues that the centralities embedded in the current blockchain governance framework fundamentally incentivize the participants in the ecosystem to be opportunistic and engage in selfish behavior. As a result, the longevity of the majority of blockchain organizations is short-lived.[96]

---

90. *See, e.g.*, De Filippi et al., *supra* note 87.

91. For a comprehensive study of different public blockchain protocols' centralization, *see* Ashish R. Sai, Jim Buckley, Brian Fitzgerald & Andrew Le Gear*, Taxonomy of Centralization in Public Blockchain Systems: A Systematic Literature Review*, 58 INFO. PROCESSING & MGMT. 1, 1 (2021).

92. *See* discussion *infra* Part II.

93. Similar to the concept of "tragedy of the commons," "blockchain tragedy" describes a situation where individuals acting in their own self-interests deplete a shared resource to the detriment of the entire group. *See* discussion *infra* Part II.C.

94. The term "tragedy of the commons" was first used by Garrett Hardin, who opted for the definition as put forth by philosopher Alfred North Whitehead. Garrett Hardin, *The Tragedy of Commons*, 162 SCI. 1243, 1244 (1968). Whitehead states that "[t]he essence of dramatic tragedy is not unhappiness. It resides in the solemnity of the remorseless working of things." *Id.* In the commons discourse, tragedy is a concept that describes a situation where individual users who have open access to a shared resource act independently, driven by self-interests, which leads to the destruction of the resources. *See* ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 2 (Cambridge Univ. Press ed., 1990) ("Much of the world is dependent on resources that are subject to the possibility of a tragedy of the commons.").

95. *See* discussion *infra* Part I.

96. Over the last decade, nearly 66.5 percent of crypto ventures have failed. *Ranked: Dead Crypto Coins by Year*, VISUAL CAPITALIST (May 9, 2023), https://www.visualcapitalist.com/cp/ranked-dead-crypto-coins-by-

Further, the discussion in this Article moves beyond the simplistic dichotomy of centralized versus decentralized and provides a nuanced understanding of how central points of influence and control can emerge within a decentralized system.[97] By doing so, it uncovers the underlying incentives that drive participants to act opportunistically and engage in selfish behavior, an area not extensively covered in previous research. Second, this Article challenges the existing reward-centric governance framework and advocates for a value-driven, decision-making process in blockchain governance. This approach would motivate participants to engage in governance more actively and organically, thereby fostering sustainable growth and achieving long-term economic objectives for the network.

Part I of this Article delves into the concept of decentralization, particularly in the context of consensus protocols like proof-of-work (PoW) and proof-of-stake (PoS), where mining power or stake ownership can become concentrated among a few entities.[98] It highlights how the governance structure of blockchain projects centralization because it primarily vests decision-making power in core developers or influential entities.[99] This centralization is the antithesis of blockchain's original promise of distributed decision-making and democratized control.[100] Part II describes the dynamics of blockchain's market centralization and its risks and implications by examining the collapse of the Terra protocol and the FTX exchange. Part III discusses blockchain as a "commons" by drawing from the historical discourse on managing shared resources. It argues that blockchain's sustainability hinges on its community's trust and governance, cautioning against centralization and opportunistic behaviors that threaten ecosystem growth. By applying Elinor Ostrom's approach to the commons governance framework, this section proposes a shift towards polycentric governance to preserve blockchain's shared resources sustainably while emphasizing cooperative management and community-driven decision-making.

---

year/#:~:text=While%20many%20familiar%20crypto%20coins,dust%20between%202013%20and%202022.&text=Abandoned%20coins%20with%20flatlining%20trading,failures%20over%20the%20last%20decade [https://perma.cc/TRZ6-QWQA].

97. *See* discussion *infra* Part I.

98. *See* discussion *infra* Part I.

99. *See* discussion *infra* Part I.

100. *See* David Rozas, Antonio Tenorio-Fornés, Silvia Díaz-Molina & Samer Hassan, *When Ostrom Meets Blockchain: Exploring the Potentials of Blockchain for Commons Governance*, 11 SAGE OPEN 1, 5–11 (2021).

II. DECONSTRUCTING BLOCKCHAIN'S DECENTRALIZATION PARADOX

A. Paradox of Trust

Bitcoin and other blockchain-based systems are often characterized as "trustless"[101]—a label that exemplifies blockchain's ability to eradicate the age-old problems of trust[102] in economic institutions.[103] The term, albeit somewhat misleading,[104] underscores blockchain's reliance and confidence on an automated, code-driven communication system that operates independently of any central authority.[105] Theoretically, the permissionless blockchain's trustlessness aligns with the concept of trust proposed by Anthony Gidden, an English sociologist known for his theory of structuration and modern societies, which posits that a visible, transparent, and

101. *See* Trevor I. Kiviat, *Beyond Bitcoin: Issues in Regulating Blockchain Transactions*, 65 DUKE L.J. 569, 570 (2015); Sinclair Davidson, Mikayla Novak & Jason Potts, *The Cost of Trust: A Pilot Study* 1 J. BRIT. BLOCKCHAIN ASS'N 1, 3–7 (2018), https://doi.org/10.31585/jbba-1-2-(5)2018 [https://perma.cc/DML6-FGJD] (referring to blockchain's ability to circumvent the need for trust).

102. *See* Usman W. Chohan, *Are Cryptocurrencies Truly Trustless?*, *in* CRYPTOFINANCE AND MECHANISMS OF EXCHANGE: THE MAKING OF VIRTUAL CURRENCY 77 (Stéphane Goutte, Khaled Guesmi & Samir Saadi eds., 2019). Trust is generally complex and nuanced. For reference, *see* RUSSELL SAGE, FOUNDATION, TRUST AND RECIPROCITY: INTERDISCIPLINARY LESSONS FOR EXPERIMENTAL RESEARCH (Elinor Ostrom & James Walker eds., 2003); Guido Möllering, *Understanding Trust from the Perspective of Sociological Neoinstitutionalism: The Interplay of Institutions and Agency* (Max Planck Institute for the Study of Societies, Working Paper No. 05/13, 2005), https://www.econstor.eu/bitstream/10419/19927/1/dp05-13.pdf [https://perma.cc/6JV8-9FBT]. For trust in human interaction and underlying factors, *see* Karen Jones, *Trustworthiness*, 123 ETHICS 61, 61 (2012). For the nuances on trust in the digital world, *see generally* Carla Ferraro, Melissa A. Wheeler, Jason I. Pallant, Samuel G. Wilson & Julian Oldmeadow, *Not so Trustless After All: Trust in Web3 Technology and Opportunities for Brands*, 66 BUS. HORIZONS 667, 668 (2023) (explaining that, in general, trust in the digital realm means that "Web3 users [need] to trust the technology itself rather than human intermediaries . . . [and] signals an urgency to better understand digital trust in the unique context of Web3 technology").

103. For an overview, *see*, DISINTERMEDIATION ECONOMICS: THE IMPACT OF BLOCKCHAIN ON MARKETS AND POLICIES (Eva Kaili & Dimitrios Psarrakis eds., Palgrave Macmillan 2021).

104. The term "trustless" can suggest the complete elimination of trust, but most scholars agree that it requires a degree of trust and confidence in the technology. *See* Yan Teng, *What Does it Mean to Trust Blockchain Technology?* 54 METAPHILOSOPHY 145, 145 (2023); *see also* Primavera De Filippi, Morshed Mannan & Wessel Reijers, *Blockchain as a Confidence Machine: The Problem of Trust & Challenges of Governance*, 62 TECH. IN SOC. 1, 1 (2020) (explaining that blockchain is not a trustless technology, rather it reinforces confidence); Chohan, *supra* note 120; Usman W. Chohan, *Are Cryptocurrencies Truly Trustless? in* CRYPTOFINANCE AND MECHANISMS OF EXCHANGE: THE MAKING OF VIRTUAL CURRENCY (Stéphane Goutte, Khaled Guesmi & Samir Saadi eds., 2019); Werbach, *Trust, But Verify*, *supra* note 2, at 497–98, 549–50 (stating blockchain has "trustless trust," offering a new alternative for the established trust-centric intermediated market).

105. Werbach, *Trust, But Verify*, *supra* note 2, at 507.

informative system eliminates the typical need for trust[106] by connecting faith and confidence.[107]

For example, Bitcoin operates on an open-source protocol governed by specific rules like hashing algorithms, public-private key cryptography, mathematics, and game theory.[108] These rules are known to all those who participate in the network, ensuring transparency.[109] Transactions are autonomously processed, verified, and authenticated on a blockchain protocol that is both immutable and tamper-proof.[110] As such, every transaction is fully visible and accessible on the network, avoiding the need for a trusted counterparty.[111]

Yet, the notion of trustlessness in blockchain operations does not completely eliminate the concept of trust.[112] Rather, it introduces a nuanced form of trust,[113] in which "[e]very peer holds some part of the information," thereby allowing everyone to witness all transactions.[114] Trust in a blockchain network demands that participants confide in the accuracy of the mathematical principles, cryptographic security, and the overall functioning of the protocol.[115] It is argued that the technology diverts trust from conventional entities to its own mechanisms and artifacts.[116] However, it is not entirely true that trust is only in the technology itself.[117] In a blockchain network, trust is shifted toward the collective network of human contributors who operate and maintain the system.[118] These human actors make crucial

106. ANTHONY GIDDENS, THE CONSEQUENCES OF MODERNITY 31–34 (1991).

107. *Id.* at 34.

108. *See* De Filippi et al., *supra* note 87.

109. *See id.*

110. *See id.*

111. *See id.* at 6.

112. *Id.* at 7.

113. Some call it a form of decentralized trust. *See* Michael J. Casey & Paul Vigna, *In Blockchain We Trust*, MIT TECH. REV. (Apr. 9, 2018), https://www.technologyreview.com/2018/04/09/3066/in-blockchain-we-trust/ [https://perma.cc/LXH4-W72Z]; *see also* Michael Casey, *The Blockchain: Decentralized Trust to Unlock a Decentralized Future*, O'REILLY (Sept. 8, 2016), https://www.oreilly.com/radar/the-blockchain-decentralized-trust-to-unlock-a-decentralized-future/ [https://perma.cc/JQ9B-429U]; John O. McGinnis, *Two Paradoxes of Crypto*, 26 CHAPMAN L. REV. 445, 446 (2023); Emanuele Bellini, Youssef Iraqi & Ernesto Damiani, *Blockchain-Based Distributed Trust and Reputation Management Systems: A Survey*, 8 IEEE ACCESS 21127, 21130 (2020), https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8970496 [https://perma.cc/JNG4-WB5E] (labelling blockchain's trust as distributed).

114. *Id.* at 21129.

115. *See* De Filippi et al., *supra* note 87, at 6. *See generally* Bellini et al., *supra* note 113, at 21130.

116. *See* De Filippi et al., *supra* note 87, at 8.

117. *See id.* at 7. *See generally* Ferraro et al., *supra* note 81, at 668.

118. The collective network of contributors consists of miners, validators, programmers, the blockchain foundation, and end users. *See* Lakshmi S. Sankar, Ma. Sindhu, & M.

decisions about protocol upgrades, changes, or forks.[119] Trust in these actors and processes remains a critical component of blockchain organization. In other words, a blockchain's trust system is a combination of algorithm information processing and human decision-making.[120]

The example of the Bitcoin block size debate and the implementation of Segregated Witness (SegWit) demonstrate how human decision-making is critical in the evolution and governance of blockchain systems, even in decentralized networks.[121] This debate unfolded through a multi-stage human decision-making process. Initially, developers and community members proposed various solutions, such as increasing direct block size and implementing SegWit.[122] The Bitcoin community then engaged in extensive debates across platforms.[123] Some proposals, like SegWit and Bitcoin Improvement Proposal (BIP), were implemented through user-activated "soft forks,"[124] where node operators enforced new rules.[125] After years of deliberation, SegWit was finally activated on the Bitcoin network in August 2017.[126] This outcome resulted from complex interactions and negotiations among various stakeholders in the Bitcoin ecosystem, highlighting the significant role of human decision-making in shaping blockchain protocols.[127]

Another key attribute of permissionless blockchains like Bitcoin and Ethereum is decentralization.[128] It is analogous to the concept of

---

Sethumadhavan, *Survey of Consensus Protocols on Blockchain Applications, in* International Conference on Advanced Computing and Communication Systems (ICACCS) 1–5 (2017), https://ieeexplore.ieee.org/document/8014672 [https://perma.cc/38GB-YMQG]; Benito Arruñada & Luis Garicano, Blockchain: The Birth of Decentralized Governance 6 (Apr. 10, 2018) (unpublished manuscript) (on file with Social Science Research Network); De Filippi et al., *supra* note 87, at 7.

119. "A fork happens whenever a community changes the blockchain's protocol or basic set of rules." *What is a Fork?*, COINBASE, https://www.coinbase.com/learn/crypto-basics/what-is-a-fork [https://perma.cc/TFJ9-GEGE] (last visited Feb. 13, 2024). As a result, the chain is divided and creates a second blockchain. *Id.*

120. Kyungmoo Heo & Sangyoon Yi, *Decentralization in the Governance of Blockchain Systems: Cryptocurrency Cases*, 12 J. ORGANIZATIONAL DESIGN 59, 76 (2023).

121. For a historical development, *see* Remo Nyffenegger, Scaling Bitcoin (2023) (M.A. Thesis, University of Basel) (on file with the Social Science Research Network).

122. *See id.* at 8.

123. *See id.*

124. A soft fork is a change to the blockchain protocol that makes only previously valid blocks/transactions invalid and requires only a majority of miners to upgrade to enforce the new rules. ANDREAS M. ANTONOPOULOS, MASTERING BITCOIN 261 (2d ed. 2017).

125. Nyffenegger, *supra* note 121, at 8.

126. *Id.* at 11–12.

127. *Id.* at 5–13.

128. De Filippi et al., *supra* note 87, at 2.

trustlessness and encourages the absence of a central authority responsible for transactions in a blockchain network.[129] Epitomized by the Bitcoin network (which relies on an open-source protocol), blockchain's architectural decentralization facilitates open access.[130] That is, everyone is free to use the network and contribute to its development.[131] From a control standpoint, a permissionless blockchain network, such as Bitcoin and Ethereum, allows a participant to access the network without requiring approval from a central authority.[132] Therefore, a permissionless blockchain's underlying design allows participation in the network from anywhere in the world, in contrast to a permissioned network that can "pre-select" and "restrict" members' right to access.[133]

Decentralization also prevents a single person or organization from taking control of the system.[134] It implies a diffusion of power rather than concentration.[135] For instance, in Bitcoin and Ethereum networks, decentralization refers to the network's ability to develop "higher resistance against censorship of individual transactions."[136] Often viewed as a blockchain's entire raison d'être,[137] blockchain's decentralization manifests in multiple decision-making centers, each

129. Angel Walch, *In Code(rs) We Trust: Software Developers as Fiduciaries in Public Blockchains*, *in* REGULATING BLOCKCHAIN: TECHNO-SOCIAL AND LEGAL CHALLENGES, 58, 61 (Philipp Hacker et al. eds., 2019); *see* Nakamoto, *supra* note 2 (laying out the design and operation framework of a peer-to-peer transaction using cryptography-based digital currency, popularly known as "bitcoin").

130. Mally Anderson, *Exploring Decentralization: Blockchain Technology and Complex Coordination*, J. DESIGN & SCI. (Feb. 6, 2019), https://jods.mitpress.mit.edu/pub/7vxemtm3/release/2#:~:text=The%20decentralized%20architecture%20of%20blockchain,is%20open%2Dsource%2C%20so%20its [https://perma.cc/W5FQ-XCEE].

131. Adem E. Gencer, Soumya Basu, Ittay Eyal, Robbert van Renesse & Emin Gün Sirer, *Decentralization in Bitcoin and Ethereum Networks*, ARXIV (Mar. 29, 2018), https://arxiv.org/pdf/1801.03998.pdf [https://perma.cc/5WKC-9NYV].

132. *Id.*

133. Seira et al., *supra* note 12.

134. DON TAPSCOTT & ALEX TAPSCOTT, BLOCKCHAIN REVOLUTION: HOW THE TECHNOLOGY BEHIND BITCOIN IS CHANGING MONEY, BUSINESS, AND THE WORLD 33–35 (2d ed. 2014).

135. Walch, *Deconstructing Decentralization*, *supra* note 44, at 45.

136. Adem E. Gencer, Soumya Basu, Ittay Eyal, Robbert van Renesse & Emin Gun Sirer, *Decentralization in Bitcoin and Ethereum Networks*, ARXIV (2018), https://arxiv.org/pdf/1801.03998.pdf [https://perma.cc/5WKC-9NYV] ("Better decentralization of miners means higher resistance against censorship of individual transactions.").

137. Vitalik Buterin, *The Meaning of Decentralization*, MEDIUM (Feb. 6, 2017), https://medium.com/@VitalikButerin/the-meaning-of-decentralization-a0c92b76a274 [https://perma.cc/X4CW-HFRV].

with individual roles, responsibilities, and contributions to the system's operation.[138]

Looking at the design architecture, blockchain has four principal decision-making agents, each with different roles and responsibilities. These vital centers are (1) core developers who launch the initiative and reserve the right to make changes to the core protocol, (2) node-runners, miners, or validators who run computer nodes to verify and validate transactions,[139] (3) foundation or investors who directly fund the blockchain project, and (4) users who constitute a broad community purchasing, holding, and trading cryptocurrencies.[140] Decentralized actors are spread across various computer nodes in a distributed manner and function autonomously.[141]

To summarize, trustlessness and decentralization are closely intertwined in the context of blockchain technology. Trustlessness promotes an environment where participants in the network do not need to trust any central authority.[142] Yet, the system is not devoid of trust since the blockchain devises a new form of trust,[143] where trust is vested in the technology itself and in the decentralized network of participants.[144] Thus, blockchain's virtue of "trustlessness" is underpinned by its ability to prevent concentration of power—in other words, achieving decentralization.

A closer examination reveals an intriguing contradiction in the practical application of blockchain technology. Blockchain technology manifests a tendency toward centralization, both in operational and governance aspects.[145] This centralization takes place in various forms, such as the concentration of mining or staking powers[146] or the dominance of certain decision-makers in the governance of blockchain

138. Long Chen, Lin W. Cong & Yizhou Xiao, *A Brief Introduction to Blockchain Economics*, *in* INFORMATION FOR EFFICIENT DECISION MAKING: BIG DATA, BLOCKCHAIN, AND RELEVANCE 1, 7 (Kashi R. Balachandran ed., 2021).

139. *See* Sankar et al., *supra* note 118.

140. Arruñada and Garicano, *supra* note 118.

141. Walch, *Deconstructing Decentralization*, *supra* note 44, at 44. *But see* Remya Stephen & Aneena Alex, *A Review on Blockchain Security*, IOP CONF. SERIES: MATERIALS SCI. & ENG'G 1, 2 (2018), https://iopscience.iop.org/article/10.1088/1757-899X/396/1/012030/meta [https://perma.cc/CW5Z-7CJ5] (showing decentralized and distributed have different implications).

142. WERBACH, THE BLOCKCHAIN, *supra* note 7.

143. *Id.* at 116, 173.

144. De Filippi et al., *supra* note 87, at 7.

145. Primavera De Filippi & Benjamin Loveluck, *The Invisible Politics of Bitcoin: Governance Crisis of a Decentralized Infrastructure*, 5 INTERNET POL'Y REV. 1, 2 (2016).

146. *See* Arthur Gervais, Ghassan O. Karame, Vedran Čapkun & Srdjan Čapkun, *Is Bitcoin a Decentralized Currency?* 12 IEEE SEC. & PRIV. 54, 57 (2014).

networks.[147] This centralization contradicts blockchain's decentralized ethos, raising questions about its efficacy in truly democratizing trust and power.[148]

B. Paradox of Decentralization

1. Centralization in Consensus Protocol

Much of the discourse around blockchain's decentralization is underpinned by its consensus protocols and the philosophy of "code is the law."[149] Consensus refers to a method of reaching an agreement in a decentralized multi-agent system, commonly known as mining or staking,[150] with participants called miners, nodes, or validators.[151] In a permissionless blockchain, decentralized consensus protocols are characterized as proof-of-work (PoW)[152] or proof-of-stake (PoS).[153] Originally implemented by Satoshi Nakamoto in the Bitcoin network, the main purpose of a consensus protocol is to verify, validate, and

147. Previously, Bitcoin and Ethereum's decentralized decision-making processes were examined utilizing a quantitative method (called "Nakamoto coefficient"), in which Balaji Srinivasan and Leland Lee argue that, in terms of bringing protocol improvement proposals, Ethereum had higher centralization than Bitcoin. Balaji S. Srinivasan & Leland Lee, *Quantifying Decentralization*, MEDIUM (July 27, 2017), https://news.earn.com/quantifying-decentralization-e39db233c28e [https://perma.cc/93YV-7DUM]. However, in both cases, only a few contributed to bringing these proposals. *Id.*

148. De Filippi & Loveluck, *supra* note 45.

149. Lawrence Lessig, *Code is Law*, HARV. MAG. (Jan. 1, 2000), https://www.harvardmagazine.com/2000/01/code-is-law-html [https://perma.cc/9Y54-5G6L]; *see also* Lawrence Lessig, *Code and Other Laws of Cyberspace, Version 2.0*, CTR. FOR INTERNET AND SOC'Y (Dec. 5, 2016), https://cyberlaw.stanford.edu/publications/code-and-other-laws-cyberspace-version-20/ [https://perma.cc/396R-LHNS].

150. Staking is the consensus mechanism to validate transactions for proof-of-stake blockchains. *What is Staking?*, COINBASE, https://www.coinbase.com/learn/crypto-basics/what-is-staking [https://perma.cc/8JGY-LYM5] (last visited Feb. 13, 2024).

151. Angela Walch, *The Path of the Blockchain Lexicon (and the Law)*, 36 REV. BANKING & FIN. L. 713, 720 (2016).

152. In a PoW protocol such as Bitcoin, validators/miners compete for the right to verify transactions and obtain their reward by solving a computationally intensive problem. Igor Makarov & Antoinette Schoar, *Cryptocurrencies and Decentralized Finance* 6 (Bank for International Settlements, Working Paper, 2022) https://www.bis.org/publ/work1061.pdf#page=13.54 [https://perma.cc/U3WV-BCHP]; Antony Lewis, *A Gentle Introduction to Blockchain Technology*, BITS ON BLOCKS (Sept. 9, 2015), [https://perma.cc/UQ8F-6CZ5] (stating that proof-of-work is a "computationally expensive . . . guessing game").

153. In a PoS protocol, instead of solving a difficult mathematical problem, a validator stakes its coins. Makarov & Schoar, *supra* note 152, at 9; *see also* Julian Roberto, *Understanding Proof of Stake: The Nothing at State Theory*, MEDIUM (June 7, 2018), https://medium.com/coinmonks/understanding-proof-of-stake-the-nothing-at-stake-theory-1f0d71bc027 [https://perma.cc/3JM3-2QEE].

finalize a transaction block.[154] The use of randomization in the consensus algorithm is designed to prevent power centralization.[155]

Critics argue that despite public blockchain's decentralization goals, decentralization is not guaranteed in the design itself.[156] Rather, it is achieved through "clever integration of cryptography, distributed systems, and incentive engineering."[157]

In a PoW, virtual miners disseminated across the globe participate in updating the network with a new block as soon as a transaction is announced in a blockchain network.[158] The winner—the first node to solve a complex algorithm set by protocol and have its proposed block accepted—gets to update the blockchain with the latest verified transactions.[159] In return, the network rewards the miner with a predetermined amount of cryptocurrency.[160] Naturally, when the value of cryptocurrency rises, it attracts more miners, potentially luring them to aggregate their computational resources to maximize their chance of winning rewards.[161] As a result, this incentive engineering design gives rise to "de facto centralization and concentration."[162]

Potential new business models have also been developed to combine the miners' resources to obtain lucrative mining rewards.[163] For example, a 2014 study showed that six major centralized mining pools at that time controlled more than 75% of Bitcoin's computing power.[164] As such, the study warned that "[i]f these pools were to collude to acquire more than 50% of computing power share in the network, they can effectively control the confirmation of all transactions

---

154. Naif Alzahrani & Nirupama Bulusu, *Towards True Decentralization: A Blockchain Consensus Protocol Based on Game Theory and Randomness*, *in* DECISION AND GAME THEORY FOR SECURITY 465, 472 (Linda Bushell et al. eds., 2018).

155. Böhme et al., *supra* note 49, at 219.

156. *See, e.g.*, De Filippi & Loveluck, *supra* note 45; Gervais et al., *supra* note 146.

157. Ashish R. Sai et al., *supra* note 91, at 2.

158. *See* John L. Quigley & John Gilbert, *What Is Proof-of-Work (PoW)? All You Need to Know*, BLOCKWORKS (Apr. 24, 2023, 11:30 AM), https://blockworks.co/news/what-is-proof-of-work [https://perma.cc/4TA9-YDGW].

159. *See id.*

160. *See* Conard Barski & Chris Wilmer, *The Blockchain Lottery: How Miners are Rewarded*, COINDESK (Sept. 11, 2021, 6:21 AM), https://www.coindesk.com/markets/2014/11/23/the-blockchain-lottery-how-miners-are-rewarded/ [https://perma.cc/7G7N-F7DL].

161. *See generally* Murtuza Merchant, *What is a Cryptocurrency Mining Pool?* COINTELEGRAPH (Sept. 24, 2022), https://cointelegraph.com/news/what-is-a-cryptocurrency-mining-pool [https://perma.cc/4BBE-XUXE] (explaining the underlying rationale for developing a mining pool as the number of blockchain miners increases).

162. Böhme et al., *supra* note 49, at 220.

163. *See* Scharnowski & Shi, *supra* note 39, at 1.

164. Gervais et al., *supra* note 146, at 56.

occurring in the system."[165] Such a concentration of power also allows for selfish behavior by mining pools to maximize benefits.[166] Moreover, it is an energy-intensive process that can have trouble scaling to accommodate a vast number of transactions.[167]

In contrast, PoS is an alternative energy-saving mechanism in which a blockchain network selects a "validator" to add the transaction to the blockchain in exchange for cryptocurrency.[168] Usually, a qualified validator stakes a certain amount of cryptocurrency for a certain amount of time,[169] as the network tends to choose the participant who has the most cryptocurrency for the longest length.[170] Thus, the network rewards the most invested participant.[171]

Although the PoS aims to bring speed and efficiency in finalizing a blockchain transaction, the consensus mechanism is "unfair" and vulnerable to the concentration of power because it is solely driven by the amount of capital, as opposed to a PoW's randomization.[172] Therefore, "the single richest person" can dominate the network.[173] For instance, Nansen, a blockchain analytics firm, reported that 64 percent

---

165. *Id.*

166. *See generally* Scharnowski & Shi, *supra* note 39, at 1–3 (finding Bitcoin mining to be "geographically concentrated").

167. *See* Zibin Zheng, Shaoan Xie, Hongning Dai, Xiangping Chen & Huaimin Wang, *An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends*, 2017 IEEE INT'L CONG. ON BIG DATA 557, 561 (2017) ("In PoW, miners hash the block header continuously to reach the target value. As a result, the amount of electricity required to process has reach[ed] an immense scale."); *Fact Sheet: Climate and Energy Implications of Crypto-Assets in the United States*, WHITE HOUSE (Sept. 8, 2022), https://www.whitehouse.gov/ostp/news-updates/2022/09/08/fact-sheet-climate-and-energy-implications-of-crypto-assets-in-the-united-states/ [https://perma.cc/GEE6-DRLS].

168. *See generally* Zheng et al., *supra* note 167, at 560. This Article will not discuss the Practical Byzantine Fault Tolerance Algorithm (PBFT), which was developed to save even more energy than the PoW algorithm; this is utilized by Hyperledger Fabric, a permissioned blockchain network. *Id.*

169. *See id.*

170. *See id.*

171. *See id.*

172. *See* Yuming Huang, Jing Tang, Qianhao Cong, Andrew Lim & Jianliang Xu, *Do the Rich Get Richer? Fairness Analysis for Blockchain Incentives*, ASS'N FOR COMPUTING MACH. (2021), https://ymhuang.me/publication/do-the-rich-get-richer-fairness-analysis-for-blockchain-incentives/do-the-rich-get-richer-fairness-analysis-for-blockchain-incentives.pdf [https://perma.cc/A5YB-QWLS].

173. Zheng et al., *supra* note 167, at 560; Ying-Ying Hsieh, Jean-Philippe Vergne, Philip Anderson, Karim Lakhani & Markus Reitzig, *The Internal and External Governance of Blockchain-Based Organizations: Evidence from Cryptocurrencies*, BITCOIN & BEYOND 48, 53 (2017).

of staked Ethereum is controlled by only five entities.[174] Additionally, it was further reported that 46.5 percent of Ethereum's post-Merge PoS nodes for storing data, processing transactions, and adding new transaction blocks were attributed to just two addresses.[175] In essence, when it comes to operations, blockchain clearly showcases the centralization of power in its consensus mechanism.

2. Centralization in the Governance Structure

Governance of the blockchain is a complex topic that garners intense academic discussion.[176] Generally, it involves "determining who has authority" at both the internal and external levels and "how these actors are endowed" with respect to their decision-making authority.[177] The concept of decentralization in blockchain governance is often confused with blockchain's distributed protocol designs[178] or "collective validation of transactions by peers of the network."[179] This Article conceptualizes blockchain governance as the methodology for enacting consensus-critical modifications to the protocol that underpins the network.[180] The governance mechanism delineates "the means of

174. Gareth Jenkinson, *64% of Staked ETH Controlled by 5 Entities – Nansen*, COINTELEGRAPH (Sept. 12, 2022), https://cointelegraph.com/news/64-of-staked-eth-controlled-by-five-entities-nansen [https://perma.cc/44JE-QPY6].

175. Ana Paula Pereira, *40%+ of Ethereum PoS Nodes Are Controlled by 2 Addresses, Says Santiment Data*, COINTELEGRAPH (Sept. 16, 2022), https://cointelegraph.com/news/40-ethereum-pos-nodes-are-controlled-by-two-addresses-says-santiment-data [https://perma.cc/N4NE-63VR].

176. *See generally* Rowan van Pelt, Slinger Jansen, Djuri Baars & Sietse Overbeek, *Defining Blockchain Governance: A Framework for Analysis and Comparison*, 38 INFO. SYS. MGMT. 21, 21–41 (2020) (offering a comprehensive literature review and approaches to blockchain governance); *see also* Evrim Tan, Stanislav Mahula & Joep Crompvoets, *Blockchain Governance in the Public Sector: A Conceptual Framework for Public Management*, 39 GOV'T INFO. Q. 1, 4–5 (2022), https://www.sciencedirect.com/science/article/pii/S0740624X21000617 [https://perma.cc/FW3P-WN7Q] (referencing governance in different layers of blockchain applications); Andrej Zwitter & Jilles Hazenberh, *Decentralized Network Governance: Blockchain Technology and the Future of Regulation*, 3 FRONTIERS BLOCKCHAIN 1, 6 (2020) (debating the fluidity of power across various blockchain network actors, "as different actors perform different governance roles within different contexts").

177. Hsieh et al., *supra* note 173, at 49.

178. *See* Hanna Halaburda & Christoph Mueller-Bloch, *Will We Realize Blockchain's Promise of Decentralization?*, HARV. BUS. REV. (Sept. 4, 2019), https://hbr.org/2019/09/will-we-realize-blockchains-promise-of-decentralization [https://perma.cc/CYT5-JVP8].

179. Firat Cengriz, *Blockchain Governance and Governance via Blockchain: Decentralized Utopia or Centralized Dystopia*, 6 POL'Y DESIGN & PRAC. 446, 450 (2023).

180. *See* Aron Fischer & María-Cruz Valiente, *Blockchain Governance*, 10 INTERNET POL'Y REV. (2021), https://policyreview.info/glossary/blockchain-governance [https://perma.cc/9BFZ-ZCQZ].

achieving the direction, control, and coordination of stakeholders" within a given blockchain project.[181]

Generally, there are two principal governance aspects: on-chain governance, consisting of rules coded in a blockchain system, and off-chain governance, which implies "all forces that subsist outside of a technological platform, but nonetheless influence its development and operations."[182] On-chain governance rules are directly encoded into the blockchain protocol, which creates an automated, self-executing, and immutable governance structure.[183] These embedded rules dictate the procedures for submitting proposals, approving them, and finalizing them upon voting—all of which occur without a centralized group of developers.[184] In contrast, off-chain governance operates on a "social and institutional level" rather than being directly tied to technical aspects, such as transaction verification and validation.[185] Unlike on-chain governance's codified rules, off-chain governance processes can be dynamic and often involve informal community engagement platforms, such as Discord and Telegram.[186] These external factors introduce a layer of complexity to the governance.[187] Each factor brings a different level of influence and interest to the table, making the governance process multifaceted and intricate.[188] In 2020, Uniswap's

---

181. van Pelt et al., *supra* note 176, at 21.

182. Primavera De Filippi & Greg McMullen, *Governance of Blockchain Systems*, BLOCKCHAIN RSCH. INST. 1, 18 (June 2018), https://coala.global/wp-content/uploads/2019/02/BRI-COALA-Governance-of-Blockchains.pdf [https://perma.cc/F44K-VXV2].

183. *See id.* at 4.

184. *See, e.g.*, Kathleen Breitman, *Tezos (XTZ): Superior Governance and Use Cases*, GEMINI (Nov. 16, 2021), https://www.gemini.com/cryptopedia/what-is-tezos-xtz-governance-use-cases [https://perma.cc/6ACG-4K3H] (noting the Tezos blockchain network allows anyone to submit a proposal for protocol updates, as "[t]he methodology for deciding and implementing upgrades to the Tezos blockchain is on-chain and is directly incorporated in the code of the underlying protocol itself").

185. De Filippi & McMullen, *supra* note 182, at 18.

186. Several blockchain foundations engage communities informally, where core developers and community members discuss and make decisions using social media. For instance, Algorand has an official Discord server. *See, e.g.*, *Join the Official Algorand Discord Server!,* ALGORAND, https://forum.algorand.org/t/join-the-official-algorand-discord-server/3455 [https://perma.cc/7YWU-U7FB] (last visited Sept. 27, 2024); *see also* Adriana Z. Robertson, *Blockchain Governance: An Outsider's Perspective*, JOLT DIG. (June 12, 2018), https://jolt.law.harvard.edu/digest/blockchain-governance-an-outsiders-perspective [https://perma.cc/22G9-W8LC] (offering an outsider's perspective on blockchain governance); *What is Blockchain Governance: Settling Platform Rules*, PHEMEX (Oct. 13, 2021, 9:07 AM), https://phemex.com/academy/what-is-blockchain-governance [https://perma.cc/9SW6-66G4].

187. *See generally* Robert Stevens, *DeFi Drama: Uniswap Governance Proposal Sparks Controversy*, DECRYPT (Oct. 14, 2020), https://decrypt.co/45060/defi-drama-defi-uniswap-governance-proposal-sparks-controversy [https://perma.cc/98D9-QNRY] (referencing growing concerns regarding the relationship between Dharma and Uniswap).

188. *See id.*

"DeFi Education Fund" proposal aimed to allocate $20 million in UNI tokens[189] for lobbying efforts. Formal voting occurred on-chain,[190] but crucial debates unfolded on Discord, Medium, and Telegram,[191] leading to governance challenges such as information asymmetry and the organization's implicit yet centralized control of the voting process and its anticipated outcomes.[192] These factors significantly impacted the governance process, highlighting how off-chain communication platforms can complicate blockchain decision-making.[193]

From a design and operation perspective, anyone with governance tokens[194] or rights to vote on proposals can vote in a public blockchain system, either on-chain or off-chain, as the situation may require.[195] Participants typically engage in voting processes within the blockchain ecosystem to influence various operational aspects, including rulemaking, validation processes, approval of transaction blocks, reward allocation, tokenomics,[196] protocol updates, security protocols, and responses to breaches.[197]

Often overlooked as a potential source of centralization, blockchain governance is structurally designed to ensure open access for individuals and allows anyone to contribute to the improvement and development of a blockchain network.[198] Yet, while blockchain

189. *See* Robin Fritch, Marino Muller & Roger Wattenhofer, *Analyzing Voting Power in Decentralized Governance: Who Controls DAOs?*, 5 BLOCKCHAIN: RSCH. & APPLICATIONS 1, 1 (2024), https://www.sciencedirect.com/science/article/pii/S2096720924000216#fn0020 [https://perma.cc/Y7PQ-428A].

190. *See* Martin Young, *Uniswap Proposal Under Fire for Enabling Dharma to 'Take Over Governance*,' COINTELEGRAPH (Oct. 14, 2020), https://cointelegraph.com/news/uniswap-proposal-under-fire-for-enabling-dharma-to-take-over-governance [https://perma.cc/G3MH-YSC6].

191. *See, e.g.*, David Felton, *Dharma's Proposal is a Threat to Uniswap,* MEDIUM (Oct. 12, 2020), https://hiturunk.medium.com/dharmas-proposal-is-a-threat-to-uniswap-464ae9ab6d63 [https://perma.cc/F9SH-CAAG].

192. Young, *supra* note 190.

193. *See id*.

194. *See* Marcel Deerm, *What are Governance Tokens, and How Do They Work?*, COINTELEGRAPH (Oct. 24, 2022), https://cointelegraph.com/news/what-are-governance-tokens-and-how-do-they-work [https://perma.cc/2E3M-95AE] (explaining governance tokens are a type of cryptocurrency that allows token holders to vote on a blockchain project).

195. *See, e.g.*, Eric Alston et al., *Interim Report on Blockchain Governance Practices*, BLOCKCHAINGOV 1, 13 (2024), https://cdn.sanity.io/files/uhmav2a4/production/3941f3a4e325bfc63aa81c21d1d461a5fa3985c5.pdf [https://perma.cc/DK8A-2GCB].

196. *See id.*; *see also* Robert Stevens, *What is Tokenomics and Why is it Important?*, COINDESK (Apr. 9, 2024, 6:08 PM), https://www.coindesk.com/learn/what-is-tokenomics-and-why-is-it-important/ [https://perma.cc/9SDZ-WKXT].

197. *See* Alston et al., *supra* note 120.

198. *See, e.g.*, *Introduction to Ethereum Improvement Proposals (EIPs)*, ETHEREUM (July 14, 2024), https://ethereum.org/en/eips/ [https://perma.cc/3KQF-Y7GH] (explaining that in the

governance structure is "decentral[ized]" in theory, the protocol development process is, in reality, "highly centralized and coordinated" among a select group of adept developers.[199] This highly centralized approach assumes that core developers, with their technical expertise, are best suited to make decisions.[200] These developers possess the unilateral authority to accept or reject network improvement proposals, which effectively circumscribes the larger user community's influence on the network's future trajectory and could lead to outvoting the network's original decision.[201]

Since the inception of Bitcoin, the authority to make influential decisions in cryptocurrency systems is predominantly vested in the hands of a few powerful entities.[202] For example, the genesis of the Bitcoin protocol's control was monopolized by its creator, Satoshi Nakamoto, who subsequently delegated the control to a handful of developers.[203] This suggests that the protocol's design was not decentralized at its provenance.[204] A similar centralization exists within the Ethereum ecosystem, in which key decisions are made by its co-founder Vitalik Buterin, developers, miners, and the non-profit foundation, Ethereum Foundation.[205] Tezos—another blockchain network's governance model, which promotes "universal participation" in its on-chain governance process without a centralized authority—also falls short of its decentralization claim.[206] Although

---

Ethereum protocol, individuals can submit alterations or proposals to change the protocol by means of Ethereum Improvement Proposals (EIPs)).

199. Halaburda & Mueller-Bolch, *supra* note 178.

200. *See, e.g.*, De Filippi & Loveluck, *supra* note 45 (arguing that this "technocratic" governance approach is implicit in Bitcoin protocol).

201. *See* Gervais et al., *supra* note 146. Drawing an example from the Bitcoin protocol, the authors demonstrated that on March 11, 2013, despite receiving less support from the majority of users, fewer than ten entities outvoted the network's original computing power. *Id.* This also proves that "such influential entities can also make more radical decisions, including accepting or rejecting decisions." *Id.*

202. Heo & Yi, *supra* note 100, at 76.

203. *See* Pete Rizzo, *The Last Days of Satoshi: What Happened When Bitcoin's Creator Disappeared,* BITCOIN MAG. (Apr. 26, 2021), https://bitcoinmagazine.com/technical/what-happened-when-bitcoin-creator-satoshi-nakamoto-disappeared [https://perma.cc/2WJJ-PQQ8].

204. *See generally id.* (showing that, given the cryptocurrency was created by a central, and unitary, actor, it follows that Bitcoin has never been truly "decentralized").

205. *See, e.g.*, Andrew R. Chow, *The Man Behind Ethereum is Worried About Crypto's Future*, TIME MAG. (Mar. 18, 2022), https://time.com/6158182/vitalik-buterin-ethereum-profile/ [https://perma.cc/2CWN-VZPF].

206. *See* Shiva Jairam, Jaap Gordijn, Isaac Da, Silva Torres, Fadime Kaya & Marc X. Makkes, *A Decentralized Fair Governance Model for Permissionless Blockchain Systems*, RESEARCHGATE (Feb. 2021), https://www.researchgate.net/publication/349251307_A_Decentralized_Fair_Governance_Model_for_Permissionless_Blockchain_Systems [https://perma.cc/UQ4N-PQJN].

Tezos's protocol is self-amending,[207] its voting process is controlled by only registered developers ("bakers").[208] The non-bakers—the majority of Tezos token-holders—can only support one of their preferred bakers' governance choices and do not have the ability to propose, vote, or implement any changes to the network.[209]

Despite their foundations in open-source code, public blockchain networks are dominated by mining pools that possess significant control over the networks' computing power.[210] The operation and maintenance of this infrastructure encourages a form of "technocracy" that leads to a concentration of powers in a few entities and challenges the blockchain's potential to remove trusted entities in a decentralized economy.[211] The concentration of power extends to the implementation phase of governance, where proposals are funneled through a core group of developers responsible for deciding which updates should be executed.[212] Such a mechanism imposes stringent controls on the network's evolutionary path, thereby solidifying a centralized grip over its future development. [213]

Blockchain's centralization trend is not limited to the technical aspects of the networks but also permeates their organizational structures. At the organizational and managerial levels, access and participation in important decision-making are also controlled.[214] Transaction authorization requires a hefty transaction fee, which challenges the idea of equal participation in a blockchain network.[215] The centralities embedded in blockchain's governance design have adverse effects on the growth of the network, such as "platform size,

---

207. *See id.* at 4 (explaining self-amending protocol means, in order to bring approval and implementation proposals in the protocol, Tezos does not depend on a group of core developers (as is the case for Bitcoin and Ethereum)).

208. *See id.* at 5.

209. *See id.* at 6; Breitman, *supra* note 184.

210. *See* Ashish R. Sai et al., *supra* note 91, at 2–27 (demonstrating that four mining pools constitute 50.36 percent of controlling power in the Bitcoin network. The power concentration is also present in the Ethereum network, where the top four mining pools have 63 percent of controlling power); Gervais et al., *supra* note 146 ("If these pools colluded to acquire more than 50 percent of computing power share, they could effectively control all transactions, for example, preventing certain transactions' execution, approving a specific set of transactions, or approving double-spending transactions.").

211. *See* De Filippi & Loveluck, *supra* note 45.

212. *See generally id.* (demonstrating that in the implementation phase of governance, there are only a few actors with power to make universally impactful decisions for all users).

213. *See, e.g.*, Felton, *supra* note 191 (referencing UNI governance tokens). *But see* Schär, *supra* note 19 (arguing decentralized finance "may potentially contribute to a more robust and transparent financial infrastructure").

214. *See* Heo & Yi, *supra* note 120, at 77.

215. *See* Halaburda & Mueller-Bloch, *supra* note 178.

token illiquidity, and long-term incentives."[216] Even the popular DAO governance models are not immune from the centralization of governance.[217] As previously mentioned, DAOs are "blockchain-based applications for the automated execution of governance process."[218] Because the voting power in DAOs is proportional to a governor's (a participant with governance rights) possession of DAO tokens, if a member has more DAO tokens, they have more authority to approve a proposal.[219] Token distribution is also centralized. One study shows that 40 percent of Uniswap's tokens are held by its developers, early investors, and advisors.[220]

This concentration of decision-making often skews toward undemocratic tendencies and starkly contrasts with the decentralized vision of blockchain software.[221] Moreover, it leads to a paradox where the actual governance of the network can become monolithic.[222] Such centralization of authority over influential decision-making not only undermines the blockchain's foundational claim of immutability but also risks its integrity and sustainability.

C. Paradox of Power and Incentives – Blockchain's Social Dilemma

Generally, a social dilemma refers to a situation in which individual rationality conflicts with collective rationality.[223] For

---

216. Jungsik Han, Jongsub Lee & Tao Li, DAO Governance 1–51 (Dec. 2023) (unpublished manuscript) (on file with Social Science Research Network).

217. *See generally* Youssef El Faqir, Javier Arroyo & Samer Hassan, *An Overview of Decentralized Autonomous Organizations on the Blockchain*, OPENSYM '20, AUG. 25–27, 2020, VIRTUAL CONF., SPAIN 1, 1 (2020), https://doi.org/10.1145/3412569.3412579 [https://perma.cc/J4K4-F4MJ] (analyzing various DAO models and highlighting issues related to centralization in their governance structures).

218. Rikken et al., *supra* note 18.

219. *See* Chainalysis Team, *Introduction to Decentralized Autonomous Organizations (DAOs)*, CHAINALYSIS (Apr. 7, 2023), https://www.chainalysis.com/blog/introduction-to-decentralized-autonomous-organizations-daos/ [https://perma.cc/CNP6-3N4C].

220. *See* Tom Josua Barbereau, Reilly Smethurst, Orestis Papageorgiou, Alexander Rieger & Gilbert Fridgen, *DeFi, Not So Decentralized: The Measured Distribution of Voting Rights*, HAW. INT'L CONF. ON SYS. SCI. 6043, 6050 (2022), https://www.researchgate.net/publication/357745429_DeFi_Not_So_Decentralized_The_Measured_Distribution_of_Voting_Rights [https://perma.cc/H5AH-AT7Q].

221. *See generally* De Philippi & Loveluck, *supra* note 45 (discussing the effects of having decision making authority for these blockchains centralized in a select number of people).

222. *See generally* Marcella Atzori, Blockchain Technology and Decentralized Governance: Is the State Still Necessary? (Jan. 2, 2016) (unpublished manuscript) (on file with Social Science Research Network) (cautioning against the dominance of private powers in distributed ecosystems, which may lead to citizen disempowerment and a stateless global society).

223. *See* Peter Kollock, *Social Dilemmas: The Anatomy of Cooperation*, 24 ANN. REV. SOC. 183, 184 (1998).

example, in a social dilemma concerning public goods or shared resources, individuals are motivated to use or exploit the resources as much as possible to maximize their personal gain.[224] Such self-interested behavior, which disregards externalities and other long-term consequences, leads to depletion, degradation, or even destruction of shared resources.[225]

The social dilemma of blockchain networks stems from the tension between the system's intended and unintended centralities, as well as the diverse motivations and behaviors of its individual participants.[226] Social dilemmas in the blockchain network materialize when a relatively small number of entities or individuals who disproportionately hold the majority of decision-making authority engage in selfish behavior, leading to the destruction of the network's shared resources.[227]

From an operational perspective, the centralities in a blockchain protocol's authentication and verification processes determine which transactions are validated and added to a block, resulting in an unequal distribution of power within the blockchain network.[228] For example, in scenarios where a faction of stakeholders—such as protocol developers—disagrees with a governance decision, the faction may resort to executing a hard fork in the blockchain.[229] A hard fork is a permanent divergence in blockchain protocol that requires all nodes or users to upgrade to the latest version of the protocol software.[230] On different occasions, scholars have argued that a hard fork is coercive,[231] technocratic,[232] and exclusionary.[233] By effectively creating an alternate

224. *See* Hardin, *supra* note 94; *supra* text accompanying notes 11–12; *see also* discussion *infra* Section III.

225. *See id.*

226. *See* Murtazashvili et al., *supra* note 83, at 112.

227. *See id.*

228. *See* De Filippi et al., *supra* note 87.

229. *See id.*

230. *See* ARVIND NARAYANAN, JOSEPH BONNEAU, EDWARD FELTON, ANDREW MILLER & STEVEN GOLDFEDER, BITCOIN AND CRYPTOCURRENCY TECHNOLOGIES: A COMPREHENSIVE INTRODUCTION 96 (2016); *see also* Fabian Schär & Aleksander Berensten, *Bitcoin, Blockchain, and Cryptoassets: A Comprehensive Introduction*, 57 BUS. ECON. 1, 63 (2018) ("[I]f a hard fork is forced against the will of the nonmining network participants, the miners are at risk of running an alternative ledger without any users or infrastructure.").

231. *See* Vitalik Buterin, *Hard Forks, Soft Forks, Defaults, and Coercion*, VITALIK.ETH.LIMO (Mar. 14, 2017), https://vitalik.eth.limo/general/2017/03/14/forks_and_markets.html [https://perma.cc/TRK7-7FTS].

232. De Filippi & Loveluck, *supra* note 45.

233. Sangita Gazi, Michele Treccani, Massimo Morini & Navroop K. Sahdev, Blockchain as Commons: Applying Ostrom's Polycentric Approach to Blockchain Governance 9

blockchain variant, hard-forking dilutes the economic value of the original network, impedes its foundational value and aspiration, and jeopardizes its long-term growth.[234] This "exit-based governance" phenomenon highlights a critical vulnerability in blockchain governance, which emphasizes the need for more inclusive decision-making mechanisms.[235]

Some instances of how blockchain's social dilemmas affect the broader blockchain community include:[236]

1) *Under or oversupply*: An undersupply of cryptocurrency can lead to increased value, as scarcity drives up prices.[237] While a token's high value benefits existing token holders, high entry costs can deter new users and investors from participating in the network.[238] Furthermore, an extreme undersupply can lead to network centralization, where a small number of holders control a significant portion of the total token supply.[239] Conversely, oversupply diminishes the value and the wealth of existing holders.[240] It can potentially lead to a loss of confidence in the blockchain project and might result in the abandonment of the project if stakeholders perceive it as unsustainable or unprofitable.[241]
2) *Forking*: As mentioned previously, the fork is the bifurcation of a blockchain protocol and can manifest as either a "soft fork,"[242] which is backward-compatible with older versions, or a "hard

(Dec. 2, 2022) (unpublished manuscript) (on file with the Social Science Research Network) ("Users of the old blockchain are excluded from transacting with users who upgraded to the new protocol.").

234. For instance, the original Bitcoin protocol was split as a result of a hard fork. Cryptopedia Staff, *Bitcoin Forks: Upgrades and Radical Blockchain Changes*, GEMINI (Nov. 2, 2023), https://www.gemini.com/cryptopedia/bitcoin-fork-protocol-upgrades-blockchain-changes [https://perma.cc/5FR4-GWSA].

235. The concept of exit-based governance revolves around the idea of leaving a system if one does not resonate with it. Primavera De Filippi, *DAOs, Constitutions, and Exit-Based Governance*, YOUTUBE (Sept. 5, 2023), https://www.youtube.com/watch?v=TlMGIBPnS20 [https://perma.cc/86UY-JJYT] (stressing the importance of interdependencies and loyalty, especially in systems with network effects).

236. An earlier draft on this section is available also. *See* Gazi, *supra* note 233, at 8–9.

237. Gazi et al., *supra* note 233, at 8.

238. *Id.*

239. *Id.*

240. *See id.*

241. *Id.* at 9.

242. *See Soft Fork vs. Hard Fork: Differences Explained*, COINTELEGRAPH (Mar. 18, 2024), https://cointelegraph.com/learn/soft-fork-vs-hard-fork-differences-explained [https://perma.cc/X3XU-XUG2].

fork,"[243] which is not backward-compatible and creates a new, distinct blockchain from the original. Forking presents a governance challenge as it forces stakeholders to choose between competing visions for the project.[244] The process of forking is not merely technical but deeply political and ideological, reflecting differing opinions on how the network should evolve.[245]

3) *51% attack:* A blockchain network can also be affected by a 51% attack. A 51% attack is defined as "an attack on a blockchain by a group of miners controlling over 50% of a network's . . . computing power."[246] Successful attackers can disrupt the blockchain network by preventing new transactions from being added, thus affecting the consumption and use of the network by other users.[247] During an economic downturn, the native[248] token's value may fall, which increases the risk of a 51% attack and jeopardizes the network's sustainability.[249]
4) *Asymmetry in power distribution:* Blockchain's resources, such as cryptocurrencies and digital tokens, can be exploited by founders or crypto whales.[250] Even blockchain's unique properties of immutability, censorship resistance, and openness can be undermined when a single authority establishes control over the maintenance and update of the blockchain protocol.[251] This power disparity further perpetuates information

243. *Id.*

244. *Id.*

245. *Id.*

246. Griffin Mcshane, *What is a 51% Attack?*, COINDESK (May 11, 2023, 10:49 AM), https://www.coindesk.com/learn/what-is-a-51-attack/ [https://perma.cc/P2LQ-D3BA].

247. *See generally* De Filippi & Loveluck, *supra* note 45.

248. *See* Paol Tasca, *Token-Based Business Models: FinTech and Strategy in the 21st Century*, *in* DISRUPTING FINANCE: FINTECH AND STRATEGY IN THE 21ST CENTURY 135 (Theo Lynn et al. eds., 2019) (explaining a native token is a cryptocurrency inherent to a specific blockchain network).

249. For example, the crash of Luna price and the threat of a 51% attack, lead to the shutdown of the Terra Protocol. *See infra* Part III.B.1.

250. Whales are individuals who have large cryptocurrency holdings and can therefore swing the market by manipulating the price of the cryptocurrency. *Crypto Whale Meaning*, LEDGER (June 18, 2023), https://www.ledger.com/academy/glossary/whale#:~:text=A%20crypto%20whale%20is%20a,hold%20at%20least%201%2C000%20BTC [https://perma.cc/VUB3-R326]; Robert Stevens, *What are Crypto Whales and Why are They Important*, COINDESK (Mar. 15, 2023, 4:26 PM), https://www.coindesk.com/learn/what-are-crypto-whales-and-why-are-they-important/ [https://perma.cc/FS62-XV6B].

251. *See infra* Part III.A.

asymmetry within the blockchain market and increases the vulnerability of everyday consumers.[252]

Blockchain protocol's incentive mechanisms significantly influence the centralization of power within blockchain organizations. Usually, the incentive system is "[a] principal variable affecting organization behavior."[253] In any shared resource management, the stakeholders' incentive structure is crucial for the governance system because it determines individuals' decisions and behavior within the collective sphere.[254] In a blockchain network, the incentive structure can be multi-dimensional. It can be financial,[255] economic,[256] social,[257] and political.[258] Some commentators classify the incentives into two groups: monetary and non-monetary.[259] The monetary incentive structure rewards participation and acts as an economic benefit that motivates entities to join the system.[260] The non-monetary incentive structure largely hinges upon the dynamic of trust and credibility of the overall network's operation.[261]

---

252. Yesha Yadav, *The Centralization Paradox in Cryptocurrency Markets*, 100 WASH. U. L. REV. 1725, 1745 (2023); Lennart Ante, *Bitcoin Transactions, Information Asymmetry, and Trading Volume*, 4 QUANTITATIVE FIN. & ECON. 365, 378 (2020) (studying information asymmetry in the Bitcoin market).

253. Peter B. Clark & James Q. Wilson, *Incentive Systems: A Theory of Organization*, 6 ADMIN. SCI. Q. 129, 130 (1961). The motivation theory behind incentives is a behavioral concept positing that individuals are driven by the prospect of rewards and positive reinforcement. *See generally* Uri Gneezy, Stephan Meier & Pedro Rey-Biel, *When and Why Incentives (Don't) Work to Modify Behavior*, 25 J. ECON. PERSP. 191, 191 (2011) (showing how the incentive structure can largely affect human behavior and motivation to pursue a goal—"[i]f incentives are not large enough, this change in perception can lead to undesired effects on behavior").

254. *See generally* Ostrom et al., *supra* note 70, at 80.

255. These are tangible rewards such as cryptocurrency tokens, monetary compensation, or dividends. Rong Han et al*., How Can Incentive Mechanisms and Blockchain Benefit with Each Other? A Survey*, 55 ACM COMPUTING SURVS. 1, 24–29 (2022). Financial incentives can be divided into direct rewards (e.g., block rewards for miners) and indirect rewards (e.g., increased token value). *Id.*

256. Economic incentives encompass financial rewards and other economic benefits, such as access to resources, reduced transaction costs, or revenue-sharing arrangements. *See id.* at 28–29.

257. *See generally* Philip Boucher, *What if Blockchain Changed Social Values*? EUR. PARL. RES. SERV. (May 10, 2017), https://www.europarl.europa.eu/RegData/etudes/ATAG/2017/603176/EPRS_ATA(2017)603176_EN.pdf [https://perma.cc/3F5C-772J].

258. *See generally* Robert Herian, *The Politics of Blockchain*, 29 L. & CRITIQUE 129, 130 (2018), https://doi.org/10.1007/s10978-018-9223-1 [https://perma.cc/8366-DJNE] (describing blockchain's political connotation, such as decentralization, democracy, and disintermediation).

259. Han et al., *supra* note 255, at 7.

260. *Id.* at 29.

261. *Id.*

Blockchain's current incentive design essentially centers around the distribution of governance tokens across stakeholders regardless of their motivations and goals.[262] The model is predominantly reward-centric, and the governing participants' incentives are primarily driven by self-interest rather than a blockchain's core values.[263] While governance tokens provide token-holders with the right to submit proposals and vote on protocol changes, network participants can also use these tokens to stake derivatives (known as liquid staking derivatives)[264] and speculate on the governance token's current and future value.[265] Governance tokens can also be used as collateral in a DeFi protocol, allowing users to engage in yield farming.[266] Although the original design of staking was meant to provide liquidity in the DeFi system, the reward structure and sudden price increase of governance tokens brought staking to the SEC's attention.[267] For instance, in February 2023, the SEC reached a $30 million settlement with Kraken, a major cryptocurrency exchange, forcing it to end its staking-as-a-service program for US customers.[268] The SEC argued that Kraken's staking program constituted an offer and sale of securities that should have been registered.[269] The regulatory intervention has brought uncertainty to the blockchain industry, particularly around the legal status of staking services.[270]

To further illustrate how self-interest and anticipation of rewards exert significant influence over the current governance process, consider the case of a node-runner who runs computer nodes to

---

262. *See id.*

263. Gazi et al., *supra* note 233, at 12.

264. *See* James Edwards, *The Biggest Crypto Trend of 2023: Liquid Staking Derivatives (LSDs)*, NASDAQ (May 5, 2023, 10:58 AM), https://www.nasdaq.com/articles/the-biggest-crypto-trend-of-2023-liquid-staking-derivatives-lsds [https://perma.cc/6DPC-EB9C].

265. *Id.*

266. *What are DeFi Yield Aggregators, and How Do They Work?*, COINTELEGRAPH, https://cointelegraph.com/learn/what-are-defi-yield-aggregators-and-how-do-they-work [https://perma.cc/2393-6D6T] (last visited Feb. 13, 2024) ("The yield farming process typically expects participants to lock up or stake their funds, and yield aggregators work by automating the farming process to produce the highest yields possible.").

267. *See* Austin Weinstein, David Pan & Olga Kharif, *Crypto Exchange Kraken Ends Staking Program in $30 Million SEC Settlement*, BLOOMBERG (Feb. 9, 2023, 8:16 PM), https://www.bloomberg.com/news/articles/2023-02-09/crypto-exchange-kraken-ends-staking-program-in-sec-settlement?embedded-checkout=true [https://perma.cc/Q2NC-HUKW].

268. Press Release, SEC, SEC Charges Kraken for Operating as an Unregistered Securities Exchange, Broker, Dealer, and Clearing Agency (Nov. 20, 2023), https://www.sec.gov/news-room/press-releases/2023-237 [https://perma.cc/TPT6-T4W6].

269. *Id.*

270. *See* Zetzsche, Arner & Buckley, *supra* note 19, at 184 (regarding the tension between DeFi and traditional financial regulations).

verify and validate transactions.[271] In the context of a blockchain network, the role of node operators holds immense importance as they validate every transaction within the network.[272] From an operational standpoint, a node-runner is chosen randomly to validate a transaction.[273] They are granted a reward upon successful validation and incorporation of their block into the blockchain.[274] Ideally, a node-runner's motivation should be rooted in a selfless desire to contribute to the growth of the ecosystem by validating each transaction and creating blocks.[275] However, as the ecosystem expands and transaction volume surges, the issue of scalability, particularly the need for an increasing number of node-runners, arises.[276] This expansion and growth of blockchain organizations leads to a shift in motivation, where self-interest, safeguarding one's assets, and maximizing the chances of receiving rewards become the primary driving factors for node operators.[277] For example, to mitigate the uncertainty associated with random selection, node-runners often diversify their stakes across multiple nodes to enhance their reward prospects.[278] This behavior, while rational from an individual's perspective, can have implications for the network's decentralization and security. Rewards in blockchain networks typically come in the form of native cryptocurrencies, which have both monetary value and voting power within the network's

271. *See* Sankar et al., *supra* note 118, at 10.

272. *See* Michael Crosby, Nachiappan, Pradan Pattanayak, Sanjeev Verma & Vignesh Kalyanaraman, *Blockchain Technology: Beyond Bitcoin*, 2 APPLIED INNOVATION REV. 6, 10 (June 2016), https://scet.berkeley.edu/wp-content/uploads/AIR-2016-Blockchain.pdf [https://perma.cc/QW8F-5666].

273. *See* Alzahrani & Bulusu, *supra* note 154, at 472.

274. Werbach, *Trust, But Verify*, *supra* note 2, at 502; *see also* Conard Barski & Chris Wilmer, *The Blockchain Lottery: How Miners are Rewarded*, COINDESK (Nov. 23, 2014), https://www.coindesk.com/markets/2014/11/23/the-blockchain-lottery-how-miners-are-rewarded/ [https://perma.cc/8WKV-4DEJ].

275. Pradeep Aswal, *What Are Blockchain Nodes?,* BLOCKCHAIN COUNCIL (June 15, 2024), https://www.blockchain-council.org/blockchain/blockchain-nodes/ [https://perma.cc/EHH4-DJ62].

276. *See generally* Kyle Croman, Christian Decker, Ittay Eyal, Adem Efe Gencer, Ari Juels, Ahmed Kosba, Andrew Miller, Prateek Saxena, Elaine Shi, Emin Gu¨n Sirer, Dawn Song & Roger Wattenhofer, *On Scaling Decentralized Blockchains: (A Position Paper)*, *in* FINANCIAL CRYPTOGRAPHY & DATA SECURITY 106 (Jeremy Clark, Sarah Meiklejohn, Peter Y.A. Ryan, Dan Wallach, Michael Brenner & Kurt Rohloff eds., 2016) (exploring the challenges in scaling Bitcoin and blockchain).

277. *See generally* Lars Brunjes, Aggelos Kiayias, Elias Koutsoupias & Aikaterini-Panagiota Stouka, *Reward Sharing Schemes for Stake Pools*, ARXIV 15, 28 (June 6, 2020), https://arxiv.org/pdf/1807.11218 [https://perma.cc/8T54-FY62] (discussing the formation of collaborative stake pools).

278. *See generally id.*

governance system.[279] Node-runners desire these rewards not only for financial gain but also to increase their influence over the network's future direction.[280]

Although the network possesses the ability to penalize underperforming node-runners by reducing their stakes,[281] identifying a node-runner's true incentive still poses challenges. Such opacity makes it difficult for the network participants to distinguish between those genuinely committed to network health and those merely seeking short-term profits.[282]

Moreover, within the realm of governance, proposing alterations to the protocol is primarily motivated by financial incentives.[283] This approach aligns with the broader trend of self-interest driving blockchain participation. As exemplified by Tezos, when developers and teams propose updates to the network, they include a payment request in XTZ (Tezos's cryptocurrency) as compensation for their efforts.[284] Upon approval by stakeholders and integration into the Tezos blockchain, the protocol generates the requested coins upon execution and disburses the payment accordingly.[285] This incentive structure serves multiple purposes. It encourages ongoing development and improvement of the protocol by directly rewarding contributors. Additionally, it creates a built-in vetting process, as stakeholders must evaluate whether the proposed changes are worth the requested compensation. However, this system also raises questions about the long-term sustainability and potential conflicts of interest in blockchain governance, mirroring the challenges seen in node operation incentives discussed earlier.[286]

---

279. For the dual nature of cryptocurrency as both a reward and a governance token, *see* De Filippi & Wright, *supra* note 5.

280. *See* Sankar et al., *supra* note 118, at 22.

281. *See* Brunjes et al., *supra* note 277, at 23.

282. *See generally* Sarah Azouvi & Alexander Hicks, *SoK: Tools for Game Theoretic Models of Security for Cryptocurrencies*, PUBPUB 1–3 (May 21, 2019), https://assets.pubpub.org/enr32vif/01581340290802.pdf [https://perma.cc/Y7YU-DZ68] ("[T]he incentives at play tend to be external to the system design, and sometimes implicit, leading to failures when the intended use of systems is misaligned with the incentives of users.").

283. *See generally id.* at 1.

284. Breitman, *supra* note 184.

285. *Id.*

286. *See infra* Part III.B.2.

III. BLOCKCHAIN'S CENTRALIZATION RISKS AND IMPLICATIONS

A. Centralized Cryptocurrency Market

As we delve deeper into the nuances of blockchain technology, it becomes increasingly clear that the risk of centralization stands as a formidable challenge to blockchain's foundational principle of decentralization. The first manifestation of blockchain's centralization risk appeared in the cryptocurrency market.[287] Currently, the global cryptocurrency market cap is $2.17 trillion,[288] comprising cryptocurrency exchanges, DeFi, non-fungible tokens (NFTs),[289] stablecoins,[290] and token-linked financial instruments.[291] However, a significant portion of these platforms, including the majority of cryptocurrency exchanges, operate on a "highly intermediated" model.[292] This intermediation creates a single point of control that grants unrestricted access to customer funds and the potential for misappropriation.[293]

In the initial phase of the Bitcoin, blockchain's rise to prominence, advocates frequently highlighted its decentralization as a key feature.[294] They argued that decentralization significantly bolstered

287. *See generally* Sangita Gazi, *Reimagining a Centralised Cryptocurrency Regulation in the US: Looking through the Lens of Crypto-Derivatives*, 6 CAMBRIDGE L. REV. 97, 112–16 (2021) (discussing cryptocurrencies' market risks).

288. *Digital Assets, Cryptocurrency Prices Today Market Cap*, FORBES, https://www.forbes.com/digital-assets/crypto-prices/?sh=4f8d52462478 [https://perma.cc/MLJ2-WF2J] (last visited Feb. 6, 2024).

289. *See generally* Yuliya Guseva, *The Economic Reality of NFT Securities*, *in* CAMBRIDGE HANDBOOK ON LAW AND POLICY ON NFTS 3 (forthcoming 2024) (on file with the Social Science Research Network), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4597447 [https://perma.cc/MK4D-4JKM] (defining NFT as "a technology-enabled innovation that ensures digital uniqueness of tokens . . . represent[s] bundle of rights with respect to assets and services in the virtual or non-virtual environment").

290. *See generally* Gary B. Gorton & Jeffrey Y. Zhang, *Taming Wildcat Stablecoins*, 90 U. CHI. L. REV. 909, 915 (2023) (defining stablecoin as "a digital form of circulating private money" which can be redeemed by customers "at par and at will for cash").

291. *E.g.*, *What is Tokenization?*, MCKINSEY & CO. (Oct. 6, 2023), https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-tokenization [https://perma.cc/M6LE-TTBS].

292. Yadav, *supra* note 252, at 1728; *see also* McGinnis, *supra* note 113, at 450.

293. A concern highlighted by incidents such as the FTX case. McGinnis, *supra* note 113, at 450–51.

294. *See, e.g.*, Zibin Zheng et al., *supra* note 167, at 557, 562; M. N. M. Bhutta et al., *A Survey on Blockchain Technology: Evolution, Architecture, and Security*, 9 IEEE ACCESS 61048, 61049 (2021); Marc Pilkington, Blockchain Technology: Principles and Applications, *in* RESEARCH HANDBOOK ON DIGITAL TRANSFORMATIONS 225 (F. Xavier Olleros & Majlinda Zhegu eds., Edward Elgar 2016).

security and made the system more resilient and less susceptible to breaches.[295] The reality is much more grim; security risks in the crypto market remain a problem and often involve cross-border malicious actors.[296] Several high-profile incidents, such as the Silk Road crackdown,[297] the Mt. Gox debacle,[298] and the 2016 DAO hack[299] cast more than a shadow of doubt over these bolstered security claims.[300] Notably, the biggest crypto security breaches occurred in March 2022, when a North Korea-linked hacker group known as "Lazarus" orchestrated a 51% attack[301] on Ronin Chain—an Ethereum-linked NFT gaming platform.[302] By seizing control over five of the nine nodes, the hackers drained $625 million in ETH and USDC through two separate transactions.[303]

---

295. *See generally* Sai et al., *supra* note 91.

296. *See* Table 1, *infra* Part III.A.

297. The Silk Road, a dark web marketplace for illegal goods, was shut down by the FBI in 2013, leading to the arrest and life sentence of its founder, Ross Ulbricht. *See* Anthony Minnaar, *Online 'Underground' Marketplaces for Illicit Drugs: The Prototype Case of the Dark Web Website Silkroad*, CRIMINOLOGICAL & VICTIMOLOGICAL SOC. S. AFR. 32–36, 40 (2017). Despite its closure, similar sites continued to pop up, selling drugs online. *Id.* The US Federal Task Team, known as Operation Marco Polo, used cyberforensic and traditional crime investigation techniques to build a strong evidence case against Ulbricht. *Id.*; *see also* Chris Crawford & Joshua Vittor, *The Silk Road and MtGox: Lessons in Law for Bitcoin*, JOLT DIG. (Sept. 10, 2014), https://jolt.law.harvard.edu/digest/the-silk-road-and-mtgox-lessons-in-law-for-bitcoin [https://perma.cc/Y9LU-9F2N].

298. Mt. Gox, the largest Bitcoin exchange, collapsed in 2014 after losing approximately 850,000 Bitcoins (worth about $450 million at the time) to hackers. *See* Crawford & Vittor, *supra* note 297. The incident, which remained one of the most scandalous cryptocurrency heists in history, severely damaged public trust in Bitcoin and led to calls for increased regulation of cryptocurrency exchanges. *Id.*

299. In June 2016, attackers exploited a vulnerability in the DAO, a decentralized autonomous organization on the Ethereum blockchain, stealing approximately $50 million worth of Ether. Usha R. Rodrigues, *Law and the Blockchain*, 104 IOWA L. REV. 679, 704–06 (2019). This event led to a controversial hard fork of the Ethereum network to recover the stolen funds, resulting in the creation of Ethereum Classic as a separate blockchain. *Id.* For an analysis of the DAO Hack, *see id.*

300. *See generally* Matthew Kien-Meng Ly, *Coining Bitcoin's "Legal-Bits": Examining the Regulatory Framework for Bitcoin and Virtual Currencies*, 27 HARV. J.L. & TECH. 588, 603–06 (2014) (examining the regulatory implication and crackdown in the cryptocurrency market).

301. *See* CoinDesk Staff, *North Korean Hackers Lazarus Group Stolen $3B in Cryptocurrency*, COINDESK (Mar. 8, 2024, 5:56 PM), https://www.coindesk.com/markets/2023/12/01/north-korean-hackers-lazarus-group-stolen-3b-in-cryptocurrency/ [https://perma.cc/EW53-M86P].

302. *See id.*; Prashant Jha, *The Aftermath of Axie Infinity's $650M Ronin Bridge Hack*, COINTELEGRAPH (Apr. 12, 2022), https://cointelegraph.com/news/the-aftermath-of-axie-infinity-s-650m-ronin-bridge-hack [https://perma.cc/L4LA-JXV3].

303. Jonathan Ponciano, *Second Biggest Crypto Hack Ever: $600 Million in Ether Stolen From NFT Gaming Blockchain*, FORBES (Mar. 29, 2022, 1:42 PM), https://www.forbes.com/sites/jonathanponciano/2022/03/29/second-biggest-crypto-hack-ever-600-

In several other cases, hackers deliberately pinpointed the vulnerability of the blockchain's security system. For example, in August 2021, hacker "Mr. Whitehat" attacked the Poly Network, a DeFi platform, resulting in the theft of approximately $611 million in various cryptocurrencies.[304] In a surprising turn of events, the hackers began returning the stolen assets and claimed that they conducted the heist to expose vulnerabilities in the system.[305]

Table 1: The largest cryptocurrency hacks[306]

Networks are falling to victims of hacks.	**Amount hacked ($ million)**
Ronin Network	625
Poly Network	611
FTX	415
Binance	570
Coincheck	534
Mt. Gox	473
Wormhole	325

Besides technical vulnerabilities, major public blockchains, such as Bitcoin and Ethereum, also suffer from market-based centralization.[307] Novel business models, such as mining pool aggregators and liquidity mining,[308] have emerged to capitalize on the

million-in-ethereum-stolen-from-nft-gaming-blockchain/?sh=117d55eb2686 [https://perma.cc/HQD6-8TQD]; Jha, *supra* note 302.

304. *See* Joanna England, *Timeline: Poly Network and the Curious Case of 'Mr. Whitehat'*, FINTECH MAG. (Dec. 6, 2021), https://fintechmagazine.com/crypto/timeline-poly-network-and-curious-case-mr-whitehat [https://perma.cc/M5YX-K4Z4].

305. Ryan Browne, *Hacker Behind $600 Million Crypto Heist Returns A Final Slice of Stolen Funds*, CNBC (Aug. 23, 2021, 9:18 AM), https://www.cnbc.com/2021/08/23/poly-network-hacker-returns-remaining-cryptocurrency.html [https://perma.cc/8WL3-LJ8V].

306. Table prepared by the author. For data on individual hacks, *see* Tom Wilson & Elizabeth Howcroft, *Blockchain Project Ronin Hit by $615 Million Crypto Heist*, REUTERS (Mar. 29, 2022, 12:12 PM), https://www.reuters.com/technology/blockchain-company-ronin-hit-by-615-million-crypto-heist-2022-03-29/ [https://perma.cc/N96K-VG6V].

307. Sarah Azouvi, Mary Maller & Sarah Meiklejohn, *Egalitarian Society or Benevolent Dictatorship: The State of Cryptocurrency Governance*, FIN. CRYPTOGRAPHY & DATA SEC. 3, 12, 22 (2018).

308. A mining pool aggregator is a service or platform that connects cryptocurrency miners to multiple mining pools, automatically switching between pools to maximize profitability based on factors like current difficulty, pool fees, and coin prices. *What is Liquidity Mining?,* COINBASE, https://www.coinbase.com/learn/your-crypto/what-is-liquidity-mining [https://perma.cc/4XAY-87SJ] (last visited Sept. 4, 2024). Liquidity mining is a mechanism in decentralized finance (DeFi) where users provide liquidity to a protocol

system's profitability,[309] for example, by maximizing miners' chances of winning rewards.[310] The power can be centralized by a few "crypto whales"[311] who swing the market by manipulating the price of the cryptocurrency.[312] These whaling activities can become dangerous for a network's sustainability because they can operate outside the network's ecosystem and "influence the price and liquidity" of the cryptocurrency market, thereby making the entire ecosystem volatile and often leading to a crash.[313] The crash of the Terra protocol is a relevant example. On May 7, 2022, in the wake of a large swap of TerraUSD (UST), the Terra protocol's stablecoin lost its peg to the US dollar,[314] which was primarily initiated by these crypto whales.[315] The de-pegging led to a massive price crash for Terra LUNA (Terra protocol's native token),[316] revealing that if several large holders independently decide that a network's asset is at stake, they have the power to swing the market and even cause a market crash.

While the influence of crypto whales demonstrates centralization risks in the broader cryptocurrency market, similar

(typically by depositing cryptocurrency pairs into a liquidity pool) and in return, receive rewards in the form of the platform's native tokens. *See id.*; *Hashrate Distribution*, BLOCKCHAIN.COM, https://www.blockchain.com/explorer/charts/pools [https://perma.cc/Q H6Q-7BPB] (last visited Feb. 13, 2024).

309. *See* Zatonatska Tetiana et al., *Investment Models on Centralized and Decentralized Cryptocurrency Markets*, NAUKOVYI VISNYK NATSIONALNOHO HIRNYCHOHO UNIVERSYTETU 1, 181 (2022), https://doi.org/10.33271/nvngu/2022-1/177 [https://perma.cc/3ASP-5JL8].

310. *See* Alireza Beikverdi & JooSeok Song, *Trend of Centralization in Bitcoin's Distributed Network*, IEEE XPLORE 1, 1–6 (Aug. 6, 2015), https://ieeexplore.ieee.org/document/7176229 [https://perma.cc/X5D6-9TL9] (analyzing all the blocks created from 2019 to 2014, showing how centralized the state of Bitcoin's network is in different years).

311. *See What are Crypto Whales?*, COINBASE, https://www.coinbase.com/learn/crypto-basics/what-are-crypto-whales#:~:text=Crypto%20whales%20are%20individuals%20or,potential%20to%20affect%20the%20market [https://perma.cc/FS62-XV6B] (last visited Nov. 5, 2024) (defining crypto whales as individuals or entities that hold large amounts of cryptocurrency).

312. *See id.*; *see also* Beikverdi & Song, *supra* note 310.

313. *See What is a Crypto Whale and how can it be Tracked*, WHITEBIT BLOG (Aug. 27, 2024), https://blog.whitebit.com/en/what-are-crypto-whales/ [https://perma.cc/UFK8-CXMT].

314. Curve is a decentralized liquidity protocol built on the Ethereum blockchain. Jeff Benson, *Get Ahead of the Curve, the Exchange for Stablecoins*, UNCHAINED (Mar. 15, 2023, 11:00 AM), https://unchainedcrypto.com/get-ahead-of-the-curve-the-exchange-for-stablecoins/ [https://perma.cc/J996-3J3M].

315. Krisztian Sando & Ekin Genç, *The Fall of Terra: A Timeline of the Meteoric Rise and Crash of UST and Luna*, COINDESK (Apr. 14, 2024, 5:21 PM), https://www.coindesk.com/learn/the-fall-of-terra-a-timeline-of-the-meteoric-rise-and-crash-of-ust-and-luna/ [https://perma.cc/Z3FH-YEYJ] (explaining TerraUSD (UST) was designed to maintain a 1:1 peg with the US dollar through an algorithmic relationship with LUNA). LUNA acted as a counterbalance to UST, with users able to swap between the two to theoretically maintain UST's dollar peg. *Id.*

316. Discussion *infra* Section III.B.2.

concerns arise within the governance structures of DeFi protocols. Even the governance tokens in the DeFi protocol have turned out to be a profit-generating tool.[317] These tokens are not just limited to voting privileges within the protocol; they also can be used for staking in the liquidity pool and generating yield.[318] The distribution of these tokens also remains highly concentrated.[319]

Moreover, this profit-driven approach to governance tokens has led to the development of sophisticated financial tools in the DeFi space.[320] For instance, web-based tools help users identify or invest in the highest-yielding DeFi instruments and venues, sharing attributes of investment products.[321] By facilitating yield optimization strategies, these apparatuses further blur the line between decentralized protocols and traditional financial products.

There is also tension among blockchain organizations to limit decentralization.[322] As new business models and financial instruments evolve, more blockchain systems have opted for a centralized approach to governance where the blockchain foundation manages and directs the use of the network's shared resources.[323] After all, a centralized decision-making authority can streamline network governance by removing complexities and resistance.[324] For example, in emergencies, a centralized authority can immediately shut down the network,[325] but such a structure can also create a single point of failure.[326] Moreover, it can expose a blockchain network's vulnerabilities to hard forking and

317. *See* Schär, *supra* note 19, at 270.

318. *Id.*

319. *Id.* at 170–71; *see also* Nic Carter & Linda Zeng, DeFi Protocol Risks: The Paradox of Defi 1, 18 (2021) (unpublished manuscript) (on file with Social Science Research Network), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3866699 [https://perma.cc/Y4ZW-LMYF].

320. Schär, *supra* note 19, at 270.

321. Caroline A. Crenshaw, *Statement on DeFi Risks, Regulations, and Opportunities*, 1 INT'L J. BLOCKCHAIN L. (Nov. 2021), https://www.sec.gov/news/statement/crenshaw-defi-20211109#_ftn6 [https://perma.cc/AZ78-ZCFJ] (citing Schär, *supra* note 19, at 164).

322. *See* Walch, *Deconstructing Decentralization*, *supra* note 44.

323. Alexandra Andhov, *Corporations on Blockchain: Opportunities & Challenges*, 53 CORNELL INT'L L.J. 1, 25 (2020).

324. *Id.*

325. *See* discussion *infra* Section III.B.1.

326. *See* Lin William Cong & Zhiguo He, *Blockchain Disruption and Smart Contracts*, 32 REV. FIN. STUD. 1754, 1773 (2019). *See generally* Yadav, *supra* note 252 ("[S]ingle organizations act as anchor intermediaries to perform a variety of critical functions: marketing, trading, risk management, lending, venture investing, infrastructure building, and so on.").

51% attacks.[327] As a result, the community's trust in overall crypto resource management deteriorates, creating information asymmetry that can impact a blockchain network's value and reliability.[328] The foundation's managerial role may also implicate regulatory considerations, such as the foundation's treatment of token holders as investors and shared resources as securities,[329] or by holding DAO governors liable for illegal offerings.[330]

B. The Onset of the Crypto Winter of 2022

1. Terra Protocol Crash

The crash of the Terra protocol, one of the largest crypto ecosystems,[331] signaled the onset of the Crypto Winter of 2022.[332] The protocol, built on a complex, sophisticated, and automated algorithm-driven stabilization system, had two sister coins: UST, an

327. Beikverdi & Song, *supra* note 310 (explaining a 51% attack occurs when a single entity or coordinated group of miners controls more than 50% of a network's mining hash rate or computing power).

328. Cohen, *supra* note 57.

329. *See Framework for "Investment Contract" Analysis of Digital Assets*, SEC (2017), https://www.sec.gov/files/dlt-framework.pdf [https://perma.cc/G5HN-HZBP] (investigative report) (noting a blockchain platform's lack of decentralization can bring it under the SEC regulation); M. Todd Henderson & Max Raskin, *A Regulatory Classification of Digital Assets: Toward an Operational Howey Test for Cryptocurrencies, ICOs, and other Digital Assets*, 2019 COLUM. BUS. L. REV. 443, 445 (2019); *cf.* Kyle Bersani, *Separating Governance Tokens from Securities: How the Utility Token May Fall Short of the Investment Contract*, 43 CARDOZO L. REV. 1305, 1317–18 (2022) (demonstrating not all governance tokens are securities).

330. Press Release, CFTC, CFTC Imposes $250,000 Penalty Against bZeroX, LLC and Its Founders and Charges Successor Ooki DAO for Offering Illegal, Off-Exchange Digital-Asset Trading, Registration Violations, and Failing to Comply with Bank Secrecy Act (Sept. 22, 2022), https://www.cftc.gov/PressRoom/PressReleases/8590-22 [https://perma.cc/M9CZ-LZ6R].

331. *See* Jiageng Liu, Igor Makarov & Antoinette Schoar, *Anatomy of a Run: The Terra Luna Crash* 1 (Nat'l Bureau of Econ. Rsch., Working Paper No. 31160, 2023); *see also* Sandor & Genç, *supra* note 315 (describing the timeline of Terra's rise and fall).

332. *See Lessons from the Crypto Winter: DeFi Versus CeFi*, OECD BUS. & FIN. POL'Y PAPERS 1, 5 (2022), https://doi.org/10.1787/199edf4f-en [https://perma.cc/HZ33-PVNZ] (showing that the rise and fall of the algorithmic stablecoin and the consecutive failures of other crypto-asset service providers exposed the far-reaching consequences of interconnectivity within the crypto-assets space).

algorithmic stablecoin,[333] and LUNA, the Terra protocol's native cryptocurrency.[334]

Terra's downfall began on May 7, 2022, when UST lost its par to the US dollar.[335] The Terra protocol relied on LUNA to maintain UST's stable value at a one-to-one ratio with the US dollar.[336] When UST lost its par, panic spread among the investors, followed by massive withdrawals of their funds and a sharp decline in the value of both UST and LUNA.[337] At the height of the crisis, LUNA's value declined to just eighty-three cents, marking almost a 98 percent price crash overnight.[338] The token's diminished value exposed the Terra protocol to the risk of 51% governance attacks,[339] compelling the developers to shut down the network and preventing the consumers from withdrawing any funds.[340] Unable to stop the death spiral, the protocol

---

333. *See* Ryan Clements, *Built to Fail: The Inherent Fragility of Algorithmic Stablecoins*, 11 WAKE FOREST L. REV. 131, 133–34 (2021); Ekin Genç, *Algorithmic stablecoins: What They Are and How They Can Go Terribly Wrong*, COINDESK (May 11, 2023, 11:47 AM), https://www.coindesk.com/learn/algorithmic-stablecoins-what-they-are-and-how-they-can-go-terribly-wrong/ [https://perma.cc/A9NA-F2GJ]. While most stablecoins peg to assets or a basket of assets (such as fiat currencies or highly liquid government bonds), algorithmic stablecoins depend on an on-chain incentive-centric, algorithm-based tokenomics that facilitates the supply and demand of the stablecoin. *See* Clements, *supra*. Therefore, if the "incentive structure in any algorithmic stablecoin ecosystem breaks down, the entire ecosystem fails without a backstop or depository insurance safety net." Douglas Arner, Raphael Auer & Jon Frost, *Stablecoins: Risks, Potential and Regulation* (Bank for Int'l Settlements Working Paper No. 905, 2020), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3979495 [https://perma.cc/W8XD-KCJ6]; *Global Stablecoin Initiatives*, INT'L ORG. SECS. COMM'NS 3–4 (2020), https://www.iosco.org/library/pubdocs/pdf/IOSCOPD650.pdf [https://perma.cc/7H57-T5NG].

334. Allison Morrow, *Why This Obscure Corner of the Crypto World has Investors in a Panic*, CNN BUS. (May 13, 2022, 4:36 AM), https://www.cnn.com/2022/05/12/investing/luna-terra-stablecoin-explained/index.html [https://perma.cc/27FA-N59F] (describing the relationship between these sister coins).

335. Sandor & Genç, *supra* note 315.

336. *Id.*; Liu et al., *supra* note 331, at 2.

337. *See What Really Happened to LUNA Crypto?*, FORBES (Sept. 20, 2022, 11:57 AM), https://www.forbes.com/sites/qai/2022/09/20/what-really-happened-to-luna-crypto/?sh=29ab1d444ff1 [https://perma.cc/4SJN-LU38] [hereinafter *LUNA Crypto*] (noting prior to the crash, Luna was sold for $116).

338. Anthony Cuthbertson, *'I Lost My Life Savings': Terra Luna Cryptocurrency Collapses 98% Overnight*, YAHOO FIN. (May 11, 2022, 11:08 AM), https://news.yahoo.com/lost-life-savings-terra-luna-160848651.html [https://perma.cc/KP5U-A228].

339. *LUNA Crypto*, *supra* note 337 (noting that LUNA was also used as governance tokens).

340. Jonathan Ponciano, *Terra Blockchain Halted to 'Prevent Attacks' After Luna Token Crashes Nearly 100% Overnight*, FORBES (May 16, 2022, 10:03 AM), https://www.forbes.com/sites/jonathanponciano/2022/05/12/terra-blockchain-halted-to-prevent-attacks-after-luna-token-crashes-nearly-100-overnight/?sh=6511b875248f [https://perma.cc/YK23-8G8W].

fully collapsed in less than seventy-two hours, wiping out billions from the market and causing many investors to lose everything.[341]

Exactly what triggered the initial plummeting of UST remains unknown. The underlying reason for the crash can be attributed to large hedge funds with substantial UST holding "adjust[ing] their position" on May 7, 2022, and other larger traders following suit.[342] The inherent transparency of the technology allowed wealthy and sophisticated investors to detect market swings early, enabling them to promptly exit the market.[343] Meanwhile, less sophisticated individuals lacking these advantages suffered substantial losses.[344]

The Terra debacle also exposed the limitations of existing blockchain organizations' tokenomics framework.[345] The crux of Terra's economic framework is the algorithmic relationship between UST and LUNA, with the latter designed to absorb the volatility of the former.[346] Hence, when UST devalued, the protocol began continuously minting LUNA, which caused precipitous inflation.[347]

The implementation of DeFi protocols, including stablecoins, often relies on smart contracts.[348] These self-executing contracts, with the terms of the agreement directly written into code, play a crucial role in automating and enforcing the rules of various blockchain-based financial instruments.[349] While the smart contract regulates the relationship between the stablecoin and other cryptocurrencies used to artificially create a supply-demand architecture,[350] there are at least

---

341. *See* David Chau, *Evil Genius' May Have Caused Terra and Luna Cryptocurrencies to Crash in a 'Death Spiral*,*'* ABC NEWS (May 12, 2022), https://www.abc.net.au/news/2022-05-13/bitcoin-crypto-terra-ust-luna-stablecoin-evil-genius-plot/101062388 [https://perma.cc/AAC3-R6SA]; *e.g.*, Keoni Everington, *Taiwanese Man Commits Suicide After Losing Nearly NT$60 Million From Luna Crypto Crash*, TAIWAN NEWS (May 26, 2022, 5:21 PM), https://www.taiwannews.com.tw/en/news/4551502 [https://perma.cc/WTY5-TKG7]; Cuthbertson, *supra* note 338.

342. Chau, *supra* note 341; Liu et al., *supra* note 331, at 2.

343. *See* Auerlie Barthere, Yong Li Khoo, Xin Yi Lim, Beili Baraki, Philip Grushyn & Joshua Ho, *On-Chain Forensics: Demystifying TerraUSD De-peg*, NANSEN (May 27, 2022), https://www.nansen.ai/research/on-chain-forensics-demystifying-terrausd-de-peg [https://perma.cc/8G9B-QD63] (describing several wallets exiting their UST positions via Curve).

344. *See* Everington, *supra* note 341.

345. *See* SEAN AU & THOMAS POWER, TOKENOMICS: THE CRYPTO SHIFT OF BLOCKCHAINS, ICOS, AND TOKENS (1st ed. 2018) ("[Tokenomics entails] the study, design, and implementation of an [ad hoc] economic system to incentivize specific behaviors in a community, using tokens . . . . It includes game theory, mechanism design, and monetary economics.").

346. Clements, *supra* note 333, at 250.

347. Genç, *supra* note 333.

348. *See* Raskin, *supra* note 16.

349. *See generally* Werbach, *supra* note 16.

350. For the specific mechanism between UST and LUNA supply and demand, *see* Gary B. Gorton & Jeffery Y. Zhang, *Taming Wildcat Stablecoins*, 90 U. CHI. L. REV. 909, 915 n.17 (2023).

three ways that concentrate risk in the trust placed in the code. First, unlike other stablecoins pegged to stable forms of assets, algorithmic stablecoins are typically undercollateralized,[351] meaning that "[s]mart contracts are used to manage the supply of the digital coin with the goal of maintaining its value against, *inter alia*, the dollar."[352] Second, a coded stabilization mechanism does not fully address the intensity or severity of an economic downturn situation.[353] Thus, if the stability mechanism breaks down at any point, the automated stabilizing mechanism is not designed to take appropriate measures, which can cause the abrupt devaluation of the stablecoins.[354] Third, the existing governance structure of a blockchain network, particularly a network built on an on-chain platform, is not designed to respond promptly to any abrupt change in the economic model.[355] Hence, when UST lost its peg, the situation was further aggravated by the centralized control wielded by the founder of Terra protocol and the development team, who struggled to address the unfolding crisis effectively.[356] The protocol's reliance on a complex, algorithm-driven design raised questions about its fundamental soundness and whether community members had meaningful input on addressing its design vulnerabilities.[357]

---

351. Yiğit Yektin, *Algorithmic Stablecoins*, MEDIUM (Nov. 29, 2023), https://medium.com/@yigit.yektin/algorithmic-stablecoins-774fd66d8e1c#:~:text=Algorithmic%20stablecoins%20are%20typically%20undercollateralized,their%20algorithm%20to%20their%20lives [https://perma.cc/RKK3-DKBG].

352. Barry Eichengreen, *From Commodity to Fiat and Now to Crypto: What Does History Tell Us?* 1, 8 (Nat'l Bureau of Econ. Rsch., Working Paper No. w25426, 2019), https://www.nber.org/system/files/working_papers/w25426/w25426.pdf [https://perma.cc/WM3W-654H].

353. *See generally* Clements, *supra* note 333.

354. *Id.*

355. *See Governance*, TERRA DOCS, https://docs.terra.money/develop/module-specifications/spec-governance/#proposal-types [https://perma.cc/D5L6-KZDK] (last visited Sept. 28, 2024) (showing, for instance, the length of the voting period on the Terra protocol was approximately one week).

356. *See* Alex Dovbnya, *Crypto's Iconic Meme: Anniversary of Do Kwon's Ill-Fated Tweet*, U TODAY (May 9, 2023), https://u.today/cryptos-iconic-meme-anniversary-of-do-kwons-ill-fated-tweet#:~:text=On%20May%209%2C%202022%2C%20Kwon,dollar%20and%20LUNA's%20plummeting%20value [https://perma.cc/F8ZF-AX5A] (showing, for example, Do Kwon's Tweet "[d]eploying more capital – steady lads" was seen as a desperate attempt to generate confidence among Terra community members).

357. *See Governance*, *supra* note 355 (noting, for instance, on the Terra platform, it takes weeks from submitting proposals to voting and implementing a suggestion regarding protocol updates).

2. The FTX Collapse

Blockchain's centralization risk was further demonstrated following the collapse of FTX, one of the leading centralized cryptocurrency exchanges. FTX specialized in trading derivatives and leveraged products and had more than one million users.[358]

On November 11, 2022, FTX, its sister firm Alameda Research, and 130 other affiliated companies filed for bankruptcy following a severe liquidity crunch.[359] Before the collapse, FTX was valued at $32 billion.[360] However, when it filed for bankruptcy, it was revealed that FTX provided a $14 billion loan to Alameda Research from customers, which was not reflected on the company's balance sheet.[361] Moreover, FTX held only $900 million in liquid assets against $13.86 billion in liabilities, which led to its collapse and the freezing of millions of users' wallets.[362] FTX is believed to have over a million creditors, the top 50 of whom collectively owe more than $3 billion.[363] FTX experienced further setbacks while it was in bankruptcy, with $323 million stolen from its international exchange and an additional $90 million taken from its US platform.[364]

Some contend the FTX collapse primarily resulted from governance failure.[365] After all, FTX conducted operations both within

---

358. Arner et al., *supra* note 14, at 2.

359. David Yaffe-Bellany, *Embattled Crypto Exchange FTX Files for Bankruptcy*, N.Y. TIMES (Nov. 11, 2022), https://www.nytimes.com/2022/11/11/business/ftx-bankruptcy.html [https://perma.cc/KT5Q-KSL2].

360. Tom Wilson, *Crypto Exchange FTX Valued at $32 bln as Softbank Invests*, REUTERS (Jan. 31, 2022, 9:34 AM), https://www.reuters.com/markets/us/crypto-exchange-ftx-valued-32-bln-softbank-invests-2022-01-31/#:~:text=LONDON%2C%20Jan%2031%20%28Reuters%29%20-%20Major%20cryptocurrency%20exchange,valuable%20start-ups%20in%20the%20fast-growing%20digital%20currency%20sector [https://perma.cc/DY7V-QSK4].

361. Angus Berwick & Tom Wilson, *Exclusive: Behind FTX's Fall, Battling Billionaires and a Failed Bid to Save Crypto*, REUTERS (Nov. 10, 2022, 4:46 PM), https://www.reuters.com/technology/exclusive-behind-ftxs-fall-battling-billionaires-failed-bid-save-crypto-2022-11-10/ [https://perma.cc/56RN-9TRE].

362. Zahra Tayeb, *FTX Held Just $900 Million in Easy-to-Sell Assets but $9 Billion in Liabilities the Day Before it Imploded, Report Says*, BUS. INSIDER (Nov. 14, 2022, 4:59 AM), https://markets.businessinsider.com/news/currencies/ftx-900-million-assets-against-9-billion-liabilities-cryptocurrency-2022-11 [https://perma.cc/W56A-A2UF].

363. Allison Morrow, *We Finally Know Whom FTX Owes Money To: Wall Street Elite, Big Tech, Airlines, and Many More*, CNN BUS. (Jan. 27, 2023, 9:10 AM), https://www.cnn.com/2023/01/26/investing/ftx-creditors-wall-street/index.html [https://perma.cc/4EDR-G9ZL].

364. Peter Hoskins, *FTX: Collapsed Crypto Exchange Says $415m was Hacked*, BBC (Jan. 17, 2023), https://www.bbc.com/news/business-64313624 [https://perma.cc/QQ8Q-W5HR].

365. *See* Julia Lamorelle & Avery Kayle, *The Downfall of FTX: A Case for Good Governance*, MALK PARTNERS (Nov. 23, 2022), https://malk.com/the-downfall-of-ftx-a-case-for-

and outside the United States and functioned without a board of directors.[366] Thus, a select few individuals held all executive authority and made capricious and risky investment choices that ultimately showed a complete lack of concern for investors and shareholders.[367] This absence of a regulatory framework destroyed FTX's ability to avail itself of emergency lending, leading to its massive collapse that deprived millions of its users of their valuable resources.[368]

To make matters worse, deceptive accounting practices produced inaccurate financial information about the company's health.[369] It was not until FTX collapsed that it was revealed that Alameda Research was trading billions of dollars from FTX accounts while leveraging FTT, the exchange's native token, as collateral.[370] Alameda hid this activity by excluding the assets involved in these trades from its balance sheets.[371] Further, the company failed to maintain accurate financial records of customer funds and apparently employed software to hide their mishandling.[372] Instead of holding any

---

good-governance [https://perma.cc/CCM7-GY5B]; *see also* Declaration of John J. Ray III in Support of Chapter 11 Petitions and First Day Pleadings at 2, *In re* FTX Trading Ltd., No. 22-11068-JTD, 2024 WL 4562675 (Bankr. D. Del. Oct. 23, 2024) ("Never in my career have I seen such a complete failure of corporate controls and such a complete absence of trustworthy financial information as occurred here.").

366. Cindy Moehring, *Six Cross-Industry Lessons from the Rise and Fall of FTX*, SAM M. WALTON COLL. BUS. (Jan. 27, 2023), https://walton.uark.edu/insights/posts/six-cross-industry-lessons-from-the-rise-and-fall-of-ftx.php [https://perma.cc/HZP9-DBGQ].

367. *See* Lamorelle & Kayle, *supra* note 365.

368. See 12 U.S.C. 342 § 13(3). Under this section of the Federal Reserve Act, it can lend directly to individuals and corporations in emergencies. *See id.* However, the FTX or any other blockchain organizations do not enjoy this privilege. *See id.*

369. *See* Paige Tortorelli & Kate Rooney, *Sam Bankman-Fried's Alameda Quietly Used FTX Customer Funds for Trading, Say Sources*, CNBC (Mar. 28, 2024, 4:22 PM) https://www.cnbc.com/2022/11/13/sam-bankman-frieds-alameda-quietly-used-ftx-customer-funds-without-raising-alarm-bells-say-sources.html [https://perma.cc/ATU8-CQW].

370. Matthew Goldstein, Alexandra Stevenson, Maureen Farrell & David Yaffe-Bellany, *How FTX's Sister Firm Brought the Crypto Exchange Down*, N.Y. TIMES (Nov. 18, 2022), https://www.nytimes.com/2022/11/18/business/ftx-alameda-ties.html [https://perma.cc/ZN98-9KC3].

371. Alexander Osipovich, *FTX Founder Sam Bankman-Fried Says He Can't Account for Billions Sent to Alameda*, WALL ST. J. (Dec. 3, 2022, 5:47 PM), https://www.wsj.com/articles/ftx-founder-sam-bankman-fried-says-he-cant-account-for-billions-sent-to-alameda-11670107659?st=g35ia0eu0bjwqzn&reflink=desktopwebshare_permalink [https://perma.cc/E98A-AME6].

372. Angus Berwick, John Shiffman & Koh Gui Qing, *Exclusive: How a Secret Software Change Allowed FTX to Use Client Money*, REUTERS (Dec. 13, 2022, 8:18 PM), https://www.reuters.com/technology/how-secret-software-change-allowed-ftx-use-client-money-2022-12-13/ [https://perma.cc/5XNZ-6HCQ].

money, Alameda engaged in unreported borrowing of billions of dollars of FTX users' funds.[373]

As the contagion of deceptive practices spilled in the crypto world, more companies' exposure to FTX's collapse came to light. For example, crypto lender Genesis sought an emergency loan of $1 billion due to its liquidity crunch.[374] Later, Genesis filed for bankruptcy,[375] and Gemini restricted customers' withdrawals in the wake of an outflow rush.[376] The contagion further spilled into the traditional banking sectors, giving rise to the fear of crypto as a new systemic risk.[377]

The bankruptcy of multiple crypto ventures in 2022 highlighted the lack of transparency, accountability, and consumer protection in crypto practices.[378] The independent examiner report, filed in Celsius Network's Chapter 11 bankruptcy case, revealed that the crypto-lender attracted customer deposits with a false promise of high rewards without providing any degree of protection for their funds.[379] Even though Celsius failed to generate enough profits and could not fulfill its promises, it used customer deposits to inflate the price of its token,

---

373. Matt Steib, *Sam Bankman-Fried Got $2 Billion in Loans from His Own Company*, N.Y. MAG. (Mar. 16, 2023), https://nymag.com/intelligencer/2023/03/sam-bankman-fried-gave-himself-usd2-billion-of-company-money.html [https://perma.cc/ZL2L-PDBM]; George Ugeux, *The FTX Collapse: Why Did Due Diligence, Regulation, and Governance Evaporate?* CLS BLUE SKY BLOG (Nov. 30, 2022), https://clsbluesky.law.columbia.edu/2022/11/30/the-ftx-collapse-why-did-due-diligence-regulation-and-governance-evaporate/ [https://perma.cc/T6BP-QBK4].

374. Paul Kiernan, *Crypto Lender Genesis Had Sought Emergency Loan of $1 Billion*, WALL ST. J. (Nov. 17, 2022, 5:12 PM), https://www.wsj.com/livecoverage/stock-market-news-today-11-17-2022/card/crypto-lender-genesis-sought-emergency-loan-of-1-billion-by-monday-573TThK17Ke15FYwJzLR [https://perma.cc/PR2Y-US2Z].

375. Rohan Goswami & Mackenzie Sigalos, *Crypto Lender Genesis Files for Bankruptcy in the Latest Blow to Barry Silbert's DCG empire*, CNBC (Jan. 20, 2023, 7:35 AM), https://www.cnbc.com/2023/01/20/crypto-lender-genesis-trading-files-for-bankruptcy-barry-silbert-digital-currency-group.html [https://perma.cc/P3LT-QNQV].

376. Nelson Wang, *Genesis' Crypto-Lending Unit Is Halting Customer Withdrawals in Wake of FTX Collapse*, COINDESK (May 8, 2022, 11:02 PM), https://www.coindesk.com/business/2022/11/16/genesis-crypto-lending-unit-is-halting-customer-withdrawals-in-wake-of-ftx-collapse/ [https://perma.cc/9HJZ-3LWE].

377. *See* Gary B. Gorton & Jeffrey Y. Zhang, Bank Runs During Crypto Winter 335 (Sept. 30, 2023) (unpublished manuscript) (on file with Social Science Research Network) (discussing "crypto winter" as a systemic event); Lee Reiners & Sangita Gazi, *Wanted: A Prudential Regulatory Framework for Crypto Assets*, 76 ARK. L. REV. 311, 319 (2023) (discussing the interconnectedness of crypto with the traditional banking sector and the threat of spillover of crypto winter on traditional banks).

378. *See Crypto Crash: Why Financial System Safeguards Are Needed for Digital Assets Before the U.S. Senate Comm. on Banking, Hous., and Urb. Aff.*, 118th Cong. 6 (2023) (statement of Lee Reiners, Policy Director, Duke Financial Economics Center, Duke University).

379. Final Report of Shoba Pillay, Examiner at 3, 5, *In re* Celsius Network LLC et al., Case No. 22-10964 (Bankr. S.D.N.Y. Oct. 3, 2023).

CEL, which benefitted its founders and insiders who made millions from the CEL token sales.[380] At the same time, their lack of transparency on the balance sheet kept millions of customers from knowing the company's true financial situation.[381] Thus, the collapse of these companies surprised customers, who instantly lost their resources.[382]

The Crypto Winter of 2022 demonstrated how blockchain's centralities in operation and management could jeopardize a blockchain network's overall reliability, security, and valuable resources.[383] Blockchain's initial promise of creating a trustless economy has faded, as the ecosystem mostly relies on an intermediated framework.[384] Consequently, community members are increasingly exposed to information and power asymmetry.[385] The single point of failure arising from blockchain's centralities creates a significant risk of resource destruction, instills doubt and fear among users, and repudiates blockchain's "decentralization illusion."[386]

Many commentators have proposed solutions to blockchain's centralities and governance problems.[387] One solution utilizes complex theory to analyze the uncertainty and instability of cryptocurrencies and Initial Coin Offerings.[388] It proposes an adapted version of a corporate governance framework, a Blockchain Governance Code, to mitigate the volatilities associated with these organizations.[389] Relying on the concept of a fiduciary relationship—usually present between the board of directors and shareholders in a company law framework—the Blockchain Governance Code envisions a similar kind of duty between core developers and community members, such as users of

380. *Id.*

381. *See* Krisztian Sandor, *Celsius Acknowledges $1.2B Hole in Balance Sheet*, COINDESK (May 11, 2023, 12:42 PM), https://www.coindesk.com/business/2022/07/14/celsius-acknowledges-12b-hole-in-balance-sheet/ [https://perma.cc/2MYZ-Y9EZ].

382. Cuthbertson, *supra* note 338.

383. *See* Hilary J. Allen, *The Superficial Allure of Crypto*, FIN. & DEV., INT'L MONETARY FUND (Sept. 2022), https://www.imf.org/en/Publications/fandd/issues/2022/09/Point-of-View-the-superficial-allure-of-crypto-Hilary-Allen [https://perma.cc/H9EJ-AQ8V].

384. *See* De Filippi et al., *supra* note 87.

385. *See* discussion *supra* Section II.C.

386. *See* Allen, *supra* note 383, at 28.

387. *See, e.g.*, Philipp Hacker, *Corporate Governance for Complex Cryptocurrencies? A Framework for Stability and Decision Making in Blockchain-Based Organizations*, *in* REGULATING BLOCKCHAIN: TECHNO-SOC. AND LEGAL CHALLENGES 140, 153 (Philipp Hacker et al. eds., 2019).

388. *See id.* (noting that, according to the proposed governance framework, a Blockchain Governance Code is a derivative of a self-regulatory organization represented by various categories of stakeholders and experts).

389. *See id.*

cryptocurrencies.[390] The dynamic of this relationship hinges upon the willingness of core developers to act in good faith and in the interest of the users.[391] This proposed framework also expects separate duties for mining pool operators, who must refrain from influencing the core developers.[392] Alternatively, some scholars have used the information technology governance[393] framework in designing an accountability framework for blockchain organizations.[394]

While these theoretical discourses provide some direction as to what a blockchain framework might look like in an ideal world, they do not sufficiently differentiate between permissioned and permissionless blockchain networks and the governance problems arising from embedded blockchain centralities.[395] Moreover, they do not address how to resolve blockchain's social dilemmas: the concentration of power and information asymmetry.[396] Current frameworks also show that it is difficult to determine the degree of accountability and transparency in important decision-making.[397] The common approach to blockchain governance must underscore the underlying incentive problems of the network in order to sustainably preserve blockchain's shared resources.

Given blockchain's purported centralities and emerging risks in the market, a decentralized and transparent blockchain governance model is instrumental in increasing trust and symmetry in the power structure of a blockchain network.

IV. TREATING BLOCKCHAIN AS A COMMONS

There is a strong case for treating public blockchain as a commons. The sustainability of a public blockchain system significantly relies on its ability to continually generate value through various applications (ranging from the creation of native tokens to myriad use cases, such as dApps, DeFi, and stablecoins) and the community's trust in the governance.[398] If trust is compromised and the governance

390. *See id.* at 157.

391. *Id.*

392. *Id.* at 162.

393. *See* Beck et al., s*upra* note 12, at 1022. Beck, Müller-Bloch & King define IT governance as "the framework for decision rights and accountabilities to encourage desirable behavior in the use of IT." *Id.* at 1030.

394. *Id.*

395. *Id.* at 1028.

396. *Id.* at 1030–31.

397. *See generally* Johannes Sedlmeir, Jonathan Lautenschlager, Gilbert Fridgen & Nils Urbach, *The Transparency Challenge of Blockchain in Organizations*, 32 ELEC. MKTS. 1779, 1783–85 (2022).

398. Gazi et al., *supra* note 233, at 9.

mechanism encourages opportunist behaviors, it can potentially jeopardize the long-term growth of a blockchain-based ecosystem and place its value at risk.[399] Therefore, blockchain organizations can benefit from Elinor Ostrom's work on commons governance, as it can provide an overarching framework for the sustainable preservation of blockchain's shared resources.[400]

A. Historical Evolution of the Commons Theory

In 1833, William Lloyd, an American social reformer, introduced the concept of commons while studying the risk of overpopulation in the consumption of public resources.[401] Using the example of cattle grazing by herders, Llyod argued that if herders added more cattle to graze, they would receive individual benefits, while all herders would suffer from the resulting damage collectively.[402] Lloyd's groundbreaking work challenged the prevailing notions of rationality and highlighted how individuals could prioritize their own interests in utilizing common property, resulting in the drastic depletion of common resources.[403] Building upon Llyod's thesis, in 1968, Garret Hardin, a prolific ecologist who, in his *Tragedy of the Commons*, echoed similar concerns and argued that when individuals have unrestricted access to a common resource, they tend to exploit it to their maximum advantage.[404] Hence, shared resources often require an effective governance mechanism that encourages the users to consume these resources responsibly and sustainably.[405]

Initially, discussions surrounding the commons governance primarily revolved around centralized methods, such as entrusting shared resources to the government or privatizing them.[406] Nevertheless, Ostrom, for the first time, demonstrated that we are not necessarily confined to a binary choice between state and market

399. *Id.*

400. *Id.* at 10.

401. William F. Lloyd, *W. F. Lloyd on the Checks to Population*, 6 POPULATION & DEV. REV. 473, 479 (1980).

402. *Id.* at 483.

403. *Id.* at 479.

404. Hardin, *supra* note 94, at 1244.

405. *Id.*

406. *See* Ostrom, *Beyond Markets and States*, *supra* note 71, at 642. Historically, researchers have recommended solving the commons problem either through privatization or centralized government structure. Ostrom, GOVERNING THE COMMONS, *supra* note 94, at 9. Commons users themselves may be able to organize small-scale, collective institutions to manage the commonly held resources successfully. *Id.*

approaches.[407] She argued that humans intrinsically possess a multifaceted motivational structure and the capacity to address the challenges of managing common resources through collective efforts.[408] Therefore, community members who consume shared resources can be self-motivated to develop a self-governance mechanism that could ensure the responsible use and sustainable preservation of the commons resources.[409] For some time, Ostrom's theory of commons and commons governance was primarily applied with respect to physical resources (such as fisheries, meadows, and lakes) and studied in terms of local conditions.[410] Later, the theory was extended to include global commons (such as climate change, oceans, and space).[411]

As technology progresses and new resources become accessible, the discourse of the commons has transcended the tangible realm to include digital resources that are developed and preserved on the internet. From a governance perspective, digital resources are often referred to as "knowledge commons,"[412] "digital commons,"[413]

---

407. *See* Ostrom, *Beyond Markets and States*, *supra* note 71, at 643.

408. *See id.* at 656–58.

409. *See id.*; Clark C. Gibson, John T. Williams & Elinor Ostrom, *Local Enforcement and Better Forests*, 33 WORLD DEV. 273, 276 (2005) (hypothesizing that "local users' monitoring and enforcement leads to better forest conditions").

410. Arun Agarwal, James Erbaugh & Nabin Pradhan, *The Commons*, 48 ANN. REV. ENV'T & RES. 531, 532 (2023).

411. *See, e.g.*, Jeffrey L. Dunoff, *Reconciling International Trade with Preservation of the Global Commons: Can We Prosper and Prospect?*, 49 WASH. & LEE. L. REV. 1407, 1408 (1992) (explaining global commons are "areas outside the jurisdiction of any nation or group of nations"); Elinor Ostrom, *A Polycentric Approach for Coping with Climate Change* 2–9, (Pol'y Rsch. Working Paper No. 5095, 2009), https://documents1.worldbank.org/curated/en/480171468315567893/pdf/WPS5095.pdf [https://perma.cc/2U63-GBNY] (discussing climate change as commons); Surabhi Ranganathan, *Global Commons*, 27 EUR. J. INT'L L. 693, 693 (2016); PATTERNS OF COMMONING (David Bollier & Silke Helfrich eds., 2015) (surveying global commons around the world including digital currencies and open-access softwares).

412. For example, scientific knowledge, which is the product of human expertise and scientific capabilities, can be governed as knowledge commons. *See* GOVERNING KNOWLEDGE COMMONS 2 (Brett M. Frischmann, Michael J. Madison & Katherine J. Strandburg eds., 2014). *See generally* Hess & Ostrom, *supra* note 81, at 3 (giving a brief history relating to the research of the knowledge commons).

413. De Rosnay & Stalder, *supra* note 81, at 1 (describing a historical evolution of "the digital commons, from free software, free culture, and public domain works, to open data and open access to science," and "analyz[ing] its foundational dimensions (licensing, authorship, peer production, governance) and finally study newer forms of the digital commons, urban democratic participation and data commons"); Christian Fuchs, *The Digital Commons and the Digital Public Sphere: How to Advance Digital Democracy Today*, 16 WESTMINSTER PAPERS COMM. & CULTURE, 9, 19 (2021) (explaining there are four types and dimensions of the digital commons—natural, economic, political, and cultural).

"information goods,"[414] or the commons-based peer production (CBPP).[415]

In 2005, legal scholar Brett Frischmann introduced the economic theory of treating digital infrastructure, such as the internet, as a commons.[416] Frischmann showed that the internet, which is a combination of "commercial, public, and social infrastructure," can be linked with commons for the purpose of its management.[417] According to his thesis, the core principles of digital infrastructure management hinge upon its ability to maintain openness and ensure non-discriminatory terms without requiring any approval or license.[418] The theoretical contribution of Frischmann provided important insights regarding internet governance that were previously thought to belong to the management of private markets (private property) or government control (public good).[419]

Like traditional commons, these unconventional common resources also encounter social dilemmas.[420] However, typical threats in digital shared resources do not emanate from overconsumption, depletion, or competitive use by human beings.[421] Rather, threats can manifest through poor quality content, low-maintenance infrastructure, lack of management, and the ability for anyone to change the digital content at any time, all of which prevent other community members from benefiting from the resources.[422]

In the context of the digital commons, the absence of a standardized national legal and regulatory framework might affect the

---

414. *See* Michael J. Madison, Brett M. Frischmann & Katherine J. Strandburg, *Reply: The Complexity of Commons*, 95 CORNELL L. REV. 839, 842 (2010).

415. CBPF refers to digital resources created and disseminated collectively like Wikipedia and the free software domain, to the list of digital resources. Mélanie Dulong de Rosnay, *An Introduction to the Digital Commons: From Common-Pool Resources to Community Governance*, HAL OPEN SCI. 5–6 (Sept. 2012), https://shs.hal.science/halshs-00736920 [https://perma.cc/3XY3-RUBP]. *See generally* Yochai Benkler & Helen Nissenbaum, *Commons-based Peer Production and Virtue*, 14 J. POL. PHIL. 394, 394 (2006) (explaining the theoretical framework of the commons-based peer production).

416. Brett M. Frischmann, *An Economic Theory of Infrastructure and Commons Management*, 89 MINN. L. REV. 917, 1015 (2005).

417. *Id.* at 1022.

418. *See id.* at 1007.

419. *See generally* Brett Frischmann, *Privatization, and Commercialization of the Internet Infrastructure: Rethinking Market Intervention into Government and Government Intervention into the Market*, 2 COLUM. SCI. & TECH. L. REV. 1, 1 (2001).

420. Hess & Ostrom, *supra* note 81, at 5.

421. Gazi et al., *supra* note 233, at 9.

422. For instance, for knowledge commons, Ostrom and Hess argue that such dilemmas arise from "commodification or enclosure" of knowledge, "pollution and degradation, and non-sustainability." *See* Ostrom & Hess, *supra* note 81, at 5.

open-access rule to these resources.[423] Moreover, a market-based private regulation can lead to the underutilization of shared resources because of strict legal and licensing regimes (the "tragedy of the anticommons").[424] Therefore, some scholars argue that a community-based approach founded on Ostrom's eight design principles[425] can inspire users to preserve online resources spontaneously, use them responsibly, and improve the shared knowledge base over time.[426] The underlying rationale, as argued by Michael Madison, Frischmann, and Kathrine Strandburg is that any shared technology infrastructure or knowledge "institutionalize[s] community governance" because they depend on contributions from various actors.[427] Hence, the community has the incentive to develop a mechanism for self-regulation driven by mutual interests,[428] which is to ensure the authenticity, credibility, and quality of scientific knowledge and information.[429]

---

423. De Rosnay, *supra* note 415, at 4.

424. *Id.* at 5. *See generally* Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 622 (1998) (explaining the theory of the anticommons).

425. Ostrom's eight design principles are: (1) the resources and the users of those resources should be clearly defined; (2) rules governing the use of common resources should be adapted to local needs and conditions; (3) most individuals affected by the operational rules should be able to participate in modifying these rules; (4) there should be monitors who actively audit CPR conditions and appropriator behavior; (5) appropriators who violate operational rules are likely to face graduated sanctions; (6) there should be rapid, low-cost, local arenas to resolve conflicts among appropriators or between appropriators and officials; (7) the rights of appropriators to devise their own institutions are not challenged by external governmental authorities; and (8) appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises. Ostrom, *Beyond Markets and States*, *supra* note 71, at 653.

426. For example, Wikipedia is improved by individual contribution. *Wikipedia: Contributing to* Wikipedia, WIKIPEDIA, https://en.wikipedia.org/wiki/Wikipedia:Contributing_to_Wikipedia [https://perma.cc/K9QL-XHXM] (last visited, Sept. 12, 2024). For the discussion on Ostrom's eight design principles in the context of digital resource management, *see* Ostrom, *Beyond Markets and States*, *supra* note 71, at 653.

427. *See* Madison et al., *supra* note 414, at 841. *See generally* Brett M. FRISHMANN, MICHAEL J. MADISON & KATHERINE J. STRANDBURG, GOVERNING KNOWLEDGE COMMONS 1–2 (Brett Frischmann et al. eds, 2014).

428. *See* Murtazashvili et al., *supra* note 83, at 112; De Filippi & Loveluck, *supra* note 45, at 3.

429. Another dimension to the application of the commons approach to digital infrastructure is to provide open accessibility to quality data for research purposes. *See, e.g.*, Jane Yakowitz, *Tragedy of the Data Commons*, 25 HARV. J. L. & TECH. 1, 4 (2011) (arguing the risks of treating data as commons).

B. Argument for Blockchain as a Commons

The utilization of commons theory in blockchain technology is relatively new.[430] Within the existing discourse, most discussions rely heavily on a technological deterministic perspective.[431] This perspective asserts that the underlying infrastructure and protocols play a pivotal role in shaping and influencing social structures, cultural values, and community engagement.[432] In a seminal work, authors David Rozas, Antonio Tenorio-Fornés, Silvia Díaz-Molina, and Samer Hassan analyzed Ostrom's design principles in relation to *commons governance by blockchain*—the organizational process that depends, at least in part, on blockchain infrastructure.[433] In their study, they contend that each of Ostrom's principles can be adapted to the potential functionalities (referred to as "affordances") of blockchain technology, which they identify as tokenization, self-enforcement, formalization of rules, autonomous automation, decentralization of infrastructure control, enhanced transparency, and trust codification.[434] These affordances construct a compelling argument for governance by blockchain, particularly for the purpose of governing commons-based peer production.[435]

Other scholars, such as Ilia Murtazashvili, Jennifer Brick Murtazashvili, Martin B. H. Weiss, and Michael J. Madison theorize blockchain networks (regardless of their accessibility and categorization of private and public blockchain networks) as "knowledge commons" by arguing that "blockchain networks rely on sharing of resources in nested, or layered, patterns."[436] The resources, such as data and information produced through blockchain networks, are "accessible to all [participants] who have access rights" and whose

430. Rozas et al., *supra* note 79, at 2.

431. *Id.* at 3.

432. *Id.*

433. *Id.*

434. *Id.* at 5–11.

435. *See id.* at 5. For alternative arguments, *see* James Grimmelmann & A. Jason Windawi, *Blockchains as Infrastructure and Semicommons*, 64 WM. L. REV. 1097, 1116 (2023) (asserting that blockchain infrastructure embodies the traits of semicommons); Chetan Chawla, *Blockchains and NFTs: Tragedy of the Digital Commons or Anticommons?*, J. ACAD. MGMT. (July 6, 2022) (online) (arguing that non-fungible tokens introduce "subtractability and exclusion to digital goods" and could convert blockchain as an anticommons).

436. Murtazashvili et al., *supra* note 83, at 113; *see also* Sinclair Davidson, Primavera De Filippi & Jason Potts, *Blockchains and the Economic Institutions of Capitalism*, J. INSTITUTIONAL ECON. 1, 3 (2017) (proposing that blockchain is a novel form of institutional technology that looks into expanding the provisions for coordinating economic activities across various organizations); Shackelford & Myers, *supra* note 2, at 374–75 (examining Ostrom's theory in the context of blockchain's data, regulation, and cybersecurity).

governance is "characteristically 'bottom-up' results of collective activity."[437] This form of collective action within a network generates various actors with different roles—some perform the core operations of the network (such as node-runners, validators, and miners) while others are ordinary users.[438] Blockchain networks also generate shared data and information that could fall within the purview of the commons.[439] Meanwhile, other researchers have made an effort to identify blockchain's common pool resources[440] and have explored the effectiveness of implementing a tiered polycentric governance approach within a blockchain network. [441]

Despite the multidimensional approach to applying Ostrom's theory in the context of blockchain, the discourse of digital commons represents a significant shift in the approach to the governance of shared resources.[442] Stemmed from the principle of "common-pool resources,"[443] Ostrom's governance approach shows that digital resources can share the attributes of physical commons resources, both in terms of characteristics and consequences, and can be effectively managed through cooperation and collective action rather than through privatization or government intervention.[444] Ostrom's insights offer a

---

437. Murtaszashvili, *supra* note 83, at 111–12.

438. *See id.* (citing De Filippi, P. & Loveluck, *supra* note 45, at 1–28).

439. *Id.* at 109. There are also opposing views regarding the characterization of blockchain networks as commons. *See* Kostakis & Bauwens, *supra* note 28, at 38 (arguing that blockchain networks (such as Bitcoin) do not necessarily form a commons-oriented project) (cited in Vangelis Papadimitropoulos, *Reflections on the Contradictions of the Commons*, 50 REV. RADICAL POL. ECON. 317 (2018))).

440. *See, e.g.*, Bronwyn E. Howell, Petrus H. Potgieter & Bert M. Sadowski, Governance of Blockchain and Distributed Ledger Technology Projects 4 (June 19–21, 2019) (unpublished paper), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3365519 [https://perma.cc/5YVH-LMNW] (applying Elinor Ostrom's Institutional Analysis for Development Framework into the DLT's comprehensive governance structures).

441. Gazi et al., *supra* note 233, at 5 (discussing a tiered governance approach, which, unlike a vertical top-down, ties governing participants with their reward and responsibility).

442. *See generally id.*

443. *See* Gardner et al., *supra* note 80, at 335–36 (outlining the pre-conditions that make common-pool resources distinguishable from the commons). First, the resources are subtractable, meaning a resource unit consumed or withdrawn by one individual is not fully available to another individual. *Id.* Therefore, "[w]hen a resource has no natural replacement (exhaustible resource), then any withdrawal rate will lead to exhaustion. *Id.* Second, there are multiple individuals who are appropriating the resource units." *Id.*

444. Elinor Ostrom, *Institutional Arrangement for Resolving the Commons Dilemma: Some Contending Approaches* 20–25 (Mar. 23–27, 1985) (unpublished paper) (on file with Indiana University), https://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/2274/Institutional_Arrangements_for_Resolving_the_Commons_Dilemma.pdf?sequence=1&isAllowed=y [https://perma.cc/CXZ9-4VJ8].

fresh perspective on the challenges and opportunities presented by the digital age.

The underlying rationale for conceptualizing blockchain as a commons lies in incorporating polycentricity into its operational and decision-making framework.[445] The paradox of the current state of blockchain is that while facing social dilemmas like commons—such as the destruction of the network and its resources—the system itself has coordination problems across various nodes and decision-making centers that are likely to arise from its flawed decentralization structure.[446] Under the current framework, each node can make decisions independently without considering what other members of the commons are thinking or doing.[447] Hence, each node can be opportunistic and make self-serving decisions without bearing any accountability, "making it difficult to determine who is responsible for a particular decision or outcome."[448] Moreover, the information asymmetry among various stakeholders (who may have access to important and relevant trade-related content) contributes to a power imbalance during transactions,[449] which jeopardizes the interests of the common consumers and threatens the reliability of the technology itself.[450]

Polycentricity, a decentralized governance approach, involves collaborative efforts among multiple actors of authority or power who

---

445. *See generally* Andreas Thiel & Christine Moser, *Foundational Aspects of Polycentric Governance: Overarching Rules, Social-Problem Characteristics and Heterogeneity*, *in* GOVERNING COMPLEXITY (Andreas Thiel, William A. Blomquist & Dustin E. Garrick eds., 2019) (explaining three foundational aspects of polycentric governance—the legitimacy and recognition of decision-making entities, identifying social problems, and heterogeneity of the characteristics of actors and groups).

446. *See supra* text accompanying notes 438–45.

447. *See* Thiel & Moser, *supra* note 445, at 65 (cited in Mahmoud Shihadeh, *Polycentric Governance in Blockchain-based applications: Transforming Government Services in the UAE* 35 (unpublished manuscript) (on file with the University of Leicester)).

448. *See id.* at 80.

449. Andrew Singer, *Is Asymmetric Information Driving Crypto's Wild Price Swings?*, COINTELEGRAPH (Apr. 18, 2022), https://cointelegraph.com/news/is-asymmetric-information-driving-crypto-s-wild-price-swings [https://perma.cc/2A56-G7TR]; De Filippi et al., *supra* note 87, at 6 (discussing replacing blockchain's trust with confidence); *see also* KWANSOO KIM & ROBERT J. KAUFFMAN, ON THE EFFECTS OF INFORMATION ASYMMETRY IN DIGITAL CURRENCY TRADING 1–4 (2024), https://ink.library.smu.edu.sg/cgi/viewcontent.cgi?params=/context/sis_research/article/9736/&path_info=InfoAsymm_DigitalCurrTrading_av.pdf [https://perma.cc/4BUH-ZEQD] (examining Bitcoin-related information asymmetry). *See generally* Krystyna Kozak, *Algorithmic Governance, Code as Law, and the Blockchain Common: Power Relations in the Blockchain-Based Society*, FRONTIERS BLOCKCHAIN (July 31, 2023), https://www.frontiersin.org/journals/blockchain/articles/10.3389/fbloc.2023.1109544/full [https://perma.cc/2NBV-P88F].

450. Cohen, *supra* note 57, at 2.

jointly create and enforce rules.[451] A polycentric system consists of many autonomous decision-making units "capable of making mutual adjustments" that have "incentives to create or institute appropriate patterns of ordered relationship."[452] At its conception, polycentricity did not eliminate the role of a central authority (a top-down approach).[453] A top-down approach is not ideal for understanding a polycentric system because it contradicts the core principle of multiple independent decision-making centers.[454] Rather, polycentricity emphasizes bottom-up governance, leveraging local knowledge and adaptability.

However, Ostrom envisioned polycentricity as a multitier governance system and transformed the system.[455] While studying the problem of overconsumption of natural resources and comparing their governance framework across many countries, Ostrom concluded that humans are capable of governing the common-pool resources spontaneously.[456] Ostrom observed that humans possess a "complex motivation structure" that cannot be regulated or confined by the binary choices between state and market.[457] Instead, common-pool resources can be managed collectively in a community via "many vibrant self-governed institutions."[458]

Based on her empirical research on community-driven commons management across the world, Ostrom devised a polycentric system comprising design principles that can operate without any control from a central authority.[459] In this system, each actor acts independently but organically builds a self-organized system that can "persist and adapt without requiring central or outside planning or direction."[460] This

---

451. *See* Shackelford & Myers, *supra* note 2, at 369.

452. Harini Nagendra & Elinor Ostrom, *Polycentric Governance of Multifunctional Forested Landscapes*, 6 INT'L J. COMMS. 104, 115 (2012) (citing Vincent Ostrom, *Polycentricity (Part 1)*, *in* POLYCENTRICITY AND LOCAL PUBLIC ECONOMIES 52, 57, 59 (Michael McGinnis ed., 1999)). *See generally* Vincent Ostrom, *Polycentricity*, *supra* note 70, at 9 (discussing polycentricity across various decision-making organizations); Michael McGinnis, Polycentric Governance in Theory and Practice: Dimensions of Aspiration and Practical Limitations 6 (unpublished manuscript) (on file with Social Science Research Network) (proposing that the decision-making authority is the foundation on which a polycentric system must be developed).

453. *See* Ostrom, et al., *supra* note 57, at 831.

454. *See* Ostrom, *supra* note 72, at 552.

455. Nagendra & Ostrom, *supra* note 452, at 117.

456. *See id.* at 117–18.

457. *Id.* at 117.

458. *Id.*

459. Ostrom, *Beyond Markets and States*, *supra* note 71, at 653.

460. *See id.*; Ostrom, *Governing the Commons*, *supra* note 94, at 38; Ostrom, *Polycentricity*, *supra* note 70, at 13; Keith Carlisle & Rebecca L. Gruby, *Polycentric Systems of Governance: A Theoretical Model for the Commons*, 47 POL'Y STUD. J. 927, 934 (2017) (citing Louis

paradigm marks a shift from a monocentric system characterized by a hierarchical flow of mandates from the top down—either through government or private market regulation—to a bottom-up approach, keeping the community's interest at the center of the governance process.[461] Yet, "polycentricity is not just about the number of levels or actors;"[462] instead, these actors "[must] have a good understanding of local conditions."[463] In such a system, the decision-makers need sufficient coordination among them and should be accountable for others' decisions.[464]

In blockchain organizations, the decision-making mechanisms are distributed across a myriad of actors and stakeholders.[465] The system involves a complex incentive structure, ranging from monetary to nonmonetary incentives.[466] While incentive mechanisms aim to pursue specific goals (for example, strengthening the safety and sustainability of a blockchain system),[467] each of these mechanisms can behave dishonestly and selfishly.[468] Ostrom particularly emphasizes the complexity involved in the governance of shared resources, given that each decision-making actor or group has a different set of responsibilities yet competitive interests.[469] Therefore, blockchain's distributed decision-making or decentralized nodes are not sufficient to implement a polycentric governance approach.[470]

C. The Three Principal Elements of Polycentricity

Based on these principles, polycentricity in blockchain organizations requires three principal elements: ensuring sufficient coordination and communication across multiple decision-making

---

Lebel et al., *Governance and the Capacity to Manage Resilience in Regional Social-Ecological Systems,* 11 ECOLOGY & SOC'Y (2006)).

461. *See* Nagendra & Ostrom, *supra* note 452, at 104.

462. Xian-Chun Tan et al., *Research on the Carbon Neutrality Governance Under a Polycentric Approach*, 13 ADVANCES CLIMATE CHANGE RSCH. 159, 160 (2022).

463. *Id.*

464. *Id.* at 161; *see also* Carlisle & Gruby, *supra* note 460, at 928.

465. *Supra* Part II.

466. For a general incentive analysis of blockchain, *see* Han et al*., supra* note 216, at 4–5, 7.

467. *Id.* at 8.

468. For instance, in a PoW consensus protocol, miners have the arbitrary power to refuse a transaction. Rahul Reddy Annareddy, Incentive Analysis of Blockchain Technology 48, 49–50 (2022) (Graduate Thesis) (on file with West Virginia University), https://researchrepository.wvu.edu/cgi/viewcontent.cgi?article=12417&context=etd [https://perma.cc/G5T3-8PET].

469. Nagendra & Ostrom, *supra* note 452.

470. Tan et al., *supra* note 462, at 160.

authorities (i.e., stakeholders),[471] harmonization between rules and incentives for participation,[472] and an accountability framework.[473]

1. Coordination and Cooperation Among Blockchain Stakeholders

As discussed in previous sections, the landscape of permissionless blockchain networks comprises a complex ecosystem.[474] It is a tapestry of actors—internal (e.g., developers, miners, node-runner users), and external (e.g., law, regulation, competition)—each harboring its own interests and stakes in the governance process.[475] Trust is distributed across these actors, who usually do not possess unilateral power to influence the operation of the network.[476] Yet, over the years, blockchain's journey towards decentralized governance was fraught with challenges, particularly in mitigating the competitive interests among various stakeholders[477] and promoting coordinating cooperation between internal and external actors.[478] To achieve optimal decentralization in blockchain governance, polycentricity requires that these actors organize in a coordinated way so that they can interact with each other and cope with conflicting interests and incentives.[479] Therefore, the key to achieving decentralization via a polycentric governance arrangement is to (1) understand the dynamics of relationships among various actors who have a stake in the governance of a resource and (2) acknowledge that every actor may have competing interests in the consumption of the resource.[480]

In order to enable coordination and communication while still maintaining decentralization in blockchain governance, it is important to find solutions that effectively curb blockchain's centralization risks.[481] One solution offers a governance framework structured to

471. Carlisle & Gruby, *supra* note 460, at 928.

472. Shackelford & Myers, *supra* note 2.

473. Tan et al., supra *note* 462, at 166.

474. *Supra* Section IV.B.

475. Alston, *supra* note 84; De Filippi et al., *supra* note 87, at 8.

476. De Filippi et al., *supra* note 4, at 359.

477. *Id.*

478. *Id.* at 366.

479. Carlisle & Gruby, *supra* note 460.

480. De Filippi et al., supra note 4, at 358–59.

481. *See* Frischmann, *supra* note 416 (discussing the example of the internet, which began as a decentralized infrastructure and subsequently came under the centralized regulatory structure).

identify blockchain's decentralization level, stakeholders, and their respective decision-making rights, accountability, and incentives.[482] Including this information in the governance structure helps all stakeholders, as well as the general public, better understand the "authority, capability, and responsibility" of blockchain governance.[483] Another framework suggests that any decision made within a blockchain system should be monitored.[484] Such a framework incorporates an enforcement mechanism that enacts, specifies, and enforces accountability.[485]

2. Harmonization of Participation Rules and Incentives

An equally vital aspect of polycentricity in blockchain involves determining how blockchain actors overcome their competitive interests, set aside their own individual interests, and actively contribute to the blockchain network's sustainable and long-term growth.[486] Since Bitcoin's popularity, scholars have analyzed users' motivations for using cryptocurrencies and the diffusion of technology in general.[487] As a currency, blockchain's native token, cryptocurrency, usually holds an appeal because it offers a promise to facilitate a social order primarily organized around individuals entering voluntary associations and relies less upon state institutions,[488] such as traditional financial institutions.[489] However, the potential of the technology is not just limited to its economic and financial benefits—it is more complex.[490]

Building upon these complex motivations and potential benefits, stakeholder incentives assume a pivotal role, particularly within the distinctive framework of a blockchain system where a centralized

---

482. Yue Liu et al., *Defining Blockchain Governance Principles: A Comprehensive Framework*, 109 INFO. SYS. 1, 2 (2022), https://www.sciencedirect.com/science/article/abs/pii/S0306437922000758 [https://perma.cc/U5Q9-UKCN].

483. *Id.* at 1.

484. Beck et al., *supra* note 12.

485. Liu et al., *supra* note 482, at 4.

486. Alston et al., *supra* note 84.

487. *See supra* Part II.

488. Bill Maurer, Taylor C, Nelms & Lana Swartz, *"When Perhaps the Real Problem is Money Itself!": The Practical Materiality of Bitcoin*, 23 SOC. SEMIOTICS 261, 262–63 (2013).

489. Masooda Bashir, Beth Strickland & Jeremia Bohr, *What Motivates People to Use Bitcoin*, SOC. INFORMATICS 347, 357 (2016).

490. *See* Walid Al-Saqaf & Nicolas Seidler, *Blockchain Technology for Social Impact: Opportunities and Challenges Ahead*, 2 J. CYBER POL'Y 338, 338 (2017) (describing blockchain's social impacts, such as protecting individuals from undue online surveillance, privacy, and censorship).

authority is conspicuously absent.[491] These incentives become the linchpin in fostering a polycentric system's spontaneity.[492] That is, the innate capacity of a large number of individuals to self-organize through "spontaneous mutual adjustment."[493] Such a spontaneous order transcends selfish behavior and destructive tendencies.[494]

Although the exact design of an incentive structure is beyond the scope of this Article, designing an efficient incentive structure involves scrutinizing the actors responsible for decision-making, their motivations and incentives, and their overall organizational values.[495] Like any institution, blockchain organizations need a dual incentive structure: "to improve their own utility while at the same time benefiting the entirety of the institution in the long run."[496] Otherwise, "rational and opportunistic internal and external constituents" may attempt to exploit the organization's governance design.[497] The incentive structure should be designed to motivate participants to "choose actions that coincide with goals of the system's design."[498] Incentive structures should also stress the importance of "aligning the incentives of the various actors" and ensuring active involvement and engagement from all stakeholders throughout the governance process.[499]

Nonetheless, the incentive design must ensure fair cost-benefit distributions among the stakeholders.[500] Even within the existing reward-based incentive system of blockchain protocols, rewards should be proportional to their responsibilities.[501] This proportional exposure system can be achieved by locking their governance token for a certain period, much like how shareholders lock their shares in an equity

---

491. Project Liberty & BlockchainGov, *supra* note 195, at 22.

492. *Id.*

493. William A. Fletcher, *The Discretionary Constitution: Institutional Remedies and Judicial Legitimacy*, 91 YALE L.J. 635, 694 (1982), (citing Michael Polyani, *Planning and Spontaneous Order*, 16 MANCHESTER SCH. 237, 239 (1948)); Ostrom, *Polycentricity*, *supra* note 57, at 6.

494. Polanyi, *supra* note 493; Ostrom, *Polycentricity*, *supra* note 57, at 6.

495. Project Liberty & BlockchainGov, *supra* note 195, at 20.

496. Wulf A. Kaal, *Blockchain-Based Corporate Governance*, 4 STAN. J. BLOCKCHAIN & POL'Y 3, 11 (2020).

497. *Id.*

498. *Id.* at 8; *see also* Han et al., *supra* note 255, at 8.

499. Mark Fenwick, Joseph A. McCahery & Erik P.M. Vermeulen, *The End of 'Corporate' Governance: Hello 'Platform' Governance*, 20 EUR. BUS. ORG. L. REV. 171, 179 (2019).

500. Ji Hyun Kim, Barry Gerhart & Meiyu Fang, *Do Financial Incentives Help or Harm or Performance in Interesting Tasks*, 107 J. APP. PSYCH. 153, 153 (2022).

501. Gazi et al., *supra* note 233, at 1.

investment.[502] This type of system would encourage stakeholders (as well as the governor) to act beyond their self-interest and pursue the collective goal.[503] Blockchain organizations can also integrate reputation-based incentive structures, which can incentivize good behavior, discourage bad behavior, and foster trust among peers.[504]

3. Designing an Accountability Framework

The third crucial aspect of a polycentric governance framework is to integrate transparency and accountability in the decision-making process, which, in turn, increases trust among the community members, especially among those who do not participate in the decision-making process.[505] A blockchain-based organization's legitimacy and credibility among regulators are more likely to increase if governance is conducted in a "morally acceptable way" that "serves the interests of the [consumers]."[506] Currently, blockchain organizations seem to consciously "avoid making 'any one person' responsible (and accountable) for how decisions are made."[507] Hence, many governance practices are informal and unwritten, which creates an information imbalance between decision-makers and community members.[508] The failure of several cryptocurrency projects highlights the lack of clear accountability.[509] Although regulators brought enforcement actions against the founders of several cryptocurrency exchanges and DAOs,[510] under the current process, it is difficult to pinpoint responsibility for

---

502. *Id.* at 12.

503. *Id.*

504. For a general idea, *see* Marcela T. de Oliveira et al., *Blockchain Reputation-Based Consensus: A Scalable and Resilient Mechanism for Distributed Mistrusting Applications*, 179 COMP. NETWORKS 107367, 107367 (2020), https://www.sciencedirect.com/science/article/pii/S1389128620300360 [https://perma.cc/8NWP-A6XL]. As an example of a specific design structure, *see* Chenyu Huang, *RepChain: A Reputation-Based Secure, Fast and High Incentive Blockchain System via Sharding*, 8 IEEE IOT J. 4291, 4299 (2021).

505. Tan et al., *supra* note 463, at 164; Carlisle & Gruby, *supra* note 460, at 927.

506. Project Liberty & BlockchainGov, *supra* note 195, at 36.

507. *Id.* at 35.

508. *Id.* at 36.

509. *Supra* Section III.B.

510. *See, e.g.*, *Global Regulatory Actions against FTX*, REUTERS (Dec. 12, 2022, 9:03 PM), https://www.reuters.com/technology/global-regulatory-actions-against-ftx-2022-12-13/ [https://perma.cc/LX6E-2XXW]; Press Release, SEC, SEC Charges Terraform and CEO Do Kwon with Defrauding Investors in Crypto Schemes (Feb. 16, 2023), https://www.sec.gov/news/press-release/2023-32 [https://perma.cc/72E4-EM2H]; Commodity Future Trading Commission, *supra* note 249.

specific decisions or outcomes for any particular actor or group of actors.[511]

One way of formalizing an accountable governance framework is to implement a blockchain network's constitution embodying a set of "governance principles."[512] Guided by Ostrom's design principles, a blockchain organization can implement a constitutional design that formalizes the rules in a "nested enterprise," enabling blockchain participants to independently organize and govern the network's shared resources..[513] The objective of this constitution is to "establish governance institutions and define their corresponding affordances and constraints."[514]

To achieve this, Ostrom's design principles are categorized into three groups: (1) entry rules, (2) enforcement and execution rules, and (3) dispute resolution mechanisms.[515]

The first set of rules (i.e., entry rules) determines processes that define the terms and conditions for individuals to join a blockchain network.[516] While entry as an actor is voluntary, adherence to these rules is mandatory.[517] Participation or entry rules aim to allow participants to opt into the boundaries and regulations incorporated within a blockchain network's governance framework.[518] Further, the effective institutional design will require properly incentivizing human behavior and establishing a framework to monitor behavior and sanction rulebreakers.[519] While this paper does not outline all the rules in detail, in the context of blockchain, the entry guidelines may incorporate a specified "lock-in period" during which tokens staked within the network cannot be withdrawn by participants.[520] Similar to the initial public offering's "lock-up period," this stipulation ensures that all participants maintain their commitment to the network for the

511. For a nuanced discussion on DAO's liability, *see* Rodrigues, *supra* note 299.

512. Alston et al., *supra* note 84, at 154. While such formalization of the governance process cannot completely abolish informal governance practices, it can foster trust among community members. Project Liberty & BlockchainGov, *supra* note 195, at 35.

513. For example, for a theoretical underpinning on blockchain's constitutionalism, *see* Primavera De Filippi et al., *Blockchain Constitutionalism—The Role of Legitimacy in Polycentric Systems*, EUR. UNIV. INST. 6, 7 (2023), https://data.europa.eu/doi/10.2870/119838 [https://perma.cc/M9JW-DXFU].

514. *Id.* at 6.

515. Gazi et al., *supra* note 233, at 19.

516. *Id.* at 16.

517. *Id.* at 7.

518. *Id.* at 10.

519. *Id.*

520. Gazi et al., *supra* note 233, at 3.

duration of the period.[521] Other potential rules may include mandatory registration for governance participants, the assignment of a unique digital identifier, and the implementation of one vote per digital identifier.[522] These rules will help maintain the integrity of the networks by ensuring that participants understand and agree to the networks' operational principles.

Additionally, in accordance with Ostrom's design principle, it is important to tailor these rules to local conditions; there is no one-size-fits-all approach to blockchain governance.[523] The community of a particular blockchain network should establish these rules according to its requirements, and the governance systems should strive to address the common issues that are pertinent to the community members.[524] Each blockchain network has the power to establish its own set of rules and procedures for participatory decision-making.[525] This empowers communities to customize solutions for individual issues rather than limiting them to a binary choice between "yes" or "no."[526] Allowing communities to establish their own rules shifts power from centralized authorities to the blockchain network's users and stakeholders. Moreover, external entities, whether regulatory or competitive, must acknowledge and respect the authority of community members to make rules.[527] The recognition and legality of the governors can be achieved through community voting.[528]

The second fundamental aspect of accountability is setting out the enforcement rules that dictate the duties and obligations of each network participant to abide by the guidelines coded in the blockchain constitution.[529] This will also include the sanctions to be imposed if a governor breaches any established rules.[530] Such individuals should face sanctions in accordance with the enforcement and execution rules agreed upon by the community.[531]

Lastly, there must be dispute resolution mechanisms to address conflicts arising from decisions.[532] In blockchain networks, conflicts can

521. *Id.*
522. *Id.* at 20.
523. *Id.*
524. *Id.*
525. *Id.* at 3.
526. *Id.* at 23.
527. *Id.* at 13.
528. *Id.* at 20.
529. *Id.* at 19.
530. *Id.*
531. *Id.*
532. *Id.* at 21.

arise from various situations, such as disagreements over protocol changes, token distribution, or the implementation of smart contracts.[533] When a governor faces sanctions or disagrees with a decision, there needs to be a structured way to address these issues. In those circumstances, disputes must be resolved in the manner agreed upon by network members.[534]

V. CONCLUSION

Blockchain's claim of decentralization attracts many users who believe in forming a disintermediated economic system.[535] They envision a fair system where power and information are not concentrated in the hands of a select few.[536] However, centralized blockchain systems have jeopardized the community's trust and exposed community members to the destruction of shared resources and the collapse of the systems.[537] The Crypto Winter of 2022 highlighted blockchain's poor risk management, lack of transparency, and governance failures and revealed its concentration of power, biased decision-making, and lack of effective decentralized models.[538] A shift in philosophy is necessary to overcome the challenges facing blockchain governance.

Elinor Ostrom demonstrates that community users can effectively manage common resources if they adhere to social or legal norms and standards governing their use.[539] Drawing from Ostrom's design principle, a polycentric approach offers a solution to mitigate the decentralization dilemma in blockchain governance.[540] By categorizing a blockchain network's shared resources and following Ostrom's design principles, blockchain technology can empower the network

533. For example, in blockchain, contention happens when multiple transactions conflict on a single record (usually a previous block). Blockchain prioritizes fault tolerance and decentralized record-keeping, eliminating the need for a central authority. Faisal Haque Bappy et al., *Maximizing Blockchain Performance: Mitigating Conflicting Transactions through Parallelism and Dependency Management*, ARXIV (July 1, 2024), https://arxiv.org/html/2407.01426v1#:~:text=In%20blockchain%2C%20contention%20occurs%20when,keeping%20without%20a%20central%20authority [https://perma.cc/HPF6-M4Y2].

534. *Id.*

535. *See generally* Maurer et al., *supra* note 488.

536. *Id.* (labeling the semiotics of blockchain as "practical materialism").

537. *Supra* Part III.

538. *Supra* Section III.B.

539. *See* Ostrom, *supra* note 94.

540. *See generally* OSTROM, UNDERSTANDING INSTITUTIONAL DIVERSITY 31 (Princeton Univ. Press ed. 2005) (exploring the concept of polycentric systems, where multiple governing authorities at different scales interact to make and enforce rules within a specific policy arena or location).

participants to collectively manage their common resources in sustainable and equitable ways.[541] This approach enables blockchain networks to benefit from the collective wisdom of their participants, mitigate the tragedy of the commons, and foster a more resilient and trustless ecosystem.

The potential of blockchain technology lies in the contributions made by its community. As the blockchain industry continues developing, it is crucial to adopt governance models that prioritize decentralization and community empowerment to fulfill the technology's transformative potential. Moving forward, it is crucial to commit to open communication, experimentation, and continuous adjustment of governance models that benefit the community while minimizing the risks of centralization.

541. Gazi et al., *supra* note 233, at 10.