Blockchain’s Embedded Centralities, Risks, and Implications: Applying Ostrom’s Commons Approach to Solve Blockchain’s Governance Dilemma

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**Abstract**

*The recent ‘crypto winter’ shows that the current blockchain governance is prone to centralization risks that can create spiraling spillover effects, destroying network participants’ valuable resources. Under the current framework, the centralized authority usually has the unilateral power to shut down the network, restraining millions of customers from accessing their funds. This ‘crypto-winter’ reminds us to revisit the original value proposition of blockchain technology—what it has promised and achieved so far. The paper posits that blockchain’s inherent value is embedded in its decentralized governance mechanism due to its capacity to distribute power among various decentralized actors—which is the original promise of the technology.
The technology’s decentralized governance mechanism is connected to a blockchain economic value. With its trustless feature and commitment to eliminate third parties in day-to-day transactions, a decentralized governance structure realizes the blockchain’s potential of building an alternative decentralized economy that relies on users’ trust and confidence, thus offering to grow blockchain sustainability. In this regard, the paper critically evaluates the concept of decentralization and what it entails in the context of blockchain’s operation and governance framework. This paper draws on Ostrom’s theories of commons and argues that blockchain protocol is prone to a ‘social dilemma’ – a consequence of blockchain’s embedded centralities in operation and governance structures. Therefore, to prevent the tragedy of the commons, blockchain networks can utilize a polycentric governance approach to curb their governance problems arising from their centralization in operation and decision-making structures.*

# Introduction

Since the advent of Bitcoin and forms of cryptocurrencies, blockchain technology has offered to create a decentralized economy with a distributed power structure.[[2]](#footnote-2) Although the technology existed before the inception of Bitcoin,[[3]](#footnote-3) its proliferation received significant momentum following the global financial crisis of 2008, particularly after the Lehman Brothers collapse, which instilled a general lack of trust in the traditional banking system, paving the way for new technology to offer new possibilities. Blockchain technology, thus, indicated the possibility of building a ‘trustless’[[4]](#footnote-4) economy without needing a third-party financial intermediary.[[5]](#footnote-5) The use of smart contracts – built on self-executing automated codes, allows entities to design novel financial instruments that act like loans, swaps, and securities on a decentralized platform. Therefore, blockchain technology has given rise to blockchain-built decentralized networks and decentralized finance (DeFi), challenging the orthodox concept of fiat money, banking, and the established notion of a third-party intermediated capital market system.[[6]](#footnote-6)

Since the surge of the Bitcoin price in 2014, the cryptocurrency market has gained massive traction among common users, driving the growth of the market, and leading to the creation of various intermediate cryptocurrency exchanges. These exchanges act as intermediaries and help the consumers open a cryptocurrency account, trade cryptocurrencies between wallets, and exchange in fiat currencies. While they capitalize on blockchain technology, crypto exchanges indicate specific structural and functional problems. Structurally, these exchanges are usually centralized and susceptible to fraudulent activities, cyber hacks, scams, regulatory violations, and financial crimes.[[7]](#footnote-7) Yet, over the past decade, the utility of blockchain-based systems has been subject to severe critiques, especially its impact on the environment and scalability,[[8]](#footnote-8) security breaches,[[9]](#footnote-9) law enforcement,[[10]](#footnote-10) and its centralization risks in governance, design features, and operation.[[11]](#footnote-11)

Particularly, the collapse of FTX—the Bahamas-based cryptocurrency exchange and its trading arm, Alameda Research, in November 2022 showed the extremities of a centralized power structure in a blockchain system, exposing vulnerabilities and lack of transparency.[[12]](#footnote-12) The multi-billion company is run by a small group of inexperienced executives and suffers from poor risk management and accounting standards and a lack of corporate control and governance mechanisms. As a result, the FTX’s C-suit executives were engaged in reckless trading businesses with customers’ deposits for their personal gains.[[13]](#footnote-13) At the time of the collapse, FTX had almost $50 billion in liabilities and included more than 100 entities across the US and other jurisdictions.[[14]](#footnote-14) Previously, the crash of Terra protocol’s native token ‘Luna’ was another demonstration of a single point of failure arising out of a protocol’s arbitrary collateralization process without mitigating the internal and external risk factors that ultimately exposed Terra’s ecosystem to external vulnerabilities and contributed to the collapse of the network.[[15]](#footnote-15) Although the protocol’s design had inherent flaws, the price of the stablecoin was artificially inflated due to unilateral decision-making mechanisms, creating a sense of euphoria in the market. However, when the system’s weaknesses were exposed, it eventually crashed as panic swept through the cryptocurrency market.[[16]](#footnote-16)

While the centralized control of a private blockchain network is undisputed, decentralization in a permissionless setting has come under significant scrutiny in various scholarly articles.[[17]](#footnote-17) It is demonstrated that a public blockchain infrastructure fails to capture the factors that may constitute the overall centralization of the system, such as system governance, wealth concentration,[[18]](#footnote-18) and geographic distribution of participants.[[19]](#footnote-19) Many times, the centralities embedded in a public blockchain system are unintended.[[20]](#footnote-20) These unintended centralities are present in its consensus mechanism,[[21]](#footnote-21) network design or aggregated consensus influence,[[22]](#footnote-22) and software architecture and can expose blockchain protocols’ vulnerabilities to various attacks.[[23]](#footnote-23) Often overlooked as a potential centralization source, the governance structure’s centralities can significantly affect a network value – which is deeply rooted in its element of decentralization and distributed power structure. Moreover, a centralized governance structure of a public blockchain can destroy community resources, jeopardizing the network’s reliability and sustainability.

Previously, Bitcoin and Ethereum’s decentralized decision-making processes were examined utilizing a quantitative method (called ‘Nakamoto coefficient’[[24]](#footnote-24)), in which the authors argue that in terms of bringing protocol improvement proposals, Ethereum had higher centralization than Bitcoin.[[25]](#footnote-25) However, in both cases, only a few contributed to bringing these proposals.[[26]](#footnote-26) Similar conclusions were arrived at in the study conducted by Geravis et al. (2014), arguing that “six major centralized mining pools currently control more than 75% computing power in Bitcoin Moreover, these mining pools can engage in selfish behavior to maximize their benefits.

Also, a centralized Bitcoin ecosystem gave rise to several risks, such as market, counterparty, and transaction risks. Reyes et al. (2017)) argue that a lack of an effective decentralized governance model among distributed autonomous organizations (DAOs) may cause “significant collective action problems and expose investors to catastrophic regulatory and governance risks.”[[27]](#footnote-27) Drawing on the example of the algorithm’s biases, the article argues that a smart contract that predicts governance actions could produce unintended results since the predictive model would be fed with biased data.[[28]](#footnote-28)

Solutions to blockchain’s centralities and governance problems are addressed in several academic literature. Hacker (2019) utilized complex theory to analyze the uncertainty and instability of cryptocurrencies and ICOs and proposed an adapted version of a corporate governance framework, a Blockchain Governance Code, to mitigate the volatilities associated with these organizations.[[29]](#footnote-29) 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 loyal affiliation between core developers and community members, such as users of cryptocurrencies.[[30]](#footnote-30) The dynamics of this relationship hinge upon the willingness of core developers to act in good faith and in the interest of the users. The proposed framework also expects a separate obligation for mining pool operators, who must refrain from influencing the core developers.

Additionally, the community members, who are not core developers or miners, “should have the right to vote on fundamental matters concerning the blockchain-based organization.”[[31]](#footnote-31) Beck et al. (2018) invoke an accountability-centric blockchain governance framework.[[32]](#footnote-32) Anchoring on the theoretical framework of IT governance and principle-agent theory,[[33]](#footnote-33) Beck et al. (2018) advocate for a three-dimensional approach to governance of a blockchain system—decisions, monitoring and enforcement, and incentives aligned with the system’s goal.[[34]](#footnote-34) First, the governance framework incorporates a decision-making mechanism, which determines the degree of decentralization – “whether decision-making power is concentrated in a single person or small group (centralized), or dispersed (decentralized).”[[35]](#footnote-35) Second, any decisions made within a blockchain system should be monitored, providing a layout for an accountable governance framework. Such a framework incorporates an enforcement mechanism, ensuring accountability is “enacted, specified, and enforced.”[[36]](#footnote-36) Finally, the governance structure should embed the design features motivating the blockchain agents to “choose actions that coincide with goals of the system’s design.”[[37]](#footnote-37)

While these theoretical discourses provide some suitable directions as to what a blockchain framework should be in an ideal world—accountable and loyal, they do not sufficiently differentiate between permissioned and permissionless blockchain networks and the governance problems arising from blockchain’s centralities. Moreover, a blockchain’s utopian world of ‘decentralization’ attracts many users who believe in realizing an alternative economic system and thereby being invested in the growth and value of a certain network. Without an effective governance framework, blockchain’s centralities jeopardize the community’s trust and the future of permissionless blockchain networks. This also increased the risk of ‘opportunism’— a governance hazard that usually refers to opportunistic management behavior contrary to shareholders’ interests.[[38]](#footnote-38) However, 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.[[39]](#footnote-39) For example, in both instances of FTX and Terra collapse, the management demonstrated opportunistic behaviors[[40]](#footnote-40)— the antithesis of what blockchain anticipated to eliminate when Bitcoin was launched.

Against this backdrop, this article has two novel contributions. *First*, it contributes to the increasing gap in understanding the intended and unintended centralities underlined in a public blockchain’s governance structure. In light of the recent FTX collapse and Luna price crash, it critically analyzes the implication of a blockchain network’s centralities. It extends the discussion to highlight how centralities in blockchain governance are detrimental to preserving the sustainability and reliability of blockchain networks. In turn, it leads to the destruction of a network’s valuable resources. It further argues that the centralities embedded in the current blockchain governance framework fundamentally incentivize the participants in the ecosystem to be opportunistic. Therefore, challenging the existing reward-centric governance framework, the article posits that the scope of blockchain governance should incorporate a value-driven decision-making process that is not just reward-focused but rather incentivizes participants to take part in the governance process spontaneously, helping a network grow sustainably and achieve its long-term micro- and macro-economic goals.

*Second*, this paper also contributes to the continuing discussions of governing blockchain under the commons framework. Despite ample studies in relation to blockchain governance, there is not enough research on “how to analyze the diversity of blockchain networks from the perspective of commons governance.”[[41]](#footnote-41) The paper introduces a governance framework that deploys political scientist Elinor Ostrom’s polycentric approach to commons governance—a critical theory to mitigate conflicting interests arising in the use of shared resources.[[42]](#footnote-42) Ostrom’s theory is rooted in the idea that common-pool resources,[[43]](#footnote-43) such as forests, fisheries, and water systems, can be sustainably managed through cooperation and collective action rather than privatization or government regulation.[[44]](#footnote-44) With the advancement of technology and common resources available offline and online, the discourse of the commons has expanded and extended beyond the physical world.[[45]](#footnote-45) Accordingly, a growing body of work discusses new and nontraditional forms of commons- digital resources created and maintained online. Examples of such commons may include the Internet, data, electromagnetic spectrum, etc. From commons governance perspective, they are often referred to as ‘knowledge commons’, [[46]](#footnote-46) ‘digital commons’,[[47]](#footnote-47) or ‘information goods’.[[48]](#footnote-48) Unlike physical resources, these digital shared resources are prone to the social dilemma – a situation in which individuals make selfish decisions causing unintended jeopardy to the entire group.[[49]](#footnote-49) A polycentricity in the governance approach can be instrumental in preventing the tragedy or social dilemma arising from shared resources.

From a political science perspective, the effects of decentralization predominantly rely on how decentralization is designed and implemented.[[50]](#footnote-50) Political scientist Vincent Ostrom highlighted a polycentric governance approach as a means to achieve decentralization in the public administration sector.[[51]](#footnote-51) In his work with Tiebout and Warren, V. Ostrom defines ‘polycentricity’ as multiplicities in decision-making points, each having its impact and autonomy.[[52]](#footnote-52) A governance arrangement supporting polycentricity garnered significant attention in other fields. Particularly, Elinor Ostrom suggested “readopting “polycentricity” as a useful analytical approach for understanding and improving efforts to reduce the threat of climate change.”[[53]](#footnote-53)

Drawing on these diverse commons discussions and governance frameworks from the physical and digital worlds, this paper argues that there is a strong case for treating public blockchain as a commons. In particular, using Ostrom’s classification of common-pool resources,[[54]](#footnote-54) the paper identifies five categories of blockchain’s shared resources.[[55]](#footnote-55) These resources are: (1) a network’s native coin/ cryptocurrency, (2) smart contracts, (3) digital tokens, (4) tokenized assets, and (5) decentralized applications.[[56]](#footnote-56) It further highlights the suboptimal results produced by blockchain’s centralities, i.e., destruction of the network’s resources and losses of value—a semblance of the *tragedy of the commons* and *social dilemma*, as evidenced in the collapses of several blockchain-based organizations in 2022. Hence, without an effective governance regime established by network participants and/or external authority, i.e., regulator, the *tragedy* will continue to occur in open-access and highly valued blockchain’s common-pool resources.[[57]](#footnote-57)

To counter this tragedy, Ostrom’s polycentric approach to governing the blockchain commons is instrumental. Ostrom’s idea of a polycentric approach usually refers to a bottom-up approach that allows members using and benefiting from shared blockchain resources to self-organize and self-govern the common resources.[[58]](#footnote-58) It involves a set of design principles and strategies (known as Ostrom’s design principles) that members can use to curate rules, responsibilities, enforcement, and conflict-mitigating mechanisms that promote sustainable management of shared resources.[[59]](#footnote-59) The framework permits a blockchain network to bring all members, namely (1) the core developers, (2) node-runners/ mining-pool operators, (3) foundation/ investors, and (4) users, within the scope of the governance framework. The underlying rationale for the proposed solution is that members participating in a blockchain network can effectively manage shared resources if they have a sense of ownership and control over the resources and when they can *communicate and cooperate with one another*.[[60]](#footnote-60)

The paper is structured as follows:

Part II of this article provides an analytical overview of blockchain technology. Specifically, it takes a nuanced approach to understand the risks of blockchain’s centralities, intended and unintended. By highlighting several crypto firms’ collapses and scandals, Part III of the paper shows that the current governance framework is highly centralized despite its promise of decentralization. Moreover, the majority of crypto firms are not designed to operate sustainably. Blockchain governance must be truly decentralized to curb this problem—a sustainable, coordinated system that keeps the community’s interest at its core. Part III of the paper presents key arguments for treating blockchain protocol as commons and posits that a polycentric approach can eliminate the problems of blockchain’s embedded centralities in the operation and governance process. Part V concludes the paper.

# Deconstructing Blockchain’s Decentralization

As a technological phenomenon, blockchain offers a critical promise to the discourse of Economics. Architecturally, the novel technology is designed to complete a peer-to-peer transaction by timestamping a transactional block and recording it in an open distributed ledger.[[61]](#footnote-61) A transaction generated on a blockchain protocol is immutable, authentic, tamper-proof, and transparent and does not need a trusted third-party financial counterpart.[[62]](#footnote-62) Therefore, the heart of blockchain’s promise is its ability to eradicate the old-age problems of ‘trust’ in an economic institution (known as ‘trustlessness’).[[63]](#footnote-63) The technological feature that underpins ‘trustlessness’[[64]](#footnote-64) is blockchain’s ability to achieve decentralization, in transactions and decision-making, thereby reducing the need for human intermediation in communication, trade, and governance.[[65]](#footnote-65)

Ideally, blockchain’s decentralized features facilitate open-access participation of any node and, therefore, promise an equal distribution of power without a central control point.[[66]](#footnote-66) Casey and Vigna (2018) compared blockchain’s decentralized trust with “the truth machine”[[67]](#footnote-67) – a means to regain control over our data and privacy – an empowered way to challenge the centuries-old concept of ‘trust’ in the intermediaries.[[68]](#footnote-68) Decentralization is also understood as a way to increase blockchain security and immutability.[[69]](#footnote-69) Nonetheless, in reality, the concepts of “decentralization” and “trustlessness” are nuanced and capture technical and social discourses and their interrelationships, and hence, they must be analyzed from a multidisciplinary perspective.

Generally, in political science, the concept of decentralization is somewhat associated with the power structure. The idea often equates with state decentralization of authority to keep central power in check against the abuse of power.[[70]](#footnote-70) In a democratic setting, decentralization has two major dimensions: first, it involves “top-down measures aimed at transferring responsibilities [and powers] – political, administrative and/or fiscal—to lower levels of government”; and second, it enables the participation from below in the spectrum of public policy decision-making process by bridging local government with the centralized government.[[71]](#footnote-71) However, the traditional discourse on decentralization does not necessarily imply a lack of central authority. Rather, it focuses on the effective ways to design an accountable governance system with the distribution of power and resources divesting from a central authority to vesting in decentralized actors, such as lower-level government units, private organizations, or individual citizens.

In economics, decentralized is tied to economic growth, fiscal sustainability, and income distribution.[[72]](#footnote-72) Within the discourse of natural resource management, decentralization is an instrumental structure that “improves [s] resource allocation, efficiency, and equity” through “a redistribution of power and resources.”[[73]](#footnote-73) It establishes the value of local knowledge and communal participation and incorporates various stakeholders’ interests in formulating a public policy that addresses natural resource management. Every form of decentralization—political, administrative, and economic—aims to fulfill certain objectives. For instance, political decentralization is often associated with pluralistic and representative government,[[74]](#footnote-74) while administrative decentralization seeks to deconcentrate, delegate, and devolve authority, responsibility, and financial resources.[[75]](#footnote-75) Economic decentralization shifts powers from the public to the private sector through privatization and deregulation.[[76]](#footnote-76)

While blockchain is predominantly identified as a ‘decentralized’ technology, what constitutes blockchain’s ‘decentralization’ is still ill-defined.[[77]](#footnote-77) Conceptually, the idea of blockchain’s decentralization stems from its capacity to generate transaction records across various computer nodes in a distributed manner, yet independently.[[78]](#footnote-78) Since every node is independent and separate, each node creates a copy of the records of the previous transactions, making it more resilient from risks likely to arise from a centralized record-keeping system.[[79]](#footnote-79) Hence, blockchain’s decentralization is affiliated with its benefits of increased security, transparency, and resilience. It also has a political undertone that views it as a means to prevent the concentration of power, preventing a single person or organization from taking control of the system.[[80]](#footnote-80) It implies a diffusion of power rather than concentration.[[81]](#footnote-81) For instance, in Bitcoin and Ethereum networks, decentralization lies in its ability to develop “higher resistance against censorship of individual transactions.”[[82]](#footnote-82) Often viewed as a blockchain’s entire raison d’être,[[83]](#footnote-83) blockchain’s ‘decentralization’ manifests in multiple decision-making centers, each with individual roles, responsibilities, and contributions to the system’s operation.[[84]](#footnote-84)

In the discourse of blockchain, there are two principal aspects of blockchain’s decentralization: (1) decentralization in consensus protocol, such as proof-of-work and proof-of-stake. (2) decentralization in governance structure—a political structure predominantly associated with the decision-making process in a blockchain network.

## **Decentralization in consensus protocols**

Much of the discourse around blockchain’s ‘decentralization’ is underpinned by its consensus protocols and the philosophy of ‘code is the law.’ Generally, consensus means “a procedure to arrive at a common agreement in a decentralized or distributed multi-agent platform.”[[85]](#footnote-85) Looking at the design architecture, blockchain has four principal decision-making agents—each having a different set of roles and responsibilities. These vital centers are (1) core developers – who launched the initiative and reserve the right to make changes to the core protocol; (2) node-runners/ miners/ validators– who run computer nodes to verify and validate transactions; (3) foundation/ investors – funders who directly fund the blockchain project, for instance, to buy mining equipment; (4) users – a broad community purchasing, holding, and trading cryptocurrencies.[[86]](#footnote-86) Epitomized by the Bitcoin network, which relies on an open-source protocol, blockchain’s architectural decentralization facilitates open access, i.e., everyone is free to use the network and contribute to its development.[[87]](#footnote-87) From a control standpoint, a permissionless (public) blockchain network (such as Bitcoin and Ethereum) allows a participant to access the network without requiring approval from a central authority.[[88]](#footnote-88) Therefore, a permissionless blockchain’s underlying design allows participants to participate in the network’s activities from anywhere in the world. Their participation in a permissionless blockchain ecosystem is open, distributed, and free from the influence of any central authority.[[89]](#footnote-89)

In a permissionless blockchain, decentralized consensus protocols are characterized as proof-of-work (PoW) or proof-of-stake (PoS).[[90]](#footnote-90) Originally implemented by Nakamoto in the Bitcoin network, the main purpose of a consensus protocol was to verify, validate, and finalize a transaction block.[[91]](#footnote-91) In a PoW, virtual miners, spread worldwide, participate to update the network with a new block as soon as a transaction is announced in a blockchain network. The winner gets to update the blockchain with the latest verified transactions. In return, the network rewards the miner with a predetermined amount of cryptocurrency.[[92]](#footnote-92) There is a correlation between PoW and incentives, as the miner who can update the network earns a reward for their work in the form of a cryptocurrency. As a result, when a cryptocurrency price goes up, more miners are incentivized to participate in the consensus protocol. In hindsight, this consensus mechanism allows miners to aggregate their computational resources to maximize their chance to win rewards[[93]](#footnote-93)—quite a juxtaposition of what the original consensus protocol intended to aim for—providing everyone an equal chance to participate in a blockchain network. It’s also an energy-intensive process that can have trouble scaling to accommodate a vast number of transactions.

The alternative is PoS—a staking mechanism in which a blockchain network selects a participant (known as a validator) to add the transaction to the blockchain in exchange of cryptocurrency. Usually, a qualified validator stakes a certain amount of cryptocurrency for a certain amount of time.[[94]](#footnote-94) The network tends to choose the participant who has the most amount of cryptocurrency for the highest length. In other words, the network rewards the most invested participant. Although the PoS aims to bring speed and efficiency in finalizing a blockchain transaction, the consensus mechanism is vulnerable to centralization since it is solely driven by the amount of capital. For instance, Nansen, a blockchain analytics firm, reported that 64% of staked Ethereum is controlled by only five entities.[[95]](#footnote-95) It was further reported that 46.5% of Ethereum’s post-Merge PoS nodes for storing data, processing transactions, and adding new transaction blocks were attributed to just two addresses.[[96]](#footnote-96)

## **Decentralization in the governance structure**

Governance of the blockchain is a complex topic that garners an intensive academic discussion.[[97]](#footnote-97) By definition, blockchain governance refers to “making consensus-relevant changes to the software running a blockchain.”[[98]](#footnote-98) It is “the means of achieving the direction, control, and coordination of stakeholders” [within] a given blockchain project.

Usually, there are two principal governance aspects—*governance by the infrastructure* (on-chain governance) consisting of rules coded in a blockchain system, and *governance of the infrastructure* (off-chain governance), implying “all forces that subsist outside of a technological platform, but nonetheless influence its development and operations.”[[99]](#footnote-99)

With respect to rules, in on-chain governance, these can be directly encoded in the blockchain protocol, setting out the automated, self-executable, and immutable governance structure. The embedded rules dictate the procedures for submitting proposals, approving them, and finalizing them upon voting without a centralized group of developers. For instance, the Tezos blockchain network allows anyone to submit a proposal for protocol updates— “the 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.”[[100]](#footnote-100) Within the realm of on-chain governance, there is the capacity to establish protocols for self-amendment. Much like legislation can outline the processes for creating, modifying, or nullifying laws, on-chain governance rules within a protocol delineate the steps for creating, modifying, or nullifying other protocol rules.[[101]](#footnote-101)

The off-chain governance, in contrast, operates on a “social and institutional level”, rather than being directly tied to technical aspects.[[102]](#footnote-102) It represents the ideological and aspirational value of a blockchain network, which is formed outside of the technical infrastructure. There can be many dimensions to the off-chain governance. The inception of a blockchain project often begins with a vision, and at this point, a foundation assumes a pivotal role in molding the future structure of decision-making within the community. This process fosters a diverse approach aimed at actively involving the community in the governance process. For instance, in the Ethereum protocol, individuals can submit alterations or proposals to change the protocol by means of Ethereum Improvement Proposals (EIPs).[[103]](#footnote-103) Several blockchain foundations engage communities informally, where core developers and community members discuss and make decisions using social media (such as Discord and Telegram).[[104]](#footnote-104)

In blockchain governance, decentralization is contextualized in achieving a community-empowered decision-making process—a horizontal process as opposed to a traditional top-down approach, in which anyone can contribute to improving and developing a blockchain network.[[105]](#footnote-105) Therefore, ideally, a decentralized governance approach refers to the ability of self-governance (and being governed) via distributed consensus protocols and voting mechanisms.[[106]](#footnote-106) Drawing on an example from Bitcoin—the most discussed permissionless blockchain network, it is argued that a Bitcoin network has a four-dimensional approach to governance.[[107]](#footnote-107) First, at the user level, decentralized governance usually means the ability to “submit a transaction.”[[108]](#footnote-108) Second, new transactions are validated by multiple nodes, which agree with adding a transaction block to the existing network. The participation of multiple nodes allows for decentralization in validating transactions.[[109]](#footnote-109) Third, at the core protocol level, decentralization implies anyone’s ability to develop and suggest protocol updates. The fourth dimension of decentralized governance depends on the blockchain protocol’s design.

Decentralized governance is also embedded in a protocol’s architecture with different layers. Pelt et al. (2021) outline three layers of Ethereum’s blockchain governance (table 1): (1) on-chain community, comprising token-holders, Ethereum Foundation industry organizations, fellowships, community figureheads, and online moderators;[[110]](#footnote-110) (2) off-chain development, including contributing to protocol’s development and maintenance;[[111]](#footnote-111) (3) on-chain protocol, consisting of miners, full nodes, and light-nodes.[[112]](#footnote-112) All these layers have different roles, incentives, and decision-making processes. Still, they are connected to achieving the foundation’s common economic goal—for instance, increasing the Ethereum network’s value, supporting its long-term applications, and broadening its user community.[[113]](#footnote-113)

It should be noted that the current discourse on blockchain governance is centered around a network’s protocol, such as proposing protocol updates, software development, and network maintenance. Nonetheless, given the proliferation of blockchains and their wide range of applications across sectors, the scope of blockchain governance has widened, from protocol updating to voting on community development. The emergence of various decentralized autonomous organizations (DAOs)[[114]](#footnote-114) also demonstrated that the governance around a blockchain network could be curated to meet any specific objective. A decentralized community can work towards achieving a shared community goal.[[115]](#footnote-115) For instance, Grants DAOs (for example, Moloch DAO) bring a community of venture capitalists who use governance tokens to make capital allocation decisions.[[116]](#footnote-116) Investment DAOs pool capital for investments in different DeFi and blockchain-based projects.[[117]](#footnote-117) Many DeFi protocols have been developed that leverage liquid DAO governance tokens.[[118]](#footnote-118)

As far as governance is concerned, blockchain’s on-chain and off-chain governance suffer from many technical and applied challenges, such as effective decision-making, centralized control, lack of credible incentives for community participation, and the overall absence of network value reflecting community interests. Moreover, the underlying decentralized consensus protocol does not necessarily guarantee a decentralized power structure and governance process. For instance, as previously mentioned, in both PoW and PoS protocols, the consensus power can be concentrated in a small number of nodes. Despite efforts by major blockchain foundations to involve a broader community in protocol development, the rules governing this process remain informal and non-standardized. For instance, EIPs are required to adhere to specific technical standards and require unanimous approval from the core developers before they can be a part of the protocol development plan. However, there is no established formal framework for these procedures, and none of these practices are legally binding, leading to controversy surrounding initiatives.[[119]](#footnote-119)

Therefore, while the design of blockchain software is polycentric, the overall network’s governance can be monolithic, with power and decision-making authority concentrated in a single actor or group. Such a lack of decentralization also challenges blockchain’s claim of immutability. For instance, if a subset of stakeholders, i.e., protocol developers, is unsatisfied with a particular governance decision, they can leave the current blockchain platform and perform a hard fork to establish a separate blockchain instance as a means of veto.[[120]](#footnote-120) This form of exit-based governance can jeopardize the economic value of a network and hamper its long-term growth.[[121]](#footnote-121)

# Blockchain’s Centralization Risks and Implications

## **Blockchain’s Embedded Centralities**

Technically, ‘decentralization’ in a blockchain network is achieved through clever integration of cryptography, distributed systems, and incentive engineering.[[122]](#footnote-122) In reality, realizing decentralization is challenging under the current state of blockchain designs. Even within the scholarly discussions, decentralization significantly focus on blockchain’s technological feature of “cutting out the middleman, a process known as “disintermediation” [and] removing the need for traditional, centralized and trusted third-parties such as financial intermediaries required to complete monetary transactions.”[[123]](#footnote-123) Usually, the protocol development is “highly centralized and coordinated.”[[124]](#footnote-124) For example, in contrast to popular belief and enthusiasm, the initial control of the Bitcoin protocol was exclusively with Satoshi Nakamoto, who subsequently delegated the control to a few developers, suggesting that the protocol’s design was not decentralized at its provenance.

Currently, the global cryptocurrency market cap is $1.10 trillion. comprising cryptocurrency exchanges, DeFi, Non-fungible tokens (NFTs), stablecoins, and token-linked financial instruments (such as security tokens and crypto-derivatives).[[125]](#footnote-125) While it is still a niche market, regulatory crackdowns, fraud, scams, hacks, and bankruptcies are rampant, exposing blockchain’s real vulnerabilities, unrealized promises, and risks primarily associated with its centralization. The first example in this regard is a centralized cryptocurrency exchange. Since its inception, cryptocurrency exchanges have been prone to security threats, leading to an enormous number of hacks due to its centralized security system.[[126]](#footnote-126) These cryptocurrency exchanges also have a single point of authority that has unfettered access to their customers’ tokens and an enormous power to misappropriate customers’ funds.

Major public blockchains, such as Bitcoin and Ethereum, suffer from a market-based centralization,[[127]](#footnote-127) often demonstrated through the emergence of novel business models (such as mining pool aggregators) capitalizing on the profitability and lucrative of the network resources.[[128]](#footnote-128) In addition, the operation and maintenance of the infrastructure carry some invisible factors leading to the concentration of powers in a few hands, challenging the blockchain’s potential to remove trusted entities in a decentralized economy.[[129]](#footnote-129) For instance, although public blockchain networks are open-source codes, they inherently are dominated by a consortium of participants, known as mining pools[[130]](#footnote-130), who possess significant control over the network’s computing power.[[131]](#footnote-131)

The development and maintenance of the blockchain protocols also rely on a small cohort of highly skilled developers who can unilaterally decide whether any network improvement proposal should be released, thereby limiting users’ overall impact.[[132]](#footnote-132) From a user’s perspective, having a transaction authorized requires a hefty transaction fee, challenging the idea of equal participation in a blockchain network.[[133]](#footnote-133) Moreover, in the existing form of governance used in Bitcoin and Ethereum networks, there is an element of centralization at the implementation level.[[134]](#footnote-134)For instance, the governance proposals are submitted by developers to a core group, which then decides which updates should be implemented. Tezos’ claim of ‘universal participation’ in the on-chain governance process without a ‘centralized authority’ is also flawed. Although the approval and implementation of changes in the Tezos protocol do not depend on a group of core developers (as is the case for Bitcoin and Ethereum), under this framework, the voting process is controlled by only registered developers (known as ‘bakers’). The non-bakers (the majority of Tezos token-holders) can only support one of their preferred bakers’ choices without having the ability to propose, vote, or implement any changes.[[135]](#footnote-135)

There is also tension among blockchain organizations to set the limit for decentralization.

As new business models and financial instruments evolve, more and more blockchain systems have opted for a centralized approach to governance in which the foundation manages and directs the use of the network’s shared resources. After all, a centralized decision-making authority can govern a network without complexities or resistance, making governance a more straightforward and faster task. Unfortunately, the foundation’s managerial role has potential regulatory implications, especially in treating community members, i.e., token holders, as investors and shared resources as securities. Consider, for instance, in exigencies, a centralized authority can immediately shut down the network. Such a structure can create a single point of failure. It can also accentuate a blockchain network’s vulnerabilities of being prone to hard forking and suffering from 51% attacks.As a result, the community’s trust in the overall resource management deteriorates, potentially impacting a blockchain network’s value and reliability.

Even the popular DAO governance models are not immune from the centralization of power since the voting power in DAOs is proportional to a governor’s possession of DAO tokens; therefore, if a member has more DAO tokens, they have more authority to approve a proposal. The concentration of power also has adverse effects on the growth of the network, such as “platform size, token illiquidity, and long-term incentives.”[[136]](#footnote-136)

The power can be centralized by a few “whales” [[137]](#footnote-137) who can manipulate a cryptocurrency’s price. These whale activities are potentially dangerous for a network’s sustainability as they can operate outside the network’s ecosystem and make the entire ecosystem volatile, often leading to its crash entirely. For example, on May 07, in the wake of a large swap of UST on the Curve,[[138]](#footnote-138) initiated by these “whales,” UST lost its peg to the US dollar, [[139]](#footnote-139) which, in turn, led to a massive price crash for Luna.[[140]](#footnote-140) The event, among many vulnerabilities, exposed the centralization risks of a blockchain platform. It showed that if several large holders independently decide that a network’s asset is at stake, it can have the power to swing the market and even crash.

## **Centralization risks and failure of crypto projects: The Example of FTX and Ronin**

Blockchain’s centralization risk was evidenced in the collapse of FTX— one of the leading centralized cryptocurrency exchanges with more than one million users, specializing in trading derivatives and leveraged products. It also acts as a spot market for more than 300 cryptocurrencies. On November 11, 2022, the FTX, its sister firm Almeda Research, and 130 other companies affiliated with the FTX filed for bankruptcy following a severe liquid crunch.[[141]](#footnote-141) Before the collapse, FTX was valued at $32 billion.[[142]](#footnote-142) However, when the turbulence hit the market, the FTX was holding only $900 million in liquid assets against USD 13.86 billion in liabilities, leading to its collapse and freezing millions of its users’ wallets.[[143]](#footnote-143)

As the contagion spilled in the crypto world, more companies’ exposure to FTX came to light.[[144]](#footnote-144) For example, crypto lender Genesis sought an emergency loan of $1 billion due to its liquidity crunch. Subsequently, Genesis was forced to suspend users’ cryptocurrency withdrawal as liquidation requests exceeded their current liquidity[[145]](#footnote-145) and required an additional $140 million equity infusion.[[146]](#footnote-146) Later, Genesis filed for its bankruptcy.[[147]](#footnote-147) Gemini also restricted customers’ withdrawals in the wake of an outflow rush.[[148]](#footnote-148)

Some contend that the FTX collapse can be attributed solely to the lack of effective governance.[[149]](#footnote-149) It alleged that the FTX conducted operations both within and outside the United States and functioned without a board of directors. Consequently, executive authority was centralized among a select few individuals who demonstrated a complete lack of concern for the welfare of investors and shareholders.[[150]](#footnote-150) They made capricious and risky investment choices. Additionally, the company failed to maintain accurate financial records of customer funds and apparently employed software to hide the mishandling of customer funds.[[151]](#footnote-151) Instead of holding any money, it borrowed billions from FTX users, unreported to its investors and stakeholders.[[152]](#footnote-152) Therefore, the financial information they had access to about the company’s health was inaccurate due to a flawed accounting method.[[153]](#footnote-153) Customers’ deposits held by FTX did not appear on the company’s balance sheet.[[154]](#footnote-154) Finally, due to the absence of any regulatory framework, the failing cryptocurrency exchanges could not avail of any emergency lending facilities, leading to the massive collapse of FTX and depriving millions of users of their valuable resources.

Table 2: The largest cryptocurrency

|  |  |
| --- | --- |
| **Networks falling to victims of hacks** | **Amount hacked ($)** |
| Ronin Network | 625 |
| Poly Network | 611 |
| FTX | 600 |
| Binance | 570 |
| Coincheck | 534 |
| Mt. Gox | 473 |
| Wormhole | 325 |

*Source*: Investopedia

The lack of decentralization also weakened the security features of a blockchain protocol (table 2). For example, in March 2022, a hacker managed to obtain access to the private keys of five out of the nine validator nodes on the Ronin Chain – an Ethereum-linked blockchain platform focused on gaming. During this breach, a hacker compromised the network’s security and successfully stole $625 million from the Ronin Bridge through two separate transactions.[[155]](#footnote-155) With control over these five nodes, the hackers effectively wielded influence over more than half of the network, granting them the freedom to either approve or reject transactions as they pleased. The primary point of vulnerability stemmed from the absence of a sufficiently decentralized network in Ronin.[[156]](#footnote-156) They exploited this access to carry out fraudulent withdrawals of ETH and USDC tokens. [[157]](#footnote-157)

## **Implication of Blockchain’s Centralities**

The current centralities in blockchain governance have three significant impacts that can potentially jeopardize a blockchain network’s security, long-term growth, reliability, and sustainability. First, the original promise of blockchain to create a ‘trustless’ economy is diluted as the existing blockchain organizations are predominantly mimicking an intermediated framework, exposing them to various forms of centralities and an imbalance in the power structure—an opposite to what Satoshi Nakamoto envisioned when Bitcoin was launched. Second, blockchain’s centralities cause significant destruction of resources, instilling doubt and fear among its users, which can potentially hamper its growth in the future. Finally, the existing blockchain governance framework is essentially reward-focused, incentivizing governance participants to behave recklessly and act in pursuit of their individual gains only.

### *Trust is depleting, and trustlessness is beyond reality*

As several prominent blockchain entities collapsed over the past few years, the credibility and reliability of the network have been significantly jeopardized. Their lack of transparency in maintaining a balance sheet and using customers’ deposits for personal profits is abrasive of blockchain true promises. Much of this is due to the centralized power structure within the blockchain network and its centralities in the design structure. As mentioned above, the recent collapse of the FTX demonstrated the risks of a centralized governance approach that undermines the customers’ trust.[[158]](#footnote-158) Similarly, the bankruptcies of several crypto ventures in 2022 showed that the currency crypto practices lack transparency. They falsely promised high yields on investments to gain more customers without providing any degree of protection to their funds. For instance, the independent Examiner report, filed in pursuance of its Chapter 11 bankruptcy case, revealed that crypto-lender Celsius Network attracted customers’ deposits with a false promise of high rewards.[[159]](#footnote-159) While Celsius failed to generate enough profits and never could fulfill its promises, it used customer deposits to inflate the price of its token, CEL, which consequently benefitted its founders and insiders who made millions from the CEL token sales.[[160]](#footnote-160) At the same time, their lack of transparency in the balance sheet kept millions of customers from knowing the company’s economic situation. Thus, the collapse of these companies took the customers by surprise, who lost their resources instantly.[[161]](#footnote-161)

Blockchain networks tend to develop complex algorithm-based business models, including hedging and staking mechanisms using customers’ tokens. With their lending protocols, these networks design a staking mechanism in which customers’ tokens are used as collateral. Since these blockchain networks’ operation and managerial role is in the hands of a few executives, most of their token users have limited knowledge about how their deposits are being used. When the FTX collapsed, it was revealed that FTX’s sister firm, Alameda Research, a hedge fund, was trading billions of dollars from FTX accounts and leveraging the exchange’s native token – FTT, as collateral. Alameda was remarkably able to cover this activity because the assets it was trading were never shown on its balance sheets. Instead of holding any money, it borrowed billions from FTX users, unreported to its investors and stakeholders.[[162]](#footnote-162)

### *Deterioration of the network’s resources*

Since the proliferation of various blockchain systems, the networks have been prone to security breaches, frauds, scams, and abrupt disruption, destroying the value of network resources. In 2022 alone, hackers stole $3.8 billion worth of cryptocurrency globally—a rise from $3.3 billion in 2021.[[163]](#footnote-163) Among 125 hacks, the largest was the Ronin Network.[[164]](#footnote-164) Before that, in 2021, Poly Network—a DeFi platform, lost over $600 million.[[165]](#footnote-165) Claimed as an act for fun, the hacker returned the stolen fund.[[166]](#footnote-166) However, this demonstrates the vulnerability of a blockchain network’s security mechanism.

In addition to external security breaches, a blockchain network suffers from a flawed economic model that poses additional threats to a network’s stability and sustainability. For instance, algorithm stablecoins.[[167]](#footnote-167) These stablecoins rely on smart contract-based on-chain algorithms for their stability. While the smart contract regulates the relationship between the stablecoin and other cryptocurrencies used to create a supply-demand architecture artificially, the risks are centralized. First, unlike other stablecoins pegged to stable forms of assets, algorithmic stablecoins are typically undercollateralized.[[168]](#footnote-168) Second, a coded stabilization mechanism does not fully grasp the intensity or severity of an economic downturn situation. 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.

Further, the community members are often driven by the profit earned through arbitrage trading, which can seriously jeopardize the network’s sustainability in an economic downturn. Finally, the majority of algorithmic stablecoins use the network’s native tokens as one of its stabilization mechanisms and governance purposes. Henceforth, if the price of the native token goes down, the possibility of a governance attack (51% attack) to take control of the network becomes higher.

For example, from the Terra debacle, the network had two major resources – its stablecoin, TerraUSD (UST), and Terra’s cryptocurrency, Luna. UST’s algorithmic relationship with Luna means that the latter must absorb the volatility of the former. When UST lost its value, the protocol started minting Luna continuously, and thereby, Luna’s started falling rapidly with the increased number of tokens in circulation.[[169]](#footnote-169) At the time of the collapse, Luna was worth less than zero ($ 0.83)– almost a 98% price crash overnight, causing community members to lose their valuable resources.[[170]](#footnote-170) It is to be noted that Luna was also used as governance tokens. Due to its meager price, the protocol’s validators fear a 51% attack might occur, leading to the shutdown of the network and preventing members from accessing their resources. Moreover, the existing governance structure of a blockchain network, particularly built on an on-chain platform, is not designed to respond promptly to any abrupt change in the economic model.[[171]](#footnote-171) For instance, on the Terra platform, it takes weeks from submitting proposals to voting and implementing a suggestion regarding protocol updates.[[172]](#footnote-172)

### *The existing incentive-centric governance is misaligned with the blockchain’s original promise*

The current practice of decentralization is essentially hinged on the distribution of governance tokens across stakeholders, regardless of their motivations and incentives. The model is predominantly reward-centric, and the governing participants’ incentives are primarily driven by self-interest rather than a blockchain foundation’s core values.[[173]](#footnote-173) All major blockchain networks have a native governance token, which can be used for staking[[174]](#footnote-174) derivatives (known as liquid staking derivatives). Users speculate on the governance token’s current and future value in this process. In addition to the right to submit proposals and vote on protocol changes, these governance tokens can also be used as collateral in a DeFi protocol—allowing its users to do yield-farming. Some of the largest centralized exchanges, such as Binance, Coinbase, and Kraken, let users stake cryptocurrencies and earnings yield as a service on their platforms and have been popular staking providers. Staking on centralized exchanges takes up about 28% of all staked ether, data by Dune Analytics shows.

To further illustrate how self-interest and the anticipation of rewards exert significant influence over the current governance process, consider the case of a node-runner. In the context of a blockchain network, the role of node operators holds immense importance as they validate every transaction within the network. From an operational standpoint, a node runner is chosen randomly to validate a transaction. Upon successful validation and incorporation of their block into the blockchain, they are granted a reward. Ideally, a node runner’s motivation should be rooted in a selfless desire to contribute to the growth of the ecosystem. However, as the ecosystem expands and transaction volume surges, the need for an increasing number of node runners arises. This evolution has led 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.

For instance, in a bid to mitigate the uncertainty associated with random selection, node runners often diversify their stakes across multiple nodes to enhance their prospects of earning rewards. While the network does possess the ability to penalize underperforming node runners by reducing their stakes, determining their true incentive becomes challenging. Within the realm of governance, proposing alterations to the protocol is significantly motivated by financial incentives. As exemplified by Tezos, when developers and teams put forth proposals to update the network, they include a payment request in XTZ (Tezos cryptocurrency) as compensation for their efforts. Upon approval by stakeholders and subsequent integration into the Tezos blockchain, the protocol generates the requested coins upon execution and disburses the payment accordingly.[[175]](#footnote-175)

Given the current governance issues and blockchain’s purported centralities, a decentralized and transparent blockchain governance model is instrumental in increasing trust and confidence in a blockchain network, especially for users who are not node-runners or participating in the currently limited governance processes. In addition, the sustainability of a blockchain ecosystem is largely dependent on the network’s decision-making process. To address these issues and stimulate the community's motivation to make decisions aligned with shared values, the paper emphasizes the effectiveness of employing a commons-based approach to blockchain governance. The underlying rationale is the sustainability of a public blockchain system relies on its ability to regenerate value through various applications (from generating native coins to multiple use cases). The inherent value of technology is predominantly dependent on the community’s trust and participation in the governance process. If unmanaged, the community behavior can potentially jeopardize the long-term growth of a blockchain-based ecosystem and place its value at risk. Therefore, treating blockchain as a commons facilitates collaborative management of its common-pool resources. It also benefits from Ostrom’s work on commons governance, which can provide an overarching framework for sustainable preservation.

# Resolving Blockchain’s Centralized Governance Risks: Applying a Commons-Based Approach

## **The Theory of Commons**

The concept of commons was first introduced in 1833 by William Lloyd, challenging the rationality of human behavior in relation to the use of shared resources.[[176]](#footnote-176) Lloyd’s argument revolved around the idea that individuals often prioritize their own interests when utilizing common property, which can result in the drastic depletion of common resources.[[177]](#footnote-177) In 1968, Garret Hardin echoed Lloyd’s hypothesis, suggesting that when individuals have unrestricted access to a common resource, they tend to exploit it to their maximum advantage.[[178]](#footnote-178) Hence, shared resources often require an effective governance mechanism that encourages the users to consume these resources responsibly and sustainably.

Several studies have explored potential strategies for effectively overseeing common resources, involving government, market, and community-driven initiatives. Initially, discussions surrounding the commons governance primarily revolved around centralized methods, such as entrusting shared resources to the government or privatizing them.[[179]](#footnote-179) Nevertheless, Nobel Laurette Elinor Ostrom demonstrated that we are not necessarily confined to a binary choice between state and market approaches.[[180]](#footnote-180) She argued that humans, intrinsically, possess a multifaceted motivational structure and the capacity to address the challenges of managing common resources through collective efforts[[181]](#footnote-181) Therefore, community members who consume shared resources are self-motivated to organize themselves voluntarily to develop local rules and enforcement mechanisms that ensure the responsible use and sustainable preservation of the commons resources.[[182]](#footnote-182)

However, in shared resources, community members compete with each other to derive benefits, making them rivalrous.[[183]](#footnote-183) One person’s utilization of these resources could diminish the availability of others, indicating the subtractability of these resources.[[184]](#footnote-184) Both subtractability and rivalry had the potential to impact another individual’s consumption and could ultimately lead to the tragedy of the commons.[[185]](#footnote-185) For this reason, the management of the commons should include [mandatory restraints](https://www.researchgate.net/publication/329029399_The_Tragedy_of_the_Commons#:~:text=The%20%E2%80%9Ctragedy%20of%20the%20commons%E2%80%9D%20is%20the%20name,but%20at%20a%20long-term%20cost%20to%20the%20environment.) encompassing rules of ‘mutual coercion, mutually agreed upon,’[[186]](#footnote-186) leading to the development of a nuanced approach to the governance of the commons.[[187]](#footnote-187)

In light of these inherent vulnerabilities and necessities, Ostrom devised a polycentric[[188]](#footnote-188) system of commons management– a decentralized governance approach that can operate without any control from a central authority.[[189]](#footnote-189) In the context of commons management, polycentric system consists of “many elements [that] are capable of making mutual adjustments for ordering their relationships within a general system of rules.”[[190]](#footnote-190) In this system, each actor acts independently but organically builds an interconnected system that prioritizes the community’s interests and preserves sustainable consumption of natural resources.[[191]](#footnote-191) Ostrom’s subsequent works incorporated a sustainable approach to polycentricity that leads to self-organizing and developing “tendencies to create or institute appropriate patterns of ordered relationships.”[[192]](#footnote-192) This means that a sustainable polycentric governance arrangement is capable of self-organization that can “persist and adapt without requiring central or outside planning or direction.”[[193]](#footnote-193)

For some time, Ostrom’s theory of commons and commons governance was primarily applied with respect to physical resources (such as fisheries, meadows, lakes, etc.) and studied in terms of local conditions. Later, it was extended to include global commons (such as climate change, oceans, space, etc.). Although theoretically established, applying the concept of commons to digital resources is relatively scarce. In the digital world, Schletz et al. (2022) built [a ‘nested’ climate accounting architecture](https://www.frontiersin.org/articles/10.3389/fbloc.2021.789953/full) incorporating distributed ledger technology, machine learning, and the Internet of Things.[[194]](#footnote-194) Several contemporary pieces of literature have discussed the Internet and data as the commons, mainly from the management perspective. Yet, such concepts are still underdeveloped, lack a specific legal framework, and contain contradictions with respect to access and privacy.[[195]](#footnote-195)

In 2005, Frischman [introduced](https://scholarship.law.umn.edu/cgi/viewcontent.cgi?article=1672&context=mlr) the economic theory of treating digital infrastructure such as the Internet as a commons.[[196]](#footnote-196) Frischmann shows that “the Internet creates [a nontraditional market] value as a commons” and argues why the Internet should be managed in an open, accessible manner.[[197]](#footnote-197) According to his thesis, the core principles of digital infrastructure management are hinged upon its ability to maintain openness and ensure non-discriminatory terms without requiring any approval or license.[[198]](#footnote-198) The theoretical contribution of Frischman was significant to the extent that it provided important insights regarding Internet governance that were previously [thought to have belonged](https://www.onthecommons.org/economic-theory-commons) to the management of private markets (private property) or government control (public good).[[199]](#footnote-199)

Ostrom also recognized the growing importance of shared scientific knowledge (known as ‘knowledge commons’), which is the product of human expertise and scientific capabilities.[[200]](#footnote-200) In a seminal work, Ostrom and Hess (2007) argue that knowledge commons encounter various social dilemmas[[201]](#footnote-201) related to the dissemination and creation of information, innovation, and creative endeavors, and therefore, a commons-based governance approach is effective in curbing the social dilemmas associated with these commons.[[202]](#footnote-202) Later on, Frischmann et al. (2010) extended the concept by encompassing shared technological infrastructure within the domain of the commons. They also made a distinction between knowledge and information generated through collectively managed technology and that stemming from natural resources.[[203]](#footnote-203) examples of such knowledge commons may include any open-access digital resources, open-source protocols, and the Internet. [[204]](#footnote-204)

Unlike intellectual property that is protected by copyright and ownership, knowledge commons are non-excludable and cannot prevent users from accessing them. In the online domain, social dilemmas can manifest through poor quality content, low-maintenance infrastructure, lack of management, and the ability to change the content by anyone at any time (such as Wikipedia), preventing other community members from benefiting from the resources. Therefore, these shared digital resources also require a commons-based governance approach that will require users to use them responsibly and improve the shared knowledge base over time. Frischmann argues that any shared technology infrastructure “institutionalize[s] community governance” as they depend on contributions from various actors.[[205]](#footnote-205) Hence, the community has the incentive to develop a mechanism for self-regulation driven by mutual interests, [[206]](#footnote-206) which is to ensure the authenticity, credibility, and quality of scientific knowledge and information.[[207]](#footnote-207)

## **Treating Blockchain as Commons: Key Arguments**

In the realm of blockchain technology, the utilization of commons theory is relatively recent. Rozas et al. (2022) conducted a techno-deterministic analysis of Ostrom’s design principles in relation to *governance by blockchain* – the organizational process that depends, at least in part, on blockchain infrastructure.[[208]](#footnote-208) 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, and formalization of rules, autonomous automation, decentralization of infrastructure control, enhanced transparency, and trust codification.[[209]](#footnote-209) These affordances construct a compelling argument for governance by blockchain, particularly for the purpose of governing commons-based peer production (such as online encyclopedia).[[210]](#footnote-210) However, it is important to note that this research does not explicitly extend to the governance of specific blockchain networks.

Certain academics have sought to employ Ostrom's principles in the context of blockchain technology, examining it through the lenses of regulation and cybersecurity.[[211]](#footnote-211) Meanwhile, other researchers have identified blockchain’s common pool resources[[212]](#footnote-212) and explored the effectiveness of implementing a ‘tiered polycentric’ governance approach within a blockchain network. [[213]](#footnote-213)

Murtazashvili et al. (2022) theorize blockchain networks (regardless of their accessibility and categorization of private and public blockchain networks) as knowledge commons[[214]](#footnote-214) by arguing that “blockchain [is] a form of community governance,” which are “characteristically ‘bottom-up’ results of collective activity.”[[215]](#footnote-215) This form of collective actions, within a network, generates from various actors, having different roles—some perform the core operations of the network (such as node runners, validators, and miners), and some are ordinary users—“people who simply hold cryptocurrencies in wallets.”[[216]](#footnote-216) Further, blockchain networks also generate shared data and information that are subject to different governance mechanisms and provide different accessible rights.[[217]](#footnote-217)

Discussions on implementing the commons approach in blockchain governance are gaining momentum. However, there is an increasing gap in addressing the built-in centralization aspects within blockchain's operational and governance structure. This paper identifies three critical arguments to contribute to the emerging literature:

1. *Incentives of a network participant in a polycentric structure*

Most of the discussions related to blockchain, and commons tend to rely heavily on a technological determinism perspective. This viewpoint asserts that the underlying infrastructure and protocols play a pivotal role in shaping and influencing social structures, cultural values, and community engagement. Although this does not inherently prohibit the consideration of blockchain as commons, it is crucial to acknowledge the potential centralization hazards associated with blockchain. This is particularly important to realize blockchain’s initial vision of decentralized and community-driven governance. Hence, an ex-ante examination is needed as to how Ostrom’s polycentric commons management is relevant to blockchain's governance characteristics. This involves scrutinizing the actors responsible for decision-making, their motivations and incentives, and the ultimate objectives guiding their decisions.

From the design perspective, blockchain protocol is polycentric.[[218]](#footnote-218) It has multiple decision-making centers (nodes) and is subject to internal rules emanating from the decision-making nodes, and external competition from other blockchain networks.[[219]](#footnote-219) From a governance standpoint, decentralization is also interpreted in the context of community governance, allowing anyone to participate in the governance process by acquiring a governance token. Furthermore, it is argued that a blockchain network, by its very essence, represents a collective, bottom-up effort as opposed to a top-down one.[[220]](#footnote-220) However, these features, operation, and governance, do not guarantee a polycentric bottom-up governance arrangement and prevent centralization risks, which jeopardize the interest of the blockchain community in general. The collapse of several cryptocurrency organizations highlights how centralities in blockchain governance are detrimental to preserving the sustainability and reliability of blockchain networks. Further, the centralities embedded in the current blockchain governance framework fundamentally incentivize the participants in the ecosystem to be opportunistic. Therefore, even if blockchain is treated as commons, a polycentric governance approach that integrates Ostrom’s design principles is not achievable unless the community members within blockchain networks act in the interest of the community, as opposed to their self-interests.

1. *Understanding social dilemmas in a blockchain network*

In a social dilemma of the commons, individuals are motivated to maximize their personal gain by using or exploiting the resource as much as possible. However, when everyone acts in their self-interest without considering the long-term consequences, the shared resource can become depleted, degraded, or even destroyed. This leads to negative outcomes for all members of the group, as the resource’s sustainability is compromised. The social dilemma of blockchain networks may hinge upon the conflict between the “affordances offered by the structure or system in which information is shared” and the “agency of actors operating in that system.”[[221]](#footnote-221) In other words, the centralities of a blockchain network may potentially give rise to the concentration of power, leading to a relatively small number of entities or individuals possessing the majority decision-making authority. From an economic standpoint, the centralities in the authentication and verification determine which transactions get validated and added to the block, resulting in an unequal distribution of power within the system. Within DAOs, the governance structure allows entities to obtain voting tokens, which can necessarily influence the governance decisions. Here are some instances illustrating how the centralization aspects of blockchain can create social dilemmas that affect the broader blockchain community.

*Forking*: A fork occurs when a community decides to change the existing blockchain protocol.17 When this happens, the chain splits and produces a second blockchain. There are usually two types of forking within the blockchain space – soft and hard forking. The difference between a soft fork and a hard fork can be described as follows: “soft forks change the rules of a protocol by strictly reducing the set of transactions that are valid, so nodes following the old rules will get on the new chain, whereas hard forks allow previously invalid transactions and blocks to become valid.”18 In 2016, the Ethereum community was split between two governance alternatives in response to a well-publicized hack resulting in the loss of nearly $50 million of Ether. One of the major criticisms regarding forking is that it changes the protocol in ways that some users may not like. In addition, a hard fork is coercive, which gives developers enormous power to change the protocol without regard for a blockchain network’s original rules.19 It also requires users and can lead to a hostile network takeover, which may not reflect users’ reason for using the network. A soft fork does not require consent from all users, meaning the power is only centralized in the hands of miners/ validators. Further, after a hard fork, there is no communication or interaction between two emergent blockchains. Users of the old blockchain are excluded from transacting with users who upgraded to the new protocol.

*51% attack:* A blockchain network can also be affected by a 51% attack. A 51% attack (also known as a majority attack) takes place when an individual or group of people gains control of more than 50% of the blockchain’s hash power.20 Although it is not certain to what extent 51% of attackers can disrupt the network’s functionalities, successful attackers can block a new transaction, hampering the remaining users’ consumption and use of the blockchain network.”21

*Asymmetry in power distribution:* Blockchain’s resources, such as cryptocurrencies and digital tokens, can be exploited by founders or whales if not subject to a common form of governance.[[222]](#footnote-222) 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.

1. *Polycentric Approach to Eliminate Embedded Centralities in Governance*

Ostrom’s theme of commons requires a polycentric governance approach of shared resources. Therefore, removing blockchain’s centralities is a critical part of the community governance design. Introducing an inclusive, polycentric, and decentralized governance structure can allow participants of a blockchain network to organize themselves voluntarily in a nested enterprise for collective interests. Therefore, the collective value of the network, in all likelihood, precedes any individual incentives. In a private blockchain network, the control is primarily assigned to a single party, which diminishes certain advantages that a public blockchain offers, especially concerning controlling who can access the network and governance. In a public network, centralities arise from the technological features and the practice of concentrating power in a few entities.

Looking at it from a governance perspective, blockchain technology, as initially conceptualized by Satoshi Nakamoto, holds the potential for a decentralized decision-making framework driven by community involvement, avoiding reliance on a central and singular authority. However, the reality is that most blockchain networks exhibit a certain level of centralization and employ a top-down approach to modify or amend network rules. Establishing a bottom-up interconnected blockchain ecosystem becomes essential for the sustainable preservation of shared resources, such as native tokens within a blockchain ecosystem, while upholding the core principle of decentralized decision-making that blockchain technology originally promised.[[223]](#footnote-223) True polycentricity is realized when each governing participant enjoys equal access to the decision-making process, eliminating the need for centralized authorities like a blockchain foundation.

## **Polycentricity in Blockchain’s Governance: Underlying Principles**

Theoretically, the original design of a polycentric governance structure does not necessarily eliminate the role of a central authority (a top-down approach).[[224]](#footnote-224) However, Ostrom shows that polycentricity can also be realized through a bottom-up approach—a community-empowered governance structure that can operate without a central government or a private institution.Departing from V. Ostrom’s polycentric idea encompassing a central government at the top, Ostrom’s pursuit of decentralization envisions a multi-tier governance system —each layer consisting of “many vibrant self-governed institutions.”[[225]](#footnote-225)

Ostrom particularly emphasizes the complexity involved in governing natural resources, such as forestry, and posits that “actors who try to govern a complex resource face a variety of incentives that often complicate collective efforts and subsequent outcomes.”[[226]](#footnote-226) Therefore, a robust polycentric governance system considers the multitude of aspects of individual incentives in the design framework and seeks to mitigate them.[[227]](#footnote-227) 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.[[228]](#footnote-228) To achieve optimal decentralization, a polycentric approach organizes these various actors in a coordinated way so that they can interact with each other and cope with conflicting interests and incentives.[[229]](#footnote-229)

Transporting Ostrom’s idea of polycentricity in a blockchain network, the ecosystem usually involves a diverse set of internal and external actors who have competitive interests and stakes in the governance process. The internal actors include developers, validators, node operators, token holders, stakers[[230]](#footnote-230), and ordinary users, while the external actors may consist of an enthusiastic blockchain community, regulators, researchers, and academics who can influence governance structure through discussions, social media, and advocacy efforts. Each of these actors has varying degrees of influence and interest in the governance of blockchain resources, making the process complex and multifaceted. Now, the fundamental question remains: How can polycentricity be achieved in blockchain that can incentivize the actors to pursue collective interests rather than their individual goals?

One distinguishing feature of a blockchain network is its capacity to utilize blockchain's programmability to establish and guarantee that rules are enforced in a transparent, automated, and immutable manner.[[231]](#footnote-231) One way of approaching this is to embody governance rules as a part of a blockchain network’s constitution.[[232]](#footnote-232) Discussions surrounding governance within cryptocurrency communities have led to the emergence of various proposed and implemented solutions—a parallel to constitutional design choices embodying “most important governance principles.”[[233]](#footnote-233). Utilizing the notion of constitutional design, Ostrom's design principles can serve as the fundamental guidelines for establishing a ‘nested enterprise’[[234]](#footnote-234) comprising blockchain participants who autonomously organize to safeguard the network's communal resources. To achieve this, Ostrom’s remaining seven design principles are categorized into three groups: (1) entry rules, (2) enforcement and execution rules, and (3) dispute resolution mechanisms.

Entry rules pertain to processes that define the terms and conditions for individuals to become a part of a blockchain network. While entry as an actor is voluntary, adherence to these rules is mandatory. The goal of participation or entry rules is to allow participants to opt into the boundaries and regulations incorporated within a blockchain network's governance framework. Enforcement rules encompass the measures taken in case a governor breaches any of the established rules. Such individuals should face sanctions in accordance with the enforcement and execution rules agreed upon by the community. Regarding dispute resolution mechanisms, to address conflicts arising from decisions, such as when a governor wishes to challenge imposed sanctions, disputes must be resolved in the prescribed manner.[[235]](#footnote-235)

An equally vital aspect of polycentricity in blockchain involves determining how blockchain actors overcome their competitive interests and actively contribute to the blockchain network’s sustainable and long-term growth, setting aside their own individual interests. Usually, the incentive system is “[a] principal variable affecting organization behavior.”[[236]](#footnote-236) The motivation theory centered on incentives is a behavioral concept positing that individuals are driven by the prospect of rewards and positive reinforcement.[[237]](#footnote-237) This theory also contends that people tend to conduct themselves in manners they anticipate will lead to favorable outcomes while steering clear of actions that might bring about negative consequences or penalties.

In a blockchain network, the incentive structure can be multi-dimensional—financial,[[238]](#footnote-238) economic,[[239]](#footnote-239) social,[[240]](#footnote-240) and political,[[241]](#footnote-241) which also can vary depending on the nature of the project. Since the onset of Bitcoin, scholars have analyzed users’ motivations for using cryptocurrencies and the diffusion of technology in general. As a currency, blockchain’s native token (cryptocurrency) usually holds political appeal “because it offers a promise to facilitate a social order primarily organized around individuals entering voluntary associations and relying less upon state institutions,” such as traditional financial institutions.[[242]](#footnote-242) Yet, the potential of the technology is not just limited to its economic and financial benefits.[[243]](#footnote-243) Despite the diverse and multitude nature of incentives centered around technology, Ostrom’s polycentric approach to blockchain governance can be a paradigm shift in incentivizing community members to pursue a collective goal.

# Conclusion

Blockchain technologies are positioned as the core for creating a shared, decentralized global economy. As opposed to a platform economy whose sole focus is capital accumulation, a blockchain-based economy enhances transparency, the capacity to generate value through the circulation of various goods and services. It can distribute resources fairly, equitably, and efficiently. It offers the promise of creating a novel form of the digital economy where participants work toward a common goal of fulfilling the community’s and ecosystem’s needs. However, as technology has grown in popularity and complexity, it has faced significant critiques and challenges.

Capitalizing on blockchain’s original promise of decentralization, private centralized cryptocurrency exchanges have revealed structural and functional issues. Vulnerabilities such as fraud, cyberattacks, regulatory violations, and financial crimes have become prevalent in these centralized exchanges. Moreover, blockchain technology itself has faced criticism related to environmental impact, scalability, security breaches, and centralization risks in governance and design. Recent high-profile incidents, such as the collapse of FTX and the Luna price crash, exposed the extreme vulnerabilities inherent in centralized blockchain systems. These incidents highlighted issues such as poor risk management, lack of transparency, and governance failures, leading to significant financial losses. The governance of blockchain networks has also come under scrutiny, with concerns about centralization, biased decision-making, and a lack of effective decentralized models.

Addressing these challenges requires a paradigm shift in the discourse of blockchain governance. One solution lies in adopting Ostrom's polycentric approach to commons governance. By categorizing blockchain's shared resources and applying Ostrom's design principles, blockchain networks can empower their participants, including core developers, node operators, investors, and users, to collectively manage shared resources in a sustainable and equitable manner. It enables blockchain networks to harness the collective wisdom of their participants, mitigate the tragedy of the commons, and foster a more resilient and trustless ecosystem. As the blockchain space continues to evolve, innovative governance models that prioritize decentralization and community empowerment will be essential to achieving the technology's transformative promise.

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2. Zibin Zheng et al., *An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends*, IEEE 6th Int’l. Cong. on Big Data 557 (2017). [↑](#footnote-ref-2)
3. *See generally*, Stuart Haber & W. Scott Stronetta, *How to Timestamp a Digital Document*, *in* Advances in Cryptology 437 (A.J. Menezes and 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). Also, Ralph C. Merkle, *A Digital Signature Based on a Conventional Encryption Function*, *in* Advances in Cryptology 369 (Carl Pomerance ed., 1988) (Providing the fundamentals of digital signature which became instrumental in designing the architecture of a cryptography hash). [↑](#footnote-ref-3)
4. The concept of ‘trustlessness’ has required significant academic attention since the advent of cryptocurrencies. Contrary to the original belief, authors have examined ‘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 (2017), https://ieeexplore.ieee.org/abstract/document/8318975 (Analyzing trustlessness from a user’s perspective and positing that while decentralized applications’ websites like Bitcoin and Ethereum refer to trustlessness, often the developers have significant control in the characterization of such element in their systems). *See also* Usman W. Cohan, *Are Cryptocurrencies Truly Trustless?* Cryptofinance and Mechanisms of Exch. 77 (2020) (Positing that trustlessness in cryptocurrencies is nuanced as it demonstrates human intervention in a variant degree. Drawing on the examples of hard forks, cryptocurrency exchanges, the distribution of Initial Coin Offerings (ICOs), and investors’ participation, the paper argues that the alleged trustlessness requires “both direct human intervention and direct human participation.”). [↑](#footnote-ref-4)
5. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System, Bitcoin.org (Oct. 31, 2008), https://bitcoin.org/bitcoin.pdf. [↑](#footnote-ref-5)
6. For a general overview of DeFi, see Igor Makarov & Antoinette Schoar, *Cryptocurrencies and Decentralized Finance (DeFi)*, NBER Working Paper 30006, NBER (Apr. 2022), https://www.nber.org/papers/w30006 (Discussing potential benefits and challenges of DeFi system which have the potential to reduce transaction costs and at the same time, it can impose challenges to enforce “tax compliance, anti-money laundering laws, and preventing financial malfeasance.”). *Cf.* Nic Carter and Linda Jeng, *DeFi Protocol Risk: The Paradox of DeFi*, SSRN Elec. J. (2021), https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=3866699 (Highlighting the risks of DeFi, the paper argues that DeFi demonstrates novel financial risks, such as interconnections with the traditional system, operational risks, governance and regulatory risks, etc. 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.”) [↑](#footnote-ref-6)
7. Sangita Gazi, *Reimagining a Centralized Cryptocurrency Regulation in the US: Looking through the Lens of Cryptoderivatives*, 6 (1) Cam. L. Rev.97 (2021). [↑](#footnote-ref-7)
8. Aino Nordgren et al., *Blockchain in the Fields of Finance and Accounting: A Disruptive Technology or an Overhyped Phenomenon*, 8 ACRN J. of Fin. & Risk Persp. Special Issue Digit. Acct. 47 (2019). [↑](#footnote-ref-8)
9. Bharat Bhushan et al., *Untangling Blockchain Technology: A Survey on State of the Art, Security Threats, Privacy Services, Applications and Future Research Directions*, 90 Comput. & Elec. Eng’g. 106897 (2021), https://www.sciencedirect.com/science/article/pii/S0045790620307497. [↑](#footnote-ref-9)
10. *Cf* Fin. Action Task Force (FATF), *Opportunities and Challenges of New Technologies for AML/CFT*. FATF (July 2021) (Viewing the innovative technologies can also improve the compliance of AML and CFT regulations). [↑](#footnote-ref-10)
11. *See* Gili Vidan & Vili Lehdonvirta, *Mine the Gap: Behind and the Maintenance of Trustlessness*, 21 (1) Sagepub J. 42 (2019) (Delving into the nuances of ‘trustlessness’ and describing the “discursive” nature of the code involving “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 undermines the intensity of human intervention required in a blockchain protocol.). [↑](#footnote-ref-11)
12. For an analysis on the FTX collapse, see Part III. [↑](#footnote-ref-12)
13. In re: FTX Trading Ltd., et al., No. 22-11068 (JTD), 2023 WL 3721527 (D. Del. May 30, 2023) at 2. (Describing the impact of the organization structure of the FTX, John Ray III who is overseeing the FTX bankruptcy proceeding states, “[n]ever 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. From comprised systems and faulty regulatory oversight abroad, to the concentration of control in the hands of a very small group of inexperienced, unsophisticated and potentially compromised individuals, this situation is unprecedented.”). [↑](#footnote-ref-13)
14. Peter Whoriskey & Dalton Bennett, *Crypto’s Free-Wheeling Firms Lured Millions: FTX revealed the dangers*, The Wash. Post (Nov. 16, 2022), https://www.washingtonpost.com/business/2022/11/16/ftx-collapse-crypto-exchanges-regulation/. [↑](#footnote-ref-14)
15. For an analysis on the Luna crash, see Part II. [↑](#footnote-ref-15)
16. *What Really Happened to Luna Crypto?* Forbes (Sep. 20, 2022), https://www.forbes.com/sites/qai/2022/09/20/what-really-happened-to-luna-crypto/?sh=60bf2c5f4ff1. [↑](#footnote-ref-16)
17. For an overview of different elements of blockchain’s purported decentralization, *See* Arati Baliga, Understanding Blockchain Consensus Models (Persistent Systems Ltd., Apr. 2017), <http://phd.artsedighi.com/wp-content/uploads/2017/09/WP-Understanding-Blockchain-Consensus-Models.pdf>, (Providing an overview of the consensus model and stating “[s]ince the consensus model maintains the sanctity of data recorded on the blockchain, it is important to ensure that it functions correctly in normal as well as adversarial conditions.”); also Juri Mattila, The Blockchain Phenomenon – The Disruptive Potential of Distributed Consensus Architectures, (The Research Institute of the Finnish Economy, ELTA Working Paper No. 38, May 2016) (Providing the overview of technology stacks underlying in a permissioned and permissionless blockchain architectures.); Sinclair Davidson et al., *Economics of Blockchain*, SSRN Elec. J. (2016), at 10, https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=2744751 (Drawing an economic analysis of blockchain, the authors argue that blockchain’s decentralization semblance a market economy which may but unlike traditional market economy, blockchains can mitigate “opportunism” by “eliminating the need for trust by using crypto-enforced execution of agreed contracts through consensus and transparency.” ); also Primavera De Filippi, *the Interplay between Decentralization and Privacy: The Case of Blockchain Technologies*, SSRN Elec. J. (2016), https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=2852689 (Arguing that blockchain’s decentralized infrastructure does not necessarily promote stronger privacy and autonomy and if not designed properly, they could be dangerous to entities using the technology.) [↑](#footnote-ref-17)
18. *See* Sami Ben Mariem et al., *All that Glitters is Not Bitcoin – Unveiling the Centralized Nature of the BTC (IP) Network, NOMS 2020* – 2020 IEEE/IFIP Network Operations and Mgmt. Symp. (Feb. 19, 2020) (Showing 4.5% of Bitcoin holders controlled 85% of Bitcoin.”) [↑](#footnote-ref-18)
19. Ashish Rajendra Sai et al., *Taxonomy of Centralization in Public Blockchain Systems: A Systematic Literature Review*, 58 (4) Info. Processing & Mgmt. 102584 (2021). [↑](#footnote-ref-19)
20. For an overview on blockchain’s unintended centralities in the design architecture, see Trail of Bits., Are Blockchains Decentralized? Unintended Centralities in Distributed Ledgers (Defense Technical Information Center, AD1172417, June 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.”) [↑](#footnote-ref-20)
21. *Id.*, at 8-9. Using the Nakamoto Coefficient, the report analyzed the centralities among blockchain protocol’s validators and argued that while the existing consensus mechanisms operate with the notion that validators are non-malicious, “most blockchain’s consensus protocols break down, if at least one-third of the assets staked by validators are malicious, effectively pausing the network. [↑](#footnote-ref-21)
22. *Id.* at 18-20. [↑](#footnote-ref-22)
23. *Id.*, at 12. [↑](#footnote-ref-23)
24. The Nakamoto Coefficient is a metric for measuring the centralization of a blockchain network. Balaji S. Srinivasan & Leland Lee, *Quantifying Decentralization*, Medium (Jul. 27, 2017), https://news.earn.com/quantifying-decentralization-e39db233c28e. The underlying method is to “(a) enumerate the essential subsystems of a decentralized system, (b) determine how many entities one would need to be compromised to control each subsystem, and (c) then use the [minimum] if these as a measure of the effective decentralization of the system. The higher the value of this minimum Nakamoto coefficient, the more decentralized the system is.” [↑](#footnote-ref-24)
25. Sarah Azouvi et al., *Egalitarian Society or Benevolent Dictatorship: The State of Cryptocurrency Governance*, *in* Financial Cryptography and Data Security 127 (Aviv Zohar et al., eds., Springer, 2018). [↑](#footnote-ref-25)
26. *Id.*, at 136. [↑](#footnote-ref-26)
27. Carla L. Reyes et al., *Distributed Governance*, 59 Wm. & Mary L. Rev. Online (2017), https://scholarship.law.wm.edu/wmlronline/vol59/iss1/1. [↑](#footnote-ref-27)
28. *Id.*, at 27. [↑](#footnote-ref-28)
29. Philipp Hacker, *Corporate Governance for Complex Cryptocurrencies? A Framework for Stability and Decision Making in Blockchain-Based Organizations*, SSRN Elec. J. (2017), https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=2998830. 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. [↑](#footnote-ref-29)
30. *Id.*, at 29. [↑](#footnote-ref-30)
31. *Id.*, at 30. [↑](#footnote-ref-31)
32. Roman Beck et al., *Governance in the Blockchain Economy: A Framework and Research Agenda*, 19 (10) J. of the Assoc. for Info. Sys. 1020 (2018). [↑](#footnote-ref-32)
33. For an overview of the IT governance dimensions, see Peter Weill, *Don’t Just Lead, Govern: How Top-Performing Firm Govern It*, 3(1) MIS Q. Exec. (2004), http://www.umsl.edu/~lacitym/topperform.pdf (Defining IT governance as “specifying the framework for decision rights and accountabilities to encourage desirable behavior in the use of IT.” According to this paper, “[a] desirable behavior is one that is consistent with the organization’s mission, strategy, values, norms, and culture, such as behavior promoting entrepreneurship, sharing and reuse, or relentless cost reduction.”); For an general analysis of principal-agent theory, see Mihnea Moldoveanu, *Agency Theory and the Design of Efficient Governance Mechanisms*, Rotman Sch. of Mgmt., Univ. of Toronto (Feb. 02, 2001), http://www-2.rotman.utoronto.ca/rogermartin/Agencytheory.pdf (Providing a theoretical framework for an efficient corporate governance and an incentive structure that can be deployed by managers to better agents to shareholders and mitigate corporate failures arising from managerial incompetencies and lack of integrity.) [↑](#footnote-ref-33)
34. Beck et al. *supra* note 32, at 1022. [↑](#footnote-ref-34)
35. *Id*. [↑](#footnote-ref-35)
36. *Id.*, at 1023. [↑](#footnote-ref-36)
37. *Id*. [↑](#footnote-ref-37)
38. Axel V. Werder, *Corporate Governance and Stakeholder Opportunism*, 22(5) Org. Sci. 1345 (2011). [↑](#footnote-ref-38)
39. *Cf.* Sinclair Davidson et al., *Economics of Blockchain*, SSRN Elec. J. (2016), at 10, https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=2744751 (Drawing on Williamson’s model of opportunism, the authors argue that blockchains could be “a mechanism to control opportunism by eliminating the need for trust by using crypto-enforced execution of agreed contract through consensus and transparency.”) [↑](#footnote-ref-39)
40. “According to the SEC complaint filed in the US District Court for the Southern District of New York on Feb. 16, Kwon and Terraform have transferred more than 10,000 Bitcoin from the platform and the Luna Foundation Guard to a cold wallet, then to a Swiss bank account to convert to fiat. The financial regulator said that the Terra co-founder and his company might have access to more $100 million in cash since withdrawals started in June 2022.” 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. [↑](#footnote-ref-40)
41. Illia Murtazashvili et al, *Blockchain as Knowledge Commons*, 16(1) Intl J. Comms. 108 (2022). [↑](#footnote-ref-41)
42. Krister P. Andersson & Elinor Ostrom, *Analyzing Decentralized Resource Regimes from a Polycentric Approach*, 41(1) Pol’y Sci. 71 (2008); Elinor Ostrom, *Beyond Markets and States: Polycentric Governance of Complex Economic Systems*, 100 Am. Econ. Rev. 641 (2010); also, Andrea Gatto, *Polycentric and Resilient Perspectives for Governing the Commons: Strategic and Law and Economic Insights for Sustainable Development*, 51 Ambio 1921 (2022) (Proposing a framework for the commons governance, where resilience and polycentricity are detected as principal assets to ensure sustainable natural resource users.); for an original discussion on the concept of polycentric governance, see Vincent Ostrom et al., *The Organization of Government in Metropolitan Areas: A Theoretical Inquiry*, 55(4) Am. Pol. Sci. Rev. 831 (1961), at 832 (analyzing the diversity of political units in a metropolitan area, the authors define polycentricity as “many centers of decision making that are formally independent of each other… To the extent that [these decision-making centers] take each other into account in competitive relationships, enter into various contractual and cooperative undertakings, or have recourse to central mechanisms to resolve conflicts, the various political jurisdictions in a metropolitan area may function in a coherent manager with consistent and predictable patterns of interacting behavior.” [↑](#footnote-ref-42)
43. Roy Gardner et al., *The Nature of Common-Pool Resources*, 2 Rationality and Soc. 355 (1990), at 6 (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. Therefore, “[w]hen a resource has no natural replacement (exhaustible resource), then any withdrawal rate will lead to exhaustion. Second, there are multiple individuals who are appropriating the resource units.) [↑](#footnote-ref-43)
44. See Elinor Ostrom, *Institutional Arrangement for Resolving the Commons dilemma: Some Contending Approaches*, (Ind. Univ., Workshop in Political Theory and Policy Analysis, Mar. 26, 1985). [↑](#footnote-ref-44)
45. See Understanding Knowledge as a Commons, (Charlotte Hess & Elinor Ostrom eds., The MIT Press. 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 (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.); also Mélanie Dulong de Rosnay & Felix Stalder, *Digital Commons*, 9(4) Internet Pol’y Rev. (online) (2020), https://policyreview.info/concepts/digital-commons (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.”) *cf.* Christian Fuchs, *The Digital Commons, and the Digital Public Sphere: How to Advance Digital Democracy Today*, 16(1) Westminster Papers in Commc’n and Culture 9 (2021) (Drawing on an analysis of big tech companies, the author argues that an open-access model is not necessarily a characteristic of a digital commons. Digital commons can be subsumed by digital capitalism in which corporations tend to adopt a model for profits out of commons. Therefore, the discourse of digital commons should focus on the commons with non-capitalistic character.) [↑](#footnote-ref-45)
46. Understanding Knowledge as Commons: From Theory to Practice (2007), (Charlotte Hess and Elinor Ostrom eds., The MIT Press. 2007). *See* Michael J. Madison et al., *Constructing Commons in the Cultural Environment*, 95 Cornell L. Rev. 657 (2010) (laying out a research framework for information and knowledge resources, “known as constructed commons in the cultural environment, in which the resources to be produced, conserved, and consumed are [only] pieces of information.”). [↑](#footnote-ref-46)
47. Dulong de Rosnay, Mélanie, and Felix Stalder, *Digital commons* (2020), Internet Pol. Rev. 9(4) 1. [↑](#footnote-ref-47)
48. *See* Lawrence B. Solum, *Questioning Cultural Commons*, 95 Cornell L. Rev. 817 (2010). [↑](#footnote-ref-48)
49. Jay W. Pope, *Commons Dilemma* (2013), *In* The Encyclopedia of Cross-Cultural Psych. [↑](#footnote-ref-49)
50. Org. for Econ. Coop. & Dev. (OECD), *Making Decentralization Work: A Handbook for Policy Makers*, *in* OECD Multi-level Governance Stud. (OECD, Mar. 19, 2019) [↑](#footnote-ref-50)
51. *See generally*, Michael McGinnis & Elinor Ostrom, *Reflections on Vincent Ostrom, Public Administration, and Polycentricity*, 72(1) Pub. Admin. Rev.15 (2012) (online) http://www.jstor.org/stable/41433139. [↑](#footnote-ref-51)
52. Ostrom et al., *The Organization of Government in Metropolitan Areas: A Theoretical Inquiry*, 55(4) Am. Pol. Sci. Rev. 831 (Vincent 1961). A polycentric governance approach realizes decentralization by way of establishing a “system-wide coordination of the decision centers” that “constitute[s] a collective good of a value.” Therefore, ‘polycentricity’ implies (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. [↑](#footnote-ref-52)
53. Elinor Ostrom, *Polycentric Systems for Coping with Collective Action and Global Environmental Change*, 20 Glob. Env’t Change 550 (2010), at 552, cited in Marcel J. Dorsch & Christian Flachsland, *A Polycentric Approach to Global Climate Governance*, 17 (2) Glob. Env’t. Pol. 45, at 47. [↑](#footnote-ref-53)
54. Gardner, *supra* note 43; also, Elinor Ostrom et al., Rules, Games, and Common-Pool Resources (The University Michigan Press, 1994). [↑](#footnote-ref-54)
55. Elinor Ostrom, *Common-Pool Resources and Institutions: Towards a Revised Theory*, *in* Handbook of Agric. Econ. 1315 (2002), at 1317; Elinor Ostrom, *Self-Governance of Common-pool Resources*, *in* The New Palgrave Dictionary of Econ.& the L. (Peter Newman, ed.) 1824 (2002). [↑](#footnote-ref-55)
56. *Infra*. [↑](#footnote-ref-56)
57. Elinor Ostrom, *Common-Pool Resources and Institutions: Towards a Revised Theory*, *in* Handbook of Agric. Econ. 1315 (2002), at 1317; Elinor Ostrom, *Self-Governance of Common-pool Resources*, *in* The New Palgrave Dictionary of Econ. & the L. (Peter Newman, ed.) 1824 (2002). [↑](#footnote-ref-57)
58. Elinor Ostrom, *Beyond Markets and States: Polycentric Governance of Complex Economic Systems*, 100 Am. Econ. Rev. 641 (2010). [↑](#footnote-ref-58)
59. *See generally*, Elinor Ostrom, Governing the Commons: The Evolution of Institutions for Collective Action. Rooted in empirical research on successful examples of commons governance around the world (Cambridge Univ. Press 1990) (laying out the design principles include clearly defined boundaries, collective choice arrangements, monitoring mechanisms, graduated sanctions, conflict resolution mechanisms, and recognition of the rights of users to self-organize). [↑](#footnote-ref-59)
60. Emphasis is mine. [↑](#footnote-ref-60)
61. *See* Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, bitcoin.org, <https://bitcoin.org/bitcoin.pdf> (laying out the design and operation framework of a peer-to-peer transaction using cryptography-based digital currency, popularly known as ‘bitcoin’); also M. N. M. Bhutta *et al*., *"A Survey on Blockchain Technology: Evolution, Architecture, and Security,"* *in* 9 IEEE Access, pp. 61048-73, 2021, doi: 10.1109/ACCESS.2021.3072849. [↑](#footnote-ref-61)
62. *Id*. [↑](#footnote-ref-62)
63. For an overview, see Disintermediation Economics: The Impact of Blockchain on Markets and Policies, (Eva Kaili & Dimitrios Psarrakis eds., Palgrave Macmillan 2021). [↑](#footnote-ref-63)
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65. Darra Hofman et al., *Blockchain Governance: De Facto (x)or Designed?* *in* Building Decentralized Trust: Multidisciplinary Perspectives on the Design of Blockchains and Distributed Ledgers (Victoria L. Lemieux & Chen Feng, eds., Springer 21 (2018)), at 24. [↑](#footnote-ref-65)
66. In contrast with the traditional concept of shareholders and board of directors. [↑](#footnote-ref-66)
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169. Ekin Genc, *Algorithmic stablecoins: What they are and how they can go terribly wrong*, Coindesk, May 16, 2022, https://www.coindesk.com/learn/algorithmic-stablecoins-what-they-are-and-how-they-can-go-terribly-wrong/. [↑](#footnote-ref-169)
170. Anthony Cuthbertson, *‘I lost my life savings’: Terra luna cryptocurrency collapses 98% overnight*, Yahoo Fin. May 11, 2022, https://news.yahoo.com/lost-life-savings-terra-luna-160848651.html. [↑](#footnote-ref-170)
171. For instance, the length of the voting period on Terra protocol was approximately one week. *Governance*, Terra Docs, <https://docs.terra.money/develop/module-specifications/spec-governance/#proposal-types. (last> visited Sept. 25, 2023). [↑](#footnote-ref-171)
172. *Id.* [↑](#footnote-ref-172)
173. Example of MakerDAO. Liquidity, and DeFi, collateralization, etc. [↑](#footnote-ref-173)
174. Staking is the consensus mechanism to validate transactions for proof-of-stake blockchains, including Ethereum, which also offers a way for investors to earn yield on their digital worldwide. [↑](#footnote-ref-174)
175. Tezos, *Governance and Validation on Tezos*, available at https://tezos.com/governance/. [↑](#footnote-ref-175)
176. William F. Lloyd, *On the Checks to Population*, Population & Dev. Rev., 473, (1980) <https://www.jstor.org/stable/1972412>. [↑](#footnote-ref-176)
177. *Id*. [↑](#footnote-ref-177)
178. Garrett Hardin, *The Tragedy of the Commons: The population problem has no technical solution; it requires a fundamental extension in morality*, Sci., Dec. 13, 1968, at 1243 .<https://www.science.org/doi/10.1126/science.162.3859.1243>. [↑](#footnote-ref-178)
179. references Considering the conflicting interests and distinct characteristics linked to shared resources, Ostrom, in her paper on polycentric governance of complex systems, suggested adjustments to the categorization of goods. As a result, she introduced a fourth category of goods known as ‘common-pool resources.’ Ostrom argues that common-pool resources share the attribute of subtractability (like private goods) and difficulty of exclusion or non-exclusivity (similar to public goods). Subtractability in the context of common-pool resources is also a form of excludability—meaning one’s access to resources may prevent others from accessing them. Ostrom argues that, like traditional commons, common-pool resources suffer similar risks of overuse, overconsumption, and selfish behavior, leading to their depletion and destruction. [↑](#footnote-ref-179)
180. Elinor Ostrom, *Beyond Markets and States: Polycentric Governance of Complex Economic Systems* Am. Econ. Rev. 641 (2010). [↑](#footnote-ref-180)
181. *Id.* [↑](#footnote-ref-181)
182. Example of Nepal. Cambodia, Ostrom’s field works. [↑](#footnote-ref-182)
183. *Technology and The Commons*, On the Commons (Sep. 10, 2006), https://www.onthecommons.org/technology-and-commons. [↑](#footnote-ref-183)
184. *Common-Pool Resources*, econPort, <https://www.econport.org/content/handbook/commonpool/Intro.html> (last visited Sept. 25, 2023). [↑](#footnote-ref-184)
185. A classic example of this was her field research in a Swiss village where farmers tend private plots for crops but share a communal meadow to graze their cows. While this would appear a perfect model to prove the tragedy-of-the-commons theory, Ostrom discovered that in reality there were no problems with overgrazing. That is because of a common agreement among villagers that one is allowed to graze more cows on the meadow than they can care for over the winter—a rule that dates back to 1517. Ostrom has documented similar effective examples of “governing the commons” in her research in Kenya, Guatemala, Nepal, Turkey, and Los Angeles. [↑](#footnote-ref-185)
186. Krvin Ells, *The Tragedy of the Commons*, *in* Companion to Environmental Studies (Norl Castree, et al. eds., Riutledge, 2018), <http://dx.doi.org/10.4324/9781315640051-24>. [↑](#footnote-ref-186)
187. Before her work, economic goods were primarily divided into two types — (1) Pure private goods – excludable and rivalrous, and (2) public goods – non-excludable and non-rivalrous. Later, Buchanan (1965) introduced a third type of goods, known as ‘club goods’. See James M. Buchanan, An Economic Theory of Clubs, 32 (125) Economica 1 (1965) (introducing ‘club goods’ which are neither purely public nor private). *See also* Elinor Ostrom, Institutions and Common-Pool Resources, 4 (3) Journal of Theoretical Politics 243 (1992) (Describing the fourth type of goods known as common-pool resources that are open to the public but are rivalrous or subtractable in nature). [↑](#footnote-ref-187)
188. See Michael D. McGinnis & Elinor Ostrom, Reflections on Vincent Ostrom, Public Administration, and Polycentricity, 72(1) Public Administration Review 15 (2011) (arguing that polycentric governance requires a complex combination of multiple levels, and diverse types of organizations drawn from the public, private, and voluntary sectors have overlapping realms of responsibility and functional capacity”.). [↑](#footnote-ref-188)
189. The original concept of polycentricity was coined by Vincent Ostrom et al. in 1961, who defined ‘polycentricity’ as multiple centers of decision-making independent of each other. They assigned three essential attributes of polycentric governance: (1) many autonomous decision-making centers; (2) a coherent system in which participants choose to act in ways taking into consideration others through. A reasonable question concerning a polycentric governance system is: how many decision-making centers are required? The answer is: ‘many’ or ‘multiple’. The specific answer is context-specific. See Vincent Ostrom et al., *The Organization of* *Government in metropolitan areas: A theoretical inquiry*, 55 Am. Pol. Sci. Rev.831, 831- 42 (1961). [↑](#footnote-ref-189)
190. Vincent Ostrom, *Polycentricity (Part 1)*. In Michael D. McGinnis(ed.) Polycentricity and Local Public Economies: Readings from the Workshop in Political Theory and Policy Analysis (University of Michigan Press, 1999), at 57; also, Keith Carlisle & Rebecca L. Gruby, *Polycentric systems of governance: A theoretical model for the commons*, The Pol’ Stud. J. (2017) (arguing that although a governance arrangement can include many decision-making centers, and hence, ‘polycentric’ in design, the operation of a ‘polycentric governance arrangement mandates that decision-centers are coordinated and capable of resolving conflicts.) [↑](#footnote-ref-190)
191. Vincent Ostrom, The Intellectual crisis in American public administration (Univ. Al. Press, 2007). [↑](#footnote-ref-191)
192. Vincent Ostrom (1999), *supra* note 198, at 59). [↑](#footnote-ref-192)
193. *See*, Lebel Louis et al., Governance and the Capacity to Manage Resilience in Regional Social Ecological Systems 11 (1) Ecology and Society (2006), cited in Carlisle and Gruby (2017), supra note 197, at 8. [↑](#footnote-ref-193)
194. Marco Schletz et al., *Nested Climate Accounting for Our Atmospheric Commons – Digital Technologies for Trusted Interoperability Across Fragmented Systems*, in 4 Front. Blockchain (Frontiers, 2022), <https://www.frontiersin.org/articles/10.3389/fbloc.2021.789953/full>. [↑](#footnote-ref-194)
195. For the internet, countries employ their domestic law to block various kinds of content and can be subject to copyright law, while for data, the contradiction is often faced between personal data and open data. [↑](#footnote-ref-195)
196. For instance, the Internet started out as more decentralized and open source until platform companies came about and appropriated access (to world wide web), imposing artificial scarcity in order to extract rent. Brett M. Frischmann, *An Economic Theory of Infrastructure and Commons Management*, Minn. L. Rev. (2005) <https://scholarship.law.umn.edu/cgi/viewcontent.cgi?article=1672&context=mlr>. [↑](#footnote-ref-196)
197. Frischmann (2005). [↑](#footnote-ref-197)
198. *Supra* note 201 at 937. [↑](#footnote-ref-198)
199. David Bollier, *An Economic Theory of the Commons*, On the Commons, July 12, 2005, <https://www.onthecommons.org/economic-theory-commons>. [↑](#footnote-ref-199)
200. Charlotte Hess and Elinor Ostrom, *Understanding Knowledge as a Commons: From Theory to Practice* (The MIT Press, 2007), cited in Brett M. Frischmann et al.(eds), Governing Knowledge Commons (Oxford University Press, 2014). [↑](#footnote-ref-200)
201. A social dilemma derives from the field of social psychology and game theory that describes a situation in which individual self-interest conflicts with a collective interest of a group. In ither words. It is a scenario wher individuals, when acting in their own best interest, can unintentionally harm the well-being of the group as a whole. [↑](#footnote-ref-201)
202. Hess and Ostrom (2007), *supra* note 207. [↑](#footnote-ref-202)
203. Madison, M. J. et al., *Constructing commons in the cultural environment*, 95 Cornell L. Rev. 657, 657–710 (2010); Frischmann, B. M. et al, *Introduction*. *in* Governing knowledge Commons 1–44(Frischmann et all, eds., Oxford University Press, 2014) https://doi.org/10.1093/acprof:oso/9780199972036.003.0001 [↑](#footnote-ref-203)
204. Open-source software projects, online encyclopedias, open-access academic journals, and collaborative research initiatives. It does not necessarily mean accessible to the public. Rather, knowledge commons have three dimensions—“shared, community or collective, governance”. *See* Ilia Murtazashvili et al., *Blockchain Networks as Knowledge Commons*, Int’l J. of the Commons (2022) <https://thecommonsjournal.org/articles/10.5334/ijc.1146#B31>. [↑](#footnote-ref-204)
205. For instance, Wikipedia is improved by individual contribution. [↑](#footnote-ref-205)
206. *Supra* note 207. *See also* *supra* note 132. [↑](#footnote-ref-206)
207. Another dimension to the application of the commons approach to digital infrastructure is to provide open accessibility to quality data for research purposes. For reference, see Jane Yakowitz, *Tragedy of the Data Commons*, 25 Harv. J. L. & Tech. 1 (2011-2012) (arguing the risks of treating data as commons). [↑](#footnote-ref-207)
208. David Rozas et al., *When Ostrom Meets Blockchain: Exploring the Potentials of Blockchain for Commons Governance*, 11(1) SAGE Open 1 (2021), <https://doi.org/10.1177/21582440211002526>. [↑](#footnote-ref-208)
209. *Id*. [↑](#footnote-ref-209)
210. *Id*. [↑](#footnote-ref-210)
211. Scott Shackelford & Steve Myers, *Block-by-block: Leveraging the Power of Blockchain Technology to Build Trust and Promote Cyber Peace*, 19 Yale J. of L. & Tech. 334 (2017)*.*  [↑](#footnote-ref-211)
212. For reference, see Bronwyn E. Howell & Petrus H. Potgieter, *Governance of Blockchain and Distributed Ledger Technology Projects: A Common-Pool Resource View,* *in* the Workshop on the Ostrom Workshop (WOW6) conference, (Ind. Univ. Bloomington, June 19–21, 2019) (in the themed panel *Blockchain: Innovation in Distributed Governance in the Cryptosphere* (Applying Elinor Ostrom’s Institutional Analysis for Development Framework into the DLT’s comprehensive governance structures)). [↑](#footnote-ref-212)
213. See Sangita Gazi et al., *Blockchain as Commons: Applying Ostrom’s Polycentric Approach to Blockchain Governance*, SSRN Elec. J. (2022), https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=4250547 (discussing a tiered governance approach, unlike a vertical top-down, ties governing participants with their reward and responsibility. Built on Ostrom’s eighth principle of “nested enterprise” as the foundation for such a framework, the approach organizes governing participants in a bottom-up fashion, connecting them through their shared responsibilities and a collective objective of effectively managing shared resources). [↑](#footnote-ref-213)
214. *Supra* note 210. [↑](#footnote-ref-214)
215. *Id.*, at 111. [↑](#footnote-ref-215)
216. *Supra* note 132. 1 [↑](#footnote-ref-216)
217. There are also opposing views regarding the characterization of blockchain networks as commons. See Vasilis Kostakis & Michel Bauwens, Network Society and Future Scenarios for a Collaborative Economy (Springer, 2014) (arguing that blockchain networks (such as Bitcoin) do not necessarily form a commons-oriented project. These networks resemble a “distributed” kind of capitalism that “utilizes peer-to-peer infrastructure to generate private profits.”5 It is also argued that often characterizing blockchain networks as commons originate from a particular political framework (i.e., anarcho-capitalism): “[promoting] scarcity and competition and thus serve to aggravate rather than ameliorate the over-accumulation of capital.”6 This often intensifies social inequalities by giving advantages to the first adopters. It is worth emphasizing that these arguments characterizing platform economics (the use of shared value to benefit the platform owners) further emphasize community governance’s critical role in the preservation, sustainability, and growth of shared resources.). [↑](#footnote-ref-217)
218. Eric Alston et al., Blockchain Networks as Constitutional and Competitive Polycentric Orders 18 (5) Journal of Institutional Economics 707 (2022). [↑](#footnote-ref-218)
219. *Id*. [↑](#footnote-ref-219)
220. Ilia Murtazashvili et al., *Blockchain Networks as Knowledge Commons*, Int’l J. of the Commons (2022) <https://thecommonsjournal.org/articles/10.5334/ijc.1146#B31>. [↑](#footnote-ref-220)
221. *Id*. [↑](#footnote-ref-221)
222. *Id*. [↑](#footnote-ref-222)
223. Gazi et al. (2022), *supra* note 220. [↑](#footnote-ref-223)
224. Vincent Ostrom et al., *The Organization of Government in Metropolitan Areas: A Theoretical Inquiry*, 55(4) Am. Pol. Sci. Rev. 831 (Vincent 1961). [↑](#footnote-ref-224)
225. Harini Nagendra & Elinor Ostrom, *Polycentric Governance of Multifunctional Forested Landscapes*, 6(2) Int’l J. of the Commons 104, at 104. [↑](#footnote-ref-225)
226. *Id.*, at 116. [↑](#footnote-ref-226)
227. *Id.*, at 117. [↑](#footnote-ref-227)
228. Vincent Ostrom et al., *The Organization of Government in Metropolitan Areas: A Theoretical Inquiry*, 55(4) Am. Pol. Sci. Rev. 831 (Vincent 1961). [↑](#footnote-ref-228)
229. *Id*. [↑](#footnote-ref-229)
230. In proof-of-stake (PoS) or delegated proof-of-stake (DPoS) blockchains, those who lock up tokens as collateral to secure the network have a say in governance decisions. [↑](#footnote-ref-230)
231. Gazi et al. (2022), *supra* note 220, at 15. [↑](#footnote-ref-231)
232. Eric Alston, *Constitutions and Blockchains: Competitive Governance of Fundamental Rule Sets*, 11 J. Of L. Tech. & The Internet 133, 154 (2019-20) <https://core.ac.uk/download/pdf/346394328.pdf> [↑](#footnote-ref-232)
233. I*d.* [↑](#footnote-ref-233)
234. Ostrom’s concept of ‘nested enterprise’ comprises of the idea that local-level organizations are not isolated in the governance structure. Rather, they are nested within larger governance structures or enterprises. There might be multiple tiers of levels of organization, each with its own rules, norms, and decision-making processes. [↑](#footnote-ref-234)
235. See Gazi et al. (20022) for a discussion on the model governance rules. [↑](#footnote-ref-235)
236. Peter B. Clark & James Q. Wilson, *Incentive Systems: A Theory of Organization*, 6 (2) Admin. Sci. Q. 129, 130 (1961) [↑](#footnote-ref-236)
237. *Id.* [↑](#footnote-ref-237)
238. These are tangible rewards such as cryptocurrency tokens, monetary compensation, or dividends. Financial incentives can be further divided into direct rewards (e.g., block rewards for miners) and indirect rewards (e.g., increased token value). [↑](#footnote-ref-238)
239. Economic incentives encompass both financial rewards and other economic benefits, such as access to resources, reduced transaction costs, or revenue-sharing arrangements. [↑](#footnote-ref-239)
240. “To say that blockchain’s popularity is due to increasing social trends to prioritize transparency over anonymity, to diminishing trust in traditional financial and governance institutions, and to expect greater levels of accountability and responsibility in all aspects of our lives, is only part of the story. Nevertheless, using blockchains instead of traditional ledgers actually invokes these very shifts in society.” Philip Boucher, What if blockchain changed social values? 2 (EPRS, 2017) https://www.europarl.europa.eu/RegData/etudes/ATAG/2017/603176/EPRS\_ATA(2017)603176\_EN.pdf [↑](#footnote-ref-240)
241. Decentralization, democracy, disintermediation. Robert Herian, *The Politics of Blockchain*, 29 L. & Critique 129, 129–131 (2018). https://doi.org/10.1007/s10978-018-9223-1. [↑](#footnote-ref-241)
242. Masooda Bashir et al., What Motivates People to Use Bitcoin, *in* Social Informatics 347, 357 (Springer, 2016). [↑](#footnote-ref-242)
243. *See* Walid Al-Saqaf & Nicolas Seidler, *Blockchain Technology for Social Impact: Opportunities and Challenges Ahead*, 2(3) J. of Cyber Pol’y 338 (2017) (describing blockchain’s social impacts, such as protecting individuals from undue online surveillance, privacy, and censorship). [↑](#footnote-ref-243)