Regulation & Governance

Regulation & Governance

ORIGINAL ARTICLE OPEN ACCESS

The Blockchain Treasury Governance Dilemma

Darcy W. E. Allen | Chris Berg | Aaron M. Lane

RMIT University, Melbourne, Victoria, Australia

Correspondence: Darcy W. E. Allen (darcy.allen@rmit.edu.au)

Received: 7 March 2022 | **Revised:** 16 January 2025 | **Accepted:** 17 January 2025

Funding: The authors received no specific funding for this work.

Keywords: blockchain foundations | blockchain Treasury | institutional possibility frontier | new comparative economics | trust

ABSTRACT

Blockchain treasuries are pools of cryptocurrency earmarked for funding goods and services within a blockchain ecosystem, such as protocol upgrades. Blockchain participants, such as users and developers, face a trust problem in ensuring that the treasury is robust to opportunism, such as theft or misappropriation of the assets. Treasury governance structures, such as committees or stakeholder voting, seek to create trust in treasury functions. In this paper, we use new comparative economics to examine how treasury governance mechanisms minimize the costs of dictatorship and disorder, thereby bolstering trust. We interpret case studies of innovative treasury governance within this Institutional Possibilities Frontier (IPF) framework, showing that the costs shift throughout the lifecycle of a blockchain community, and those costs are often revealed or learned through governance crises. These changes lead ecosystem participants to choose and innovate on treasury governance.

1 | Introduction to the Treasury Trust Problem

Growing blockchain ecosystems and decentralized autonomous organizations (DAOs) require ongoing spending on goods and services such as protocol research and development, startup projects and bridging infrastructure, and promotion and education. These ecosystems typically fund these goods and services through a "treasury."[1] The goods and services that are purchased with treasury assets often have positive externalities that flow to that blockchain's participants (such as network effects) or to the decentralized digital economy more broadly. Treasury capital can therefore be understood to be serving some collective purpose for a given blockchain. We define blockchain treasuries as pools of cryptocurrency (such as the native token or stablecoin) that are earmarked for funding towards collective goals. The objectives of treasuries often focus on how the assets will be used for the benefit of the blockchain or the cryptoeconomy ecosystem more broadly. This paper investigates some of the governance structures that help to ensure stakeholder trust in blockchain treasuries.

Blockchain treasuries are diverse in terms of where their assets come from and how those assets are spent. The stakeholders of a blockchain ecosystem include founders, venture capital investors, developers, network validators and private token holders. Even defining such blockchain stakeholders is difficult (Allen and Berg 2020). The ways that treasuries are funded is likewise diverse. For instance, many treasuries are funded by an allocation of tokens before those tokens are released to the market. Other ecosystems fund their treasury post-launch, using sources such as an on-going portion of network transaction fees. The allocation and spending of those treasury funds is even more diverse, and is currently subject to experimental innovation through grant programs, expert committees, elected foundations, and voting mechanisms. Most blockchains and applications do not just choose one of these tools, but rather deploy new combinations of these tools to create their own unique governance system. This experimental nature can create unpredictable interactions and outcomes of governance processes.

The blockchain treasury governance dilemma is to produce trust between ecosystem stakeholders that the treasury is both secure and is being used for its intended purposes. Our contention is that the structural diversity of blockchain treasuries is the result of different attempts to address this problem. Because blockchain treasuries are often denominated in their native token, as blockchain ecosystems grow so too does the potential treasury value that can be opportunistically attacked. Indeed, at the time of writing several blockchain treasuries are holding the equivalent of billions in United States dollars. As these trust problems grow, so too does the need for effective governance mechanisms to bolster trust.

Different fields approach the trust problem in different ways (Anheier and Kendall 2002), although three examples suffice: law, sociology, and economics. First, in law, courts of equity have dealt with disputes involving breaches of trust for at least 500 years. The legal conception of trust focuses on a fiduciary relationship—a person placed in position of trust and confidence to make decisions or hold property on behalf of another—and provides personal remedies for beneficiaries if that trust is breached. Corporate governance, for example, has evolved alongside the equitable tradition where company directors owe a range of fiduciary duties to the members of the company (as a whole) to guard against the possibility that the directors could use their powers to further their own interests at the expense of the members interests. Fiduciary duties are a substitute or complementary alternative to direct monitoring by auditors or financial controllers (which comes with direct costs and does not resolve the age-old governance question: Quis custodiet ipsos custodes?) (Easterbrook and Fischel 1981). Greater legal constraints tend to foster higher levels of trust, such as a non-distribution constraint for a non-profit entity (e.g., Hansmann 1980) or protection of minority interests (e.g., Johnson et al. 2000; La Porta et al. 2000). Recent legal scholarship has leveraged this understanding of trust as the basis for proposing that developers in public blockchains might owe fiduciary duties to other participants in the blockchain ecosystem such as users (e.g., Walch 2019; c.f., Haque et al. 2019) although the substantive legal argument has yet to fully tested in the courts.[2]

Second, sociology takes both broader and narrower conceptions of trust. On the one hand, trust is conceived more broadly in the sense of the unit of analysis being at the group, community, or society level rather than individual level. On the other hand, trust can be conceived more narrowly in the sense that "trust" (in the realm of prior personal decisions) is disentangled from, and therefore does not include "confidence" (in some outer system beyond direct control) (see Luhmann 2000). Beyond Luhmann's distinction between trust and confidence, sociological perspectives on trust emphasize its role in reducing social complexity and enabling cooperation. Gambetta (1988) defines trust as a subjective probability assessment of beneficial behavior from others, while trust has also been examined as "encapsulated interest" where trust emerges from aligned incentives between parties (see Hardin 2002). These sociological perspectives complement our economic analysis by highlighting how trust functions as both a psychological state and social mechanism.

Third, and for the purposes of this paper, we take an economic conceptualization of the trust problem—one that emerges from the threat of opportunism, or what Oliver Williamson (1975) refers to as "self-interest seeking with guile". Accordingly, trust emerges between stakeholders through effective governance that reduces the perceived costs of opportunism. Those costs are imposed by different stakeholders differently, including theft through hacking, or more subtle acts such as collusion or corruption. Rather than relying on interpersonal trust of legal duties, the economic approach focuses on creating "trustworthy" institutions through clear, stable rules that govern interactions, constraints on power, and alignment of economic incentives (e.g., Buchanan and Tullock 1962; Brennan and Buchanan 1985; North 1990).

Governance mechanisms can bolster trust or confidence in blockchain treasuries by reducing the perceived or actual scope of opportunism. De Filippi, Mannan, and Reijers (2020) distinguish between trust and confidence in a blockchain context. While trust involves personal vulnerability and risk-taking, confidence emerges from internalized expectations based on knowledge or past experiences. They argue that blockchain technology acts more as a "confidence machine" than a "trustless" system, as it increases confidence in procedural operations while still requiring trust in various human actors involved in governance. In the context of our analysis, we recognize that blockchain treasuries face challenges of both trust and confidence. The technological infrastructure of blockchains enhances confidence in procedural operations, as De Filippi et al. suggest, but our focus on governance mechanisms primarily engages with issues of trust because governance involves human actors and decision-making processes that cannot be fully automated or made purely procedural. While we acknowledge the role of confidence in blockchain systems, we primarily explore how different governance structures and mechanisms can bolster trust in the human elements of treasury management.

The scope of governance mechanisms in blockchain treasuries is both diverse and expanding. Those mechanisms include elected or unelected foundations and committees, stakeholder voting and automatic execution of spending decisions, as well as innovative voting mechanisms with asymmetric voting weights (such as quadratic voting and time weighted voting systems, see Mohan, Khezr, and Berg 2024). Designing blockchain governance is complicated by the perceived purpose of a treasury, the bases of legitimacy for treasury governance (Buterin 2021), and the potential need to diversify treasuries across asset classes (Talamas and Nystrom 2021). To answer these questions, many blockchain communities have derived their theoretical influence from understanding that blockchains have institutional similarities to firms or nations, and therefore to design blockchain governance they leverage insights from corporate governance, internet governance, or political governance. There are, however, limitations to the application of these disciplines to blockchains as a distinct institutional form (Davidson, de Filippi, and Potts 2018). For instance, ex post enforcement issues abound in blockchain ecosystems given that attention needs to be given to ex ante governance design to foster trust.

This paper investigates how treasury governance structures can mitigate the costs of opportunism, thereby bolstering trust. Blockchain participants seek to trust that the treasury will be robust to opportunistic behavior. This paper takes a broad view of such opportunistic behavior. For instance, treasuries might be opportunistically stolen from outsiders hacking the treasury (i.e., theft), misappropriated by a holder of the funds in a position of power for their own purposes (i.e., defalcation)[3], or misappropriated by holders of the funds by transferring assets to another entity under their control (i.e., tunneling). The mitigation of these different types of opportunism through governance mechanisms bolsters trust that the treasury is secure and operating as intended.

Our methodology draws on "new comparative economics" (Djankov et al. 2003, Shleifer 2005) and its Institutional Possibility Frontier (IPF). This field has been developed to examine how different institutions minimize different types of social costs. Through the analytical lens of "new comparative economics," societies choose between different institutional possibilities to minimize the social losses from opportunism (whether imposed by private or state-based actors). In relation to blockchain treasuries, this is a choice between different governance solutions to the problem of treasury opportunism, such as centralized committees or decentralized voting. We apply the IPF to the question of blockchain treasury governance before examining various case studies. The IPF enables analysis of institutions on how they minimize two types of social costs: dictatorship costs, and disorder costs. Both types of costs are the result of opportunistic behavior from different individuals.

Both dictatorship costs and disorder costs manifest in unique ways in blockchains. Dictatorship costs are typically understood to be imposed by state-based actors. Examples include property expropriation and coercion by governments. In blockchains, dictatorship costs include those costs born by actors in institutionalized positions of power, such as holders of keys in multisignature contracts, board members of a foundation, or founding teams.[4] On the other hand, disorder costs are imposed by private actors, and include theft and banditry. In blockchains disorder costs include collusion or hacking. There are blurry lines between these categories, which is why we theoretically explore them throughout this paper. Different institutions, such as private orderings or regulatory frameworks, trade-off between these costs in different ways.

The primary contribution of this paper is to apply the established IPF framework to examine blockchain treasury governance, showing how the trade-off between dictatorship and disorder costs shapes governance choices across different blockchain communities. The IPF framework reveals that communities face different magnitudes and types of costs depending on factors like community size, treasury value, and stage of development. Costs of dictatorship and disorder in blockchain treasuries evolve. A shift in the composition of governance token holders through a large public sale of tokens, for instance, changes the relative threat of dictatorship versus disorder costs. Subsequently, the cost-minimizing blockchain treasury governance structure to minimize those costs might also shift. Rather than converging on a single optimal governance structure, we find that different combinations of governance mechanisms—from multisignature contracts to voting—represent attempts to minimize these context-specific costs. This helps explain both the diversity of treasury governance mechanisms we observe and their evolution over time as the relative threats of dictatorship and disorder shift. Furthermore, the cost-minimizing governance structure for a blockchain treasury is also open to institutional innovation, including through the deployment of blockchain-based voting infrastructure to create new types of governance structures, such as the delegation of voting rights. Our theoretical framework is a useful tool to compare innovation, diversity, and choice in blockchain governance mechanisms as they mitigate opportunism and generate trust.

We proceed as follows. In Section 2 we explore the blockchain governance literature and introduce the broad features of blockchain treasuries to examine their trust problem. In Section 3 we introduce new comparative economics and the IPF. We explore how different applications of treasury governance tradeoff between dictatorship costs, such as founders expropriating the treasury, and disorder costs, that emerge from hacking or collusion to misappropriate treasury funds, enabled through the permissionless nature of blockchain treasury governance. We also emphasize the application of the IPF in a blockchain context, including the complexities that emerge through more fluid and informal governance. In Section 4 we apply the IPF to case studies of treasury governance, including both innovations in treasury governance, and how different institutional costs shift over time. In Section 5 we conclude.

2 | The Trust Problem in Blockchain Treasuries and Foundations

2.1 | Governance of and by Blockchains

A key distinction made in the blockchain governance literature is between the governance *of* blockchains and governance *by* blockchains (De Filippi and McMullen 2019). The former refers to the mechanisms used to facilitate the evolution *of* blockchain ecosystems, such as protocol improvement processes to make code updates. The latter generally refers to the governance of economic, social, and political activities *by* blockchains and related technologies, such as the creation of DAOs for various purposes.

This distinction between governance *of* and *by* blockchains is useful but complex. For instance, new decentralized finance (defi) protocols often include innovations in tokenholder voting (governance *by* blockchain) to aid in collective decision making around incentives and fees (governance *of* blockchains). Blockchain is a technology that needs to be governed, but its properties as a distributed ledger that can record votes and aid coordination also enable it to be a tool for governance. While the primary focus of this paper is on the governance *of* blockchain treasuries, much of that process involves the utilization of blockchain and related technologies as tools in that process.

The literature on governance *of* blockchain focuses on adaptability, upgradability, and security (for a recent review see Liu et al. 2021), including how blockchain communities coordinate, make decisions, and enforce changes to their protocol (Finck 2018; Pelt et al. 2021). Designing blockchain governance comes up against issues of legitimacy, polycentricity, and sovereignty (De Filippi, Reijers, and Mannan 2024). The governance of blockchains includes different combinations of decision rights, accountability, and incentives (Beck, Müller-Bloch, and King 2018; Smit et al. 2020). Blockchains provide new ways to organize people and collaborations (Lumineau, Wang, and Schilke 2021). One way that the design space for governance of blockchains has been opened is through innovations in tools for aggregating and coordinating votes (Allen, Berg, and Lane 2019) or leveraging reputation systems (e.g., Pazaitis, De Filippi, and Kostakis 2017; Mannan 2018). The combinations of governance tools are often designed either by the founding team, or evolved over a process of "progressive decentralization" away from a centralized team to a decentralized community (e.g., see Walden 2020).

Much of our understanding of blockchain governance today has drawn on lessons from the theory of governance of more familiar organizational forms. Scholars have observed familiar aspects of other institutions and organizations that have a deeper literature and applied those lessons to blockchain governance. For instance, scholarship on blockchain governance has drawn on corporate governance (Allen and Berg 2020; Davidson 2021, 2024; Hsieh, Vergne, and Wang 2018), information technology, and internet governance (Beck, Müller-Bloch, and King 2018; Zachariadis, Hileman, and Scott 2019), information governance (De Fillipi and Lovelock 2016; Hofman et al. 2019), and political and constitutional governance (Alston 2020; Berg, Berg, and Novak 2020; Rajagopalan 2018; De Filippi and Wright 2018). Improving blockchain governance through analogy to other organizational forms has conceptual challenges (Hofman et al. 2021), partly because of a lack of understanding of the reasons where different governance mechanisms are best deployed (see Davidson this issue). Designing blockchain governance mechanisms has proven difficult partly because blockchains are institutional technologies that have characteristics of a range of different institutions including commons, clubs, firms, and states (Davidson, de Filippi, and Potts 2018).

Before examining the specific case of governing blockchain treasuries, we note three major challenges in designing blockchain governance. First, public blockchains are open institutional systems. Investors, developers, and users experience low entry and exit costs, such as buying a token on an exchange (with associated rights, such as governance) or building and developing complementary ecosystems (e.g., Layer 2 scaling solutions)[5] or forking the open source code. One of the key design questions in governance (at least from a corporate governance perspective) has been to define the stakeholders who participate in governance (e.g., see Allen and Berg 2020)—who is it that is being governed? Defining the stakeholders of blockchain ecosystems is hard. There are complex relationships with other institutional systems, such as regulations or other layers of the same ecosystem. At the same time blockchain ecosystems often have rapidly changing stakeholders as a network is bootstrapped (many of whom may have different incentives).

Second, a lack of identity infrastructure compounds challenges with stakeholder definitions. Other more familiar governance structures, such as governments, rely on a clear and trusted identity system to achieve the desired outcomes, such as fair elections. The pseudonymous and anonymous identities that characterize blockchains make it possible for bad actors to use multiple identities to their advantage (i.e., a "sybil" attack). These attacks have clear implications for the design of blockchain governance, including the decision rules and aggregation rules of on-chain votes (e.g., quadratic voting or quadratic funding). There have also been related innovations in blockchains, such as "contribution systems," that seek to define and allocate value in a pseudonymous environment (see Rennie and Potts 2024).

Third, the decentralized ethos of blockchain communities requires governance to evolve over time. The early stages of blockchain development tend to be centralized around a small group of founders. Community norms, however, have a clear preference towards more decentralized governance (i.e., more actors within the decision-making process, particularly relating to consensus processes and other major changes). As Alston (2024 in this volume) argues, norms blockchain governance must recognize the role of norms in situations of uncertainty. The governance of blockchains must evolve over time to deal with different problems at different stages (including changes in the size and norms of the stakeholders themselves). Rikken, Janssen, and Kwee (2019), for instance, distinguish between three governance phases—design phase, operation phase, and the evolvement/crisis phase—each of which have different challenges in terms of decision rights and time sensitivity.

2.2 | Trusting Blockchain Treasuries

Economic theory suggests that pure public goods—goods that are both non-rival in consumption as well as non-excludable—will be privately "underproduced" (Samuelson 1954). From here the argument is that societies implement other institutional forms, such as governments, to raise the production of those goods to some Pareto-efficient socially desirable level. Blockchains also require goods that have some similar "public" characteristics. Those goods include bug fixes, protocol upgrades, wallets, and bridges. Those goods also may include projects to gain new users and generate network effects in multi-sided markets. Each of these goods may be required for the long-term sustainability of a blockchain ecosystem, and they may require funding to undertake them. But blockchains do not have governments to tax-and-spend on those goods. In addition to more altruistic projects that seek to provide these public goods for the ecosystem more broadly (e.g., Gitcoin), blockchains project themselves often create and spend "treasuries" to fund those goods.

Zhang et al. (2018, 1) define a treasury system as "a community controlled and decentralized collaborative decision-making mechanism for sustainable funding of the blockchain development and maintenance." We define a blockchain treasury as a pool of cryptocurrency raised and held to support the blockchain ecosystem (including both a specific blockchain and the decentralized economy more broadly). Existing literature often analogizes blockchain treasuries with other more familiar treasuries, such as the role of corporate treasuries in managing a corporation's liquidity and funding private operations (e.g., see Allen and Berg 2020; Davidson 2024). While the analogy to corporate governance is useful, its application does not apply to many of the goods that treasuries fund. Blockchains and their treasuries are unique institutions that have characteristics of both firms and governments (e.g., see Berg 2021). Blockchains have systems of rules that have been described as constitutional (Alston 2019, Alston et al. 2021, 2022), and those platforms are increasingly built-upon by further innovation. Therefore our approach in this paper is to examine whether blockchain treasuries can be understood through frameworks typically deployed to understand regulatory frameworks in nation states.

Our analysis of blockchain treasuries fits within a broader literature on the private provision of public goods. While the traditional economic view has been that public goods require government provision due to free-rider problems, a growing body of research has demonstrated various mechanisms by which public goods can be privately supplied. Bergstrom, Blume, and Varian (1986) show how even with non-cooperative behavior, private provision of a public good can approach efficient levels under certain conditions. Candela and Geloso (2018, 2019) examine historical cases of private lighthouse provision, challenging the classic example of lighthouses as a public good requiring government provision; this builds on Ronald Coase's (1974) seminal work and sits alongside a rich debate about private provision of public goods (see also Van Zandt 1993; Bertrand 2006; Lindsay and Dougan 2013). This literature suggests that the public or private nature of a good is not inherent, but rather dependent on the institutional context—a principle that applies equally to blockchain networks.

Blockchain treasuries fund a range of different goods and services that could be characterized as "local public goods" (Tiebout 1956) or "club goods" (Buchanan 1965) because they are for a particular community or ecosystem, are excludable on some margins, but don't relate to a territorial jurisdiction. Treasuries sometimes fund goods, such as research, that have spillover effects on other blockchain ecosystems. Without venturing into the fraught definitions of public goods (Holcombe 1997; Nair and Sutter 2018), in this paper, we contribute to the understanding of treasury governance by utilizing a framework typically used for nation state governance.

Blockchains can also be understood as a type of knowledge commons (Dekker and Kuchař 2021). Rozas et al. (2021) show that blockchains rely on collectively managed technologies to pool and manage distributed information, institutionalizing community governance to produce shared resources. This perspective aligns with knowledge commons as involving institutionalized sharing of resources among community members, including resources such as culture and law (Madison, Frischmann, and Strandburg 2009). Blockchains combine features of markets, firms, and commons in novel ways that facilitate decentralized cooperation (Davidson, de Filippi, and Potts 2018). Murtazashvili et al. (2022) elaborate on this idea, suggesting that blockchain networks represent knowledge commons governance in their reliance on shared protocols, open-source code, and collectively managed ledgers. This framing helps explain both the public good aspects of blockchains and their complex governance structures, including the interplay between on-chain and off-chain governance mechanisms (Bodon et al. 2022).

In this complex institutional context, blockchain treasuries are institutionally structured pools of assets that are allocated over time for broad objectives such as "ecosystem development." Such broad aims are partly explained by ongoing uncertainty about precisely what treasuries are for. Particularly where treasuries are formed early in a protocol, it is not clear what the future needs of the ecosystem will be, and so loosely defined objectives enable adaptability in the allocation of funds over time. The wide range of uses of treasury funds are not clearly visible ex ante, particularly where a treasury is created and filled in the early stages of a protocol. Ambiguous objectives matter because they open the scope of opportunistic behavior, exacerbating the trust problem. How can stakeholders trust that the treasury funds will be both effectively allocated and that those funds will be robust to opportunistic behavior?

3 | The New Comparative Economics of Treasury Governance

3.1 | An Introduction to the IPF

The "new comparative economics" emerged as a coherent tool to compare different institutional systems. The underlying premise is that systems of property rights protection are not perfectly costless and societies choose between institutions (e.g., courts, regulatory state, and state ownership) to minimize social losses (Djankov et al. 2003; Shleifer 2005). From this perspective, the new comparative economics is "a new formalization of the new institutional economics of Coase (1937), Williamson (1975) and North (1981) at the societal level rather than the firm level" (Rosser and Rosser 2008, 82).

The theoretical focus on costs and the ways that institutions minimize them is operationalized through the IPF. The IPF is a map of how institutions minimize the costs of expropriation of property by states ("dictatorship costs") and the costs of expropriation by private agents ("disorder costs"). For our purposes, minimizing these social costs through institutional choice and institutional innovation bolsters trust. To the extent that governance participants believe that governance mechanisms minimize the costs of dictatorship and disorder, these beliefs manifest in trust in those institutions.

The IPF helps us to understand institutional trade-offs in blockchain treasury governance.[6] The conventional application of the IPF is at the "societal level" because of a focus on comparison between jurisdictions. For blockchains, however, we interpret institutional choice at the "ecosystem level," with the relevant costs imposed on ecosystem stakeholders of a blockchain (e.g., Bitcoin, Ethereum, and Cosmos). There are two types of costs in the IPF framework, defined by the actors imposing those costs. First, "dictatorship costs" that stem from expropriation by governments. Second, "disorder costs" that individual impose on each other.[7] Societies (imperfectly) choose between a set of institutional possibilities that impose these costs in different ways. On the one hand, state-controlled business imposes high potential dictatorship costs, such as through excessive taxation or reductions in liberties. On the other hand, private orderings generate high potential disorder costs, such as through deceptive or anti-competitive behavior. Shifting between institutional possibilities may reduce the costs of disorder, for instance, but raise the costs of dictatorship. Figure 1 represents the application of the IPF to the regulation of business as in Djankov et al. (2003).

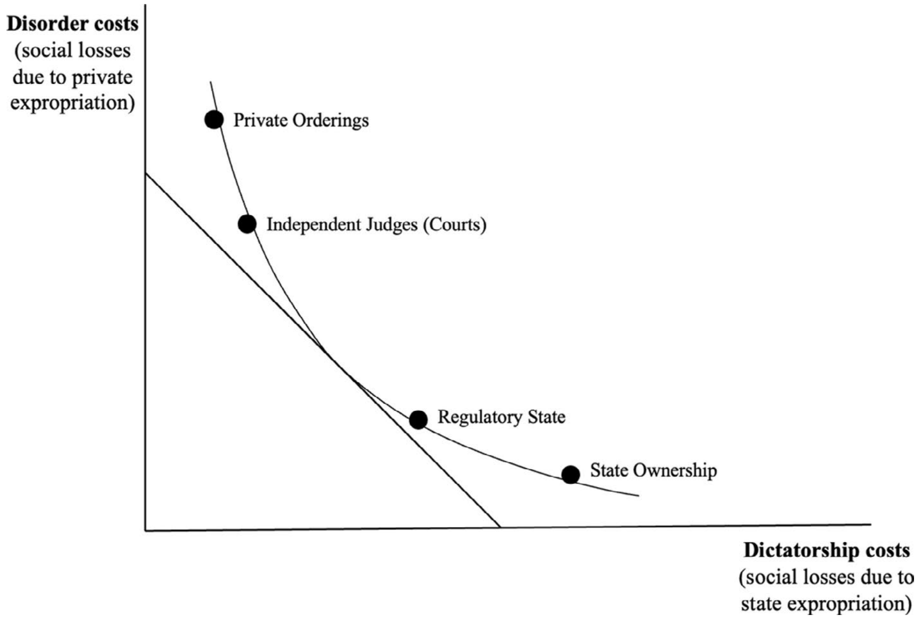

FIGURE 1 | An IPF for the regulation of business. A representation from Djankov et al. (2003).

The function in Figure 1 is convex, implying some cost-minimizing institutional point where dictatorship costs and disorder costs are minimized. According to Djankov et al. (2003), the IPF's distance from the origin is a function of "civic capital"—including community trust and norms, technological innovation (those technologies that facilitate governance) and human capital. While Rosser and Rosser (2008) have criticized the definition of "civic capital" as inadequate, the analytical power of the IPF remains as a tool for comparing institutional solutions through the focal point of an economic problem, rather than beginning with the nature of an institution itself. Changes in "civic capital," such as norms, as well as governance innovation, can shift the IPF, or change its slope. This process opens or constrains institutional possibilities. Furthermore, as Allen and Berg (2017) argue, institutional costs are fundamentally subjective—different actors perceive and weigh dictatorship and disorder costs differently based on their position and experiences within the system. This subjectivity means the IPF may not represent a continuous set of possibilities, and multiple institutional equilibria could exist. The value of the IPF nevertheless lies in a way to explore the fundamental trade-offs communities face when designing governance mechanisms, even if those trade-offs manifest in complex ways. Indeed, the IPF was originally developed to compare different institutional controls on business but has since been applied to a variety of institutional solutions to economic problems including innovation (Davidson and Potts 2016), dispute resolution (Allen et al. 2020), and democratic governance (Allen, Berg, and Lane 2019). In these applications the same analytical premise of the IPF has been applied to new domains, providing insights in empirically and theoretically understanding different institutions.

3.2 | Dictatorship and Disorder in Treasury Governance

How does dictatorship and disorder manifest in open, permissionless blockchain ecosystems? While both firms and blockchains are not directly controlled by governments, they are impacted by them. There is of course a threat that governments may seek to expropriate treasury funds, but these costs largely come indirectly. For instance, governments could exert regulatory pressure by requiring blockchain projects to comply with existing financial laws or new blockchain-specific regulations, potentially limiting the autonomy of treasury management. Tax enforcement presents another avenue for government intervention; although direct taxation of decentralized treasuries is challenging, governments might mandate reporting of treasury assets and transactions, creating potential tax liabilities. Legal action against key individuals, such as founders, developers, or known treasury signatories, serves as another indirect method of pressuring treasury governance. Governments could restrict fiat on/off ramps by regulating exchanges and financial institutions, limiting the ability of blockchain treasuries to convert assets to fiat currencies and impacting the liquidity and flexibility of treasury management. Nevertheless, these dictatorship costs are limited by the capacity for governments to act in a comparatively decentralized, permissionless, on-chain, and global treasury environment.

For the purposes of our analysis we focus on the institutional governance structures developed by blockchains to govern their treasuries (rather than the potential costs of nation states). In this section, we apply the basic analytical trade-off within the IPF framework to the unique context of blockchain ecosystem governance. What we show is that dictatorship and disorder manifest in unique ways in blockchains, but that the analytical framework is useful for understanding the dynamics of blockchain governance.

If dictatorship costs are imposed by governments, and blockchains do not have governments, then how can the IPF framework apply to blockchains? Some blockchain communities govern their treasury through the decisions of a small group of people. Often these people include founders or foundation members in a multisignature contract.[8] There are many reasons for this approach of few decision makers. They include rapid decision making, public and known identities of individuals with governance power, and potentially aligned incentives with the long-term success of the protocol or project. The idea of a (benevolent) "dictator" in the open source software is an example of a prototypical person who may occupy one of these positions well-understood (Azouvi, Maller, and Meiklejohn 2018). The costs that these individuals, who are delegated or claim positions of power above other token holders, is a type of dictatorship cost. The open nature of blockchain ecosystems, including the comparatively low entry and exit costs compared to territorial jurisdictions, still generate dictatorship costs because there are people with positions of power (e.g., election, path dependent holding of a position) and who can act opportunistically on the treasury.

Because blockchains often have centralized origins, high dictatorship costs in their early stages is not necessarily an explicit choice, but an organizational need to quickly launch a new project. The decisions of how to raise capital and allocate early treasury funds is often made through a small founding team. Even where different projects launch "DAO-first," or undertake a "fair drop" of tokens to distribute them widely (see Allen, Berg, and Lane 2023), these decisions must first be made, and their mechanisms must be designed (see Allen 2024). A treasury needs some form of governance, and when an ecosystem is small, that governance is likely to fall to a small set of people with privileges over other token holders (e.g., founders, foundation members, and multisignature holders). As the ecosystem grows, these people may hold on-going positions of authority (whether that authority comes from social norms or from explicit formal authorized positions within a governance structure) that enable them to opportunistically act on the treasury, such as through corruption or theft.

While those in positions of power benefit from these opportunities for rent extraction, the dictatorship costs themselves are borne by the broader ecosystem stakeholders. For instance, when a small group controlling treasury keys misappropriates funds for their own benefit, they capture the upside while the costs—both direct financial losses and broader erosion of trust—fall on the wider community of token holders, users, and developers. Similarly, when foundation board members allocate treasury funds to projects they have undisclosed interests in, they privately capture the benefits of this self-dealing while the costs are distributed across the ecosystem in the form of misallocated capital, reduced innovation, and damaged community trust in the governance process.

Blockchain communities can alternatively attempt to govern their blockchain treasury, even from an early stage, across a much broader group of stakeholders. This approach includes decentralizing the governance of the treasury to a broader group of stakeholders, typically token holders, and can be understood as a reduction in dictatorship costs. This approach typically includes grant proposals, decided through an on-chain or off-chain proposal process. For instance, Snapshot is a popular off-chain voting system for DAOs and blockchain projects. It allows token holders to vote on proposals without incurring gas fees, as the voting occurs off the main blockchain. While this approach might reduce some dictatorship costs, there is a corresponding increase in the costs of disorder, which is where we now turn.[9] Disorder costs arise from opportunistic actions such as hacking or collusion on the treasury.

Disorder costs are more amorphous than dictatorship costs, yet they still represent a useful framing to understand the governance of blockchain treasuries. Disorder costs arise not from positions of authority, such as rights given to particular positions of authority (e.g., treasury committee member) or access to digital assets (e.g., holding a key in a multisig contract), but from the open nature of token-based governance in blockchain ecosystems. For instance, all blockchain treasuries have public addresses that are visible through a simple search, opening the potential for hacks. More broadly, private actors can coordinate to siphon off funds through the voting process of a DAO, whether directly through amassing many governance tokens, or indirectly through sybil attacks. Indeed, as Zachariadis et al. (2019, 111) notes in a different blockchain context, "enduring paradox of blockchain is that although it is one of the most distributed foundational technologies ever developed, its governance is often comprised of simple majority voting mechanisms that are potentially vulnerable to lobbyists (for example investors) and/or the influence of particularly active contributors." Berg (2021) also discusses the nature of this "rent seeking" problem from private stakeholders.

3.3 | Distinguishing Between Dictatorship and Disorder

Applying the IPF to traditional forms of governance, such as the regulation of business, is understood to have some challenges of delineating between dictatorship and disorder. For instance, Djankov et al. (2003, 598) give the example of bribery and corruption: "When individuals pay bribes to avoid penalties for harmful conduct, corruption is a reflection of disorder. When officials create harmful rules to collect bribes from individuals seeking to circumvent them, corruption is a cost of dictatorship." There are some key factors in blockchains that also blur the distinction between these two costs.

First, token holders can fluidly move between positions and roles. For instance, an initial small group of early adopters might hold the majority of tokens in a protocol, introducing potential dictatorship costs. But if an investment firm suddenly purchases a large quantity of tokens on the open market, it could rapidly shift the governance structure. The effect of this could be to potentially reduce dictatorship costs by diluting early adopters' influence, while simultaneously introducing new sources of disorder costs as the firm's intentions and strategies may not align with the protocol's long-term interests. Depending on the extent of the investment, this change could also be interpreted as an increase in dictatorship costs from the centralized influence of the investment firm.

Second, there is a disconnect between formal roles and influence on governance decisions. Unlike traditional organizational structures, formal positions within blockchains (e.g., committee membership) do not always align neatly with the intent or impact of actions taken, and do not capture the distribution of power or influence of individuals or coalitions. A community member might transition from a casual participant to a de facto leader based solely on the quality and frequency of their governance proposals, without any official change in position. Intent and impact can carry more weight than official positions, particularly in ecosystems where there is an environment of off-chain informal governance, such as in governance forums. This disconnect also complicates definitions of stakeholders and tokenholders in blockchain governance, where participants can act as a stakeholder without holding tokens.

Third, participants can simultaneously occupy different roles. Participants can simultaneously act as developers, token holders, and investors. This overlap makes it challenging to isolate the source and nature of costs associated with their actions. A developer who is also a significant token holder might propose changes that benefit both the protocol's technical development and their own token value, blurring the line between actions that mitigate dictatorship costs and those that potentially introduce them. Overlapping roles and actions complicate the categorization of costs, as participants can simultaneously serve both individual and collective interests. This challenge also relates to indistinguishability (see Garimindi et al. 2022). It is difficult to distinguish between actions made for the good of the protocol, and attacks that are made out of self-interest—both of which can happen through the same institutional mechanisms, such as token holder voting on proposals. This indistinguishability has raised various community debates where projects have disagreements about whether a governance proposal is an attack or not (see governance takeover examples below).

Despite these challenges, the IPF is a useful and appropriate framework for examining the complexities of blockchain governance. The IPF's flexibility provides tools to explore the unique ways that dictatorship and disorder costs manifest, and are ameliorated, through different institutional structures. For instance, novel voting structures, delegation, and vesting schedules are all mechanisms to reduce dictatorship and disorder costs. What specific costs these mechanisms reduce depend on the specific implementation and dynamics of the community. The blurred lines between dictatorship and disorder in blockchain governance is also reflective of the innovative nature of these systems. Traditional governance frameworks often assume clear distinctions between rulers and the ruled, but blockchains challenge these assumptions. The IPF is an effective framework to analyze these blockchain governance complexities, including as new mechanisms are developed and as the governance of any given blockchain ecosystem evolves over time.

Before we explore some specific treasury governance in the section below, we explore some generic examples (see Figure 2). One option for a blockchain or blockchain-based application is to govern their treasury through a founders' multisignature contract, where a small group of founders hold keys to the treasury funds (or even a single founder does). This option has high potential dictatorship costs, where that founder(s) has the opportunity to siphon off funds for their own purposes. Associated with this approach, however, there are relatively low disorder costs: it is difficult for people to hack or steal the funds, particularly if the address is kept secret. While our focus here is not on governments, it is worthwhile noting that having fewer actors controlling a blockchain treasury (e.g., in a multisig) increases dictatorship costs from those actors, it simultaneously increases the risk that governments might identify and exploit that centralized governance structure (thereby increasing the potential of dictatorship costs).

Rather than centralize governance within a small group of people controlling the treasury, blockchain communities could implement a different institutional possibility, such as a committee, working group or team structure. This institutional possibility involves the funds being controlled by, for instance, a legal non-profit entity domiciled within a jurisdiction. This institutional possibility has theoretically lower dictatorship costs than a founders' multisignature contract, perhaps because the identities of foundation members are known (rather than pseudonymously) and there are potentially more people involved in

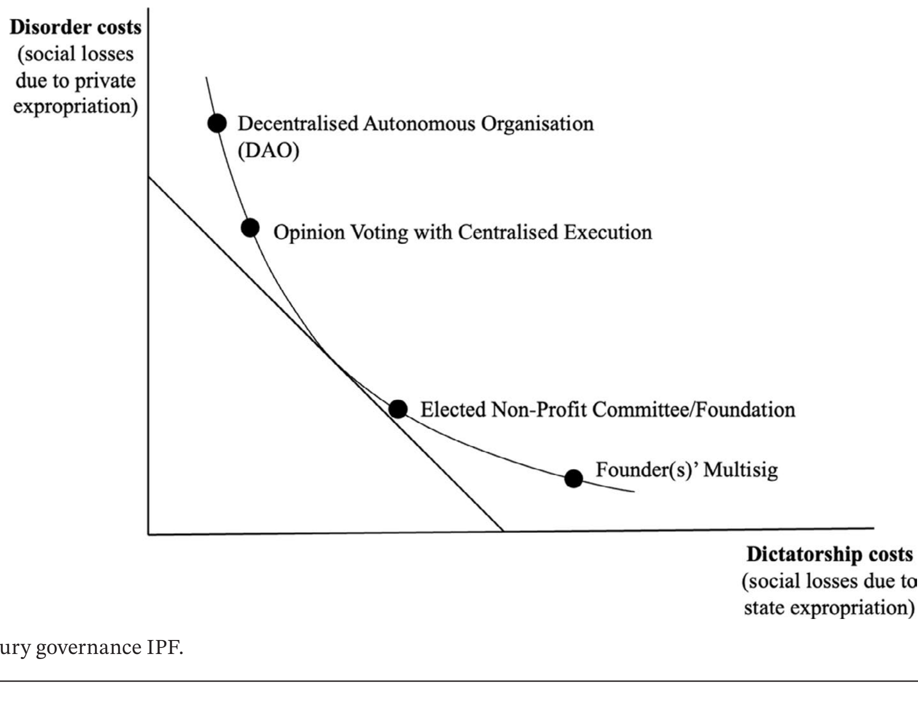

FIGURE 2 | A treasury governance IPF.

governance (including the creation of positions that are specifically not tied to the founding team). This institutional possibility may also be associated with further jurisdiction-specific obligations such as fiduciary duties or reporting. But with more potential individuals involved in the foundation, there are potentially higher disorder costs from individuals, for instance, stacking the foundation for their own purposes. Of course, different structures of foundations, such as the structure and composition of membership, give different constellations of costs.

Some blockchain treasuries attempt to further reduce dictatorship costs from committees by integrating voting mechanisms from the community. For instance, a project can create a grants process whereby stakeholders can vote on proposals to spend treasury funds. These are often opinion polls, where the control of the treasury assets still rests with a relatively centralized group, such as a foundation or committee, who ultimately executes the spend. This institutional possibility reduces some dictatorship costs by publicly revealing preferences of a broader group of stakeholders (adding transparency to the governance process), but also correspondingly increases disorder costs where individuals can use those voting mechanisms to their advantage, such as voting to fund their own projects, or acquiring additional governance tokens to sway the vote. Voter apathy that results in lower voter turnouts can exacerbate the potential of attacks. As we will see below, different mechanisms of governance execution (such as random committee allocation to enforce voting outcome) trade-off between dictatorship and disorder costs in different ways.

Our final stylistic point here is the governance of a blockchain treasury purely through token holder voting. There are various names for this institutional structure, such as a DAO or on-chain voting. This institutional possibility involves the governance of a blockchain treasury through a process of voting and self-execution of transactions. This institutional possibility reduces some dictatorship costs by reducing the potential for people who control the treasury keys will not execute decisions of voters. But in doing so it imposes a further threat of disorder costs—people or groups of people could collude or amass relevant governance rights and siphon off treasury funds for their own purposes.

There have been several governance attacks or takeovers through on-chain voting processes. For instance, in 2022 the Build Finance DAO was subject to a hostile governance takeover where a malicious actor proposed and voted through spending of treasury funds, costing over $400,000 USD (see Kelly 2022). These disorder costs may be theoretically higher where there is a small community, a centralized distribution of governance voting rights, or low voter turnout. More recently, in 2024, a proposal to the Compound Finance DAO by the Golden Boys was widely identified as a governance attack or capture. The proposal allocated $24 million USD in COMP tokens to a yield-bearing protocol controlled by the proposers. To reduce some of these disorder costs, DAOs can implement different decision and aggregation rules (e.g., quadratic voting) or grant limits. A well-known challenge here is that of indistinguishability, where projects cannot "distinguish between users who want to make valuable contributions to a project and attackers who attach high value to disrupting or otherwise controlling it. In a world where tokens can be bought or sold in a public marketplace, both of these groups are, from the market perspective, behaviorally indistinguishable" (Garimindi, Kominers, and Roughgarden 2022).

In the following section we outline how some of these different stylistic possibilities manifest in practice, through a series of case studies of blockchain treasury governance.

4 | Innovations, Evolution, and Discovery of Treasury Governance

The space of treasury governance mechanisms is diverse, owing to a rapid process of innovation. As mentioned above, blockchains themselves open up new possibilities of how we structure our collective decisions (Allen, Berg, and Lane 2019), changing the way that we can conceivably govern treasuries. Blockchains, for instance, lower the transaction costs of decentralized voting (including bargaining and enforcement costs) so that organizational forms such as DAOs become institutionally possible (see Allen, Berg, and Lane 2019; Allen et al. 2020; Berg et al. 2021). Other frontier technologies, such as zero knowledge proofs that enable information to be proven without being revealed (see for instance Sun et al. 2021), open up yet more governance possibilities, innovating on different margins such as privacy.

We can understand these innovations through the IPF framework. For instance, new innovative governance mechanisms could shift the IPF inwards, creating new cost-minimizing points of dictatorship and disorder costs.[10] If those innovations have disproportionate impacts on dictatorship or disorder costs, then the shape of the IPF might change, altering where the cost-minimizing institutional possibility is. But there are also two further important points to note regarding this. First, dictatorship and disorder costs are perceived by ecosystem participants in different ways. Indeed, a general ethos that ties together many blockchain-based communities are the perceived high dictatorship costs. Second, a blockchain ecosystem does not costlessly and seamlessly implement a cost-minimizing institutional possibility—those points need to be discovered and they need to be chosen (often through the very same governance structures). The IPF does not assume that projects will tend towards cost-minimizing or efficiency-enhancing positions, but rather that by innovating on their governance they are learning and revealing dictatorship and disorder costs in their specific context. Of course blockchain projects can also learn from the public experiments of other protocols, perhaps evolving and improving their own governance.

One useful way to understand this is through the lens of the Buchanan (1975) distinction between pre-constitutional and post-constitutional stages. When blockchain projects launch they have effectively engaged in pre-constitutional stage decisions. These innovations shape the fundamental structure within which post-constitutional decisions—the day-to-day operations and resource allocations—take place. Movements along the IPF, representing different trade-offs between dictatorships and disorder costs, impact the resource allocations that occur in the post-constitutional stage. This two-level perspective helps explain why blockchain communities invest significant effort in governance design: they recognize that these constitutional-level decisions fundamentally shape the space of possibilities for subsequent operational decisions and resource allocations within the ecosystem.

In this section, we demonstrate some of these dynamics by exploring recent innovations in treasury governance, as well as how treasury governance can shift over time through either shifting perceptions of the optimum governance structure (e.g., "progressive decentralization"), or the specific threats revealed through crises. Case studies are the primary research methodology for applying new comparative economics. Further, blockchain research is a frontier field and case studies are a useful research methodology to gain insight when there is not a lot of existing theory or the context is important in operationalizing the theory (e.g., Dul and Hack 2008). The unit of analysis here is a particular blockchain ecosystem. Our selection of cases is not exhaustive. Instead, the cases that have been included reflect the size of the treasury pool, its uniqueness of governance, and the ways these communities have navigated the challenges of governance choice in the face of dictatorship and disorder costs. In Section 4.1 we begin with brief case studies of unique innovations in treasury governance in Polkadot, Uniswap and Dash, before turning to the evolution of treasury governance mechanisms through SushiSwap, MakerDAO, and Gitcoin.

4.1 | Innovations in Treasury Governance

4.1.1 | Polkadot

Polkadot is an interconnected network of public blockchains with a distinct architecture. It consists of a main blockchain—the "relay chain" which in the Polkadot network is responsible for security, consensus, and communication between a nominated set of "parachains." These parachains host decentralized applications and specialize in particular areas—such as defi or non-fungible tokens. Polkadot's governance is directly controlled by holders of its native token, DOT. Polkadot's treasury is funded primarily out of transaction fees; 80% of which are sent to the treasury. Other sources of revenue include a residual from token inflation that results when the chain deviates from its ideal staking rate and a claim on tokens slashed from validators for misbehavior.

Polkadot's treasury management system has gone through two major phases. Each of the approaches sought to strike a balance between the costs of dictatorship—expropriation—and disorder—failure to make decisions effectively or in a timely manner. At launch, the model gave a 13 member elected council a supervisory role over treasury spending. Potential fund recipients would submit proposals and the Council members would vote to endorse or reject a proposal. The proposal would then be passed to a "referenda" where all DOT holders could accept or reject the proposal. If the council had endorsed the proposal on a simple majority then the referenda required a simple majority to pass. However, if the council decision was unanimous, then the vote would require a supermajority to be rejected; that is, there was a built in presumption that proposals which received unanimity from the council would be approved. Finally, treasury spends were subject to an enactment delay, preventing the "capture" of the treasury by the Council, or some other undesirable behavior in the treasury process, by giving users greater chance for users to respond through other governance processes (i.e., a reduction in the dictatorship costs associated with the Council).

Low costs of proposals can theoretically lead to malicious or spam proposals that overwhelm the system. These costs are disorder costs reduced through high proposal costs—a 5% deposit from the proposer is refunded if the project is accepted. If it is rejected, then the deposit is "burned." This mechanism could also be interpreted as a type of institutional enforcement of costly signaling (see Spence 1973). Reducing the disorder costs related to spam, however, increases dictatorship costs: fewer proposers can engage in each round, favoring proposals of those holding more DOT.

Polkadot's decision to shift from this model to a new platform called "OpenGov" in 2023 was driven by several key problems with the former system. The most prominent issue was centralization. Although the Council was elected, its control over parameters, administration, and spending proposals created a perception of centralized authority that conflicted with Polkadot's decentralization goals. This centralized structure also resulted in a bottleneck in the proposal process, as only one referendum could be voted on at a time (except for emergencies). This limited the number of proposals that could be considered and led to delays in decision-making. Further exacerbating this problem was the rigid voting timetable, which allowed for voting on only one type of proposal (either public or council) every 28 days. These limitations hindered the platform's agility and responsiveness to the evolving needs of the community, and some stakeholders argued that they were stifling innovation and discouraging participation in the ecosystem. OpenGov aims to resolve these issues by dissolving the Council and transferring its responsibilities to the public through a direct democracy voting system. It also implemented multiple voting tracks to allow for the simultaneous consideration of proposals with varying levels of urgency and impact.

4.1.2 | Uniswap

Uniswap is a major defi protocol that operates within the Ethereum ecosystem, enabling users to swap between tokens without a centralized exchange. Uniswap has a community-owned treasury that hopes "to see a variety of experimentation, including ecosystem grants and public goods funding, both of which can foster additional Uniswap ecosystem growth."[11] The capital for the Uniswap treasury was funded through a premine of UNI tokens (43% of total supply) and was vested over a period of 4 years. In addition to the community uses, UNI tokens were initially distributed to the development team, early investors, and advisors (40% of total supply) and an airdrop to past users (15% of total supply). After the treasury was created, the funds were locked from proposals for 30 days so that the "community could familiarize itself with the governance system."[12] These two features were governance choices designed to reduce the disorder costs of moving to decentralized treasury governance by lowering the possibility that private actors could siphon off funds quickly.

Recently there was a vote on the process for how the Uniswap treasury should be governed, with the proposal to implement a committee so that not every proposal needs to go to a vote:

> ...we propose a nimble committee of 6 members—1 lead and 5 reviewers—to deliver an efficient, predictable process to applicants, such that funding can be administered without having to put each application to a vote. We propose the program start with an initial cap of $750K per quarter and a limit of 2 quarters before renewal—a sum that we feel is appropriate for an MVP relative to the size of the treasury that UNI token holders are entrusted with allocating.[13]

The committee itself functions as a four of five multisignature contract (where four of five signatures are required to execute transactions from the wallet). This decision to create a reasonably centralized grant program was "... to ensure that the application and decision process will be efficient and predictable."[14] This proposal can be understood as a comparative centralization of governance power, with an increase in the dictatorship costs that the "nimble committee" will expropriate the funds. The cap on the program funding of $750,000 per quarter is a mechanism to limit this dictatorship cost.

Controversial funding proposals from community-owned treasuries can reveal dictatorship and disorder costs. An early example was a proposal to fund a crypto-analytics firm without clear deliverables or accountability measures. Although no direct connection was between major token-holders and the firm was alleged, another competing analytics firm publicly criticized the proposal as favoritism stating that there was no reason to fund the proposal because "the market is full of analytics services" and would result in a "misuse of funds and attempt to monopolize UNI analytics grants."[15] On one hand, dictatorship costs manifested as allegations of favoritisim and attempted monopolization while disorder costs are observed in competitors publicly campaigning against proposals.

More recently, the Uniswap Community Treasury was subject to controversy regarding the successful funding of a $20 million "Defi Education Fund" (originally referred to as a Defi Defense Fund).[16] The focus of the Defi Education Fund (DEF) is to fund "education and advocacy" and to "provide grants for political, educational, and legal engagement."[17] The funding of the proposal received 79.7 million votes for and 15 million against (although the final vote does not display how many wallets those votes were cast from). The DEF funds are governed through a Committee of publicly known people, and controlled through a four of seven multisignature contract. Importantly, the Committee associated with the DEF was given "considerable discretion to allow for flexibility and speed." After funding, this proposal was subject to public controversies including the role of large tokenholders in the passing of the vote, the considerable autonomy given to the fund with few "checks and balances," and the decision by the fund to exchange half of the funds into the USDC stablecoin.[18] Uniswap's DEF represents a unique institutional possibility where an ecosystems' token holders allocate funds to a separate body who has autonomy to implement their own grants process. This institutional possibility has theoretically lower disorder costs, but increases the potential dictatorship costs that could be imposed by the Committee.

4.2 | Evolutions and Discovery of Treasury Governance

In this section, we focus on how the governance of blockchain treasuries shifts over time as either (1) costs are revealed through governance crises; or (2) as the community shifts so too does the optimum governance structures (i.e., progressive decentralization). We focus on three examples of evolutions and discoveries in treasury governance through SushiSwap, MakerDAO, and Ethereum's Gitcoin.

4.2.1 | SushiSwap

The decentralized exchange SushiSwap was released in 2020 as an almost-identical fork of Uniswap. SushiSwap played a prominent role in the evolution of defi. SushiSwap was a highly aggressive competitor to Uniswap, forcing the latter protocol to make strategic decisions that have been replicated throughout the defi ecosystem. At the same time, the SushiSwap project has been dogged by a series of governance crises—almost since its first day of operation. In this way, SushiSwap offers a narrative evolution of how one protocol navigated the challenges of dictatorship and disorder.

SushiSwap launched with a plan to attract Uniswap's liquidity through an aggressive strategy known as "vampire mining." SushiSwap incentivized Uniswap's liquidity providers (LPs) to deposit their Uniswap LP tokens into SushiSwap in exchange a new native token, SUSHI. This process allowed SushiSwap to accumulate a large amount of Uniswap LP tokens, which would later be redeemed for the underlying assets, effectively transferring Uniswap's liquidity to SushiSwap pools. This strategy, while controversial, proved highly successful, enabling SushiSwap to rapidly gain a significant share of the decentralized exchange market.

When the SUSHI token was minted, 90% of the tokens were allocated to the vampire mining strategy. A "developer fund" created to "ensure the long-term viability and sustainability of the protocol" and was funded through a 10% reserve of all newly minted SUSHI tokens. The SushiSwap whitepaper specified that the "Major structural changes and use of the [developer fund] are voted on by the community, whereas smaller changes affecting operations...are decided on by the Sushi Core Team."

On September 5, 2020, the founder of SushiSwap, the pseudonyumous "Chef Nomi" withdrew approximately 13 million USD from the fund. Approximately 1 week later, Chef Nomi apologetically returned (then approximately 14 million USD) to the treasury. Following a vote by SUSHI holders (the token is a governance token), the control of the treasury was handed over to seven well-known early SushiSwap investors who controlled the multisignature contract (one of whom was Sam Bankman-Fried, head of the cryptocurrency exchange FTX who was later imprisoned for fraud unrelated to the SushiSwap protocol). We can interpret the controversy over Chef Nomi as a discovery of (or realization of potential) dictatorship costs in the institutional choice of the governance structure, and correspondingly the ecosystem deciding to choose a different institutional possibility (as represented in Figure 3 below).

However, this new structure faced criticism for a lack of transparency and alleged financial mismanagement on the part of the SushiSwap management team. In late 2021 a fired team member, A.G., along with anonymous sources, accused the core team of prioritizing their own interests over the community. The accusations included excessive spending on events, travel, entertainment, and unevenly distributed bonuses to team members.

These complaints exemplify how mitigating dictatorship costs can inadvertently create opportunities for disorder costs, in this case manifested as potential abuse of power by the core team. This situation led to community calls for greater transparency and accountability, including demands for CTO Joseph Delong's resignation and a return to a more community-driven approach. Delong, however, defended the team's actions and argued for greater autonomy for the core team. This power struggle underscored the ongoing challenge of finding a sustainable governance model that balances community participation with efficient decision-making.

In 2022 SushiSwap attempted to join a collective of DeFi protocols called Frog Nation, which, it was argued, would bring a degree of stability to SushiSwap governance. The plan, proposed by the Frog Nation lead, was aimed at addressing SushiSwap's persistent management issues since the Chef Nomi controversy and the subsequent struggles to maintain a cohesive team and clear direction. However, the merger ultimately fell apart, when it was revealed that the chief financial officer of Frog Nation had been a co-founder of the infamous failed Canadian crypto exchange, QuadrigaCX. This revelation raised concerns about the Frog Nation team's credibility and trustworthiness, leading to the SushiSwap community's decision to withdraw from the merger and pursue alternative leadership options. The failed merger highlighted the ongoing challenges of establishing effective governance and leadership in a decentralized organization like SushiSwap, where community trust and consensus play critical roles.

4.2.2 | MakerDAO

One of the first defi protocols, MakerDAO, initially had a treasury that was governed through the Maker Foundation. The roadmap for Maker, however, has an explicit understanding that the Foundation will be dissolved over time, in favor of "complete decentralization" and community voting. That is, "The voting community being in charge of the entire Maker project is the *only way* to ensure the long-term security and sustainability of the Maker Protocol" (emphasis in original).[19]

In May 2021, the Maker Foundation shifted the governance structure of the treasury by transferring 84,000 MKR tokens (approximately $500 million at the time) to the MakerDAO.[20] This was an explicit shift between different institutional possibilities of treasury governance: from a centralized Board of the foundation (albeit with some decentralizing mechanisms); to a decentralized DAO where the power rests with token holders. Holders of the MKR token could collectively decide how to spend the treasury funds. The Foundation "has retained less than one percent of the total current MKR supply to manage the transition and as a bulwark against future potential liabilities."[21]

More recent developments in MakerDAO's governance further illustrate how treasury governance evolves in response to shifting costs. In 2023 the community approved the "Endgame Plan" proposed by founder Rune Christensen. The Endgame Plan is

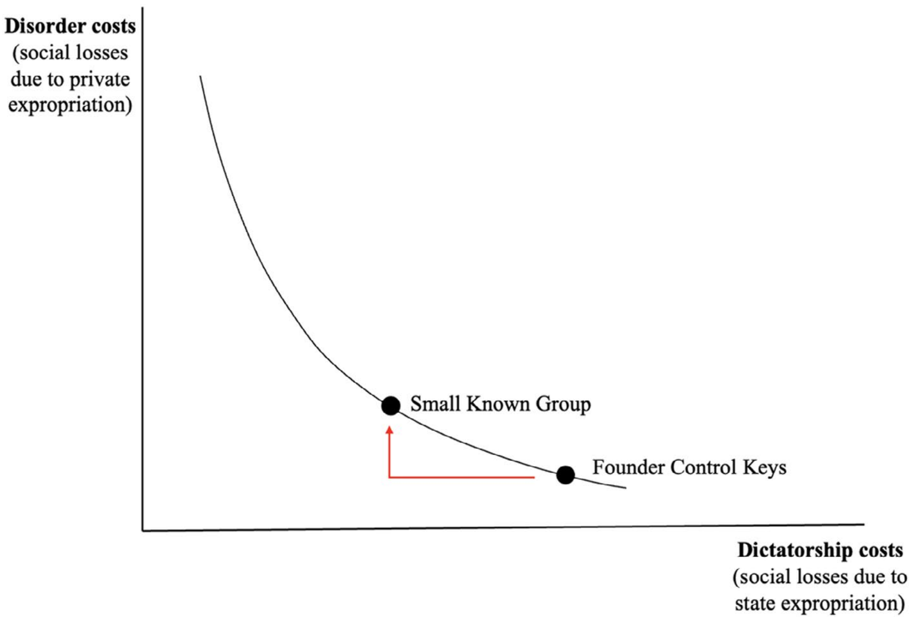

FIGURE 3 | Discovering SushiSwap institutional possibilities.

a three stage roadmap intended to evolve MakerDAO's governance structure so that the founder, Rune, could step away from operations. This plan, which includes establishing a constitution and reorganizing MakerDAO into distinct MetaDAOs with their own tokens, represents another institutional response to perceived dictatorship and disorder costs. In a later update, founder Rune described these subDAOs as "highly efficient DAOs that draw on the power and infrastructure of MakerDAO, while remaining flexible and autonomous." The original plan directly cited challenges of governance paralysis (a disorder cost) and the need for smaller teams that can act quickly.[22]

MakerDAO demonstrates how blockchain communities continuously adapt their governance structures as they learn about and experience different institutional costs. More broadly, we can see that as the community of an ecosystem shifts, so too might the optimum governance structure of the treasury. For instance, in the bootstrapping phase of a protocol, the community is often small, bound together through reputational trust. Decisions and deployment of the treasury to fund development may need to happen quickly. Here, the trust between the community might imply that a founders' multisig contract is the cost-minimizing institutional solution. Over time, however, the ecosystem may grow. New stakeholders such as users, speculators, investors, and developers join the network. As the token price increases, so too does the value of the underlying treasury. These stakeholders might perceive potential higher dictatorship costs from having the treasury with concentrated governance. As such, the social loss minimizing level of treasury governance might shift towards more decentralized governance alternatives, such as community voting or a DAO.

5 | Conclusion

In this paper, we applied the IPF to the problem of blockchain treasury governance. The IPF is a useful tool to compare how communities govern blockchain treasuries as a trade-off between dictatorship and disorder costs. The ways that communities navigate these governance challenges—such as implementing voting mechanisms or committees—can generate trust in the ecosystem that the treasury is robust to opportunism. Our approach has not only been theoretical, but also empirical. Through case studies we outlined empirical evidence of the institutional diversity of blockchain treasury governance.

Our case studies revealed two aspects of treasury governance worth reiterating here. First, blockchain communities are governing their treasures in unique ways, including combinations of quadratic voting, budgeting periods, and tipping past behavior. Many of these governance mechanisms are made possible (or feasible) by the implementation of blockchain itself, through a process of governance innovation. Our IPF framework suggests that different communities will minimize dictatorship and disorder costs in different ways—thereby bolstering trust in different ways—because their underlying communities and conditions are different. Put another way, institutional diversity in generating trust should be embraced.

Second, the ways that institutional choice bolsters trust is both uncertain and dynamic. The uncertainty about how dictatorship and disorder costs manifest in practice is, as the SushiSwap and Gitcoin case studies showed, sometimes (1) revealed through crisis or attack; and (2) resolved through new institutional choices. Furthermore, as we saw through the MakerDAO transition, it may also be the case that as the community evolves, so too might the optimum governance structure. Understanding this uncertainty and the dynamic nature of the trust problem in treasuries is critical in designing governance structures.

The institutional diversity of blockchain treasury governance aligns closely with economics Nobel laureate Elinor Ostrom's (2005) work that emphasized how communities can develop a wide variety of rule systems to effectively govern shared resources, pushing back on the simplistic dichotomy between market and state solutions. Indeed, recent scholarship applying commons governance frameworks to blockchain systems (see Rozas et al. 2021; Murtazashvili et al. 2022) align with our findings on treasury governance, where communities must develop rules and norms for managing collective resources in decentralized contexts. Our analysis of treasury governance mechanisms contributes to this growing literature by showing how different institutional arrangements attempt to solve collective action problems. These diverse arrangements reflect the ongoing process of institutional discovery, where communities experiment with and refine their rules over time. This process involves adapting governance mechanisms to address unique challenges of digital asset management and decentralized decision-making. The absence of a single dominant governance model in the blockchain space underscores Ostrom's insight that effective institutional arrangements are often context-specific and collectively developed.

As further empirical evidence emerges (particularly through the build-out of DAO communities) a further analytical research program can be built around the trust problem in blockchain treasuries. Future research could benefit from applying Ostrom's approach to studying failed commons systems to blockchain treasury governance. Just as Ostrom's work revealed important insights about common pool resource management by examining both successful and failed systems, examining failed blockchain protocols could reveal institutional features that undermine effective treasury governance. While our analysis has focused on understanding the theoretical framework and implementations of treasury governance that have survived, future work could systematically document cases of treasury governance failure to better understand how different combinations of dictatorship and disorder costs contribute to protocol collapse.

We expect that our findings will aid in the evolution of existing governance structures (e.g., clarifying discussions over governance changes) as well as informing further innovations in treasury governance tooling. Indeed, at the time of writing there are significant entrepreneurial resources focusing on the design of DAO tooling (e.g., tools for contributor compensation, security, treasury management, community communication). Our framework, and an accompanying empirical research program, will aid in designing these DAO tools and the ways that those tools mitigate dictatorship and disorder costs.

Our analysis also has implications for regulation. The institutional diversity we have observed suggests that a one-size-fits-all regulatory approach may be inappropriate or ineffective. Any regulations must grapple with the varied governance profiles of blockchain communities. Such approaches might involve flexible regulatory structures that can accommodate diverse treasury management models. Regulations should aim to preserve the innovative potential of these diverse governance systems while addressing concerns about financial stability and user protection. Regulatory approaches may also need to be adaptive, drawing inspiration from the polycentric governance models observed in many blockchain projects. Furthermore, attempts to apply existing financial regulations to treasury management must consider the unique environment of dictatorship and disorder costs in blockchain treasuries including the complex relationships between on-chain deterministic governance and off-chain community decision-making.

In this paper we have focused on the specific problem of opportunism through a single analytical lens. Solutions to opportunism (both dictatorship and disorder costs) must also align with the broader governance challenges of blockchain treasuries. For instance, treasuries face a fundamental knowledge problem over how to allocate the scarce capital. No one actor knows the most effective way to deploy a blockchain treasury; that local information is distributed among ecosystem participants (Hayek 1945). This problem has some similarities to the entrepreneurial challenge of the private procurement of innovation (such as through venture capital) and the public procurement of innovation (such as through prizes and grants). Implementing mechanisms that aid in knowledge coordination (such as broader voting or mechanisms such as quadratic voting), might also raise new unknown vectors of dictatorship and disorder costs.

Acknowledgments

The authors have nothing to report. Open access publishing facilitated by RMIT University, as part of the Wiley - RMIT University agreement via the Council of Australian University Librarians.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Endnotes

[1] Some blockchains rely more heavily on funding from external private sources or the activities of related foundations. On the challenges of funding open source software see Eghbal (2020).

[2] See: Tulip Trading v van der Laan [2023] EWCA Civ 83.

[3] Defalcation refers to the misappropriation or embezzlement of funds by someone in a position of trust, such as when those entrusted with treasury assets misuse them for their own purposes.

[4] A multisignature (multisig) contract is a blockchain-based arrangement that requires multiple parties to approve a transaction before it can be executed. For example, a 3-of-5 multisig requires any three out of five designated key holders to sign off on a transaction. This provides additional security and governance controls compared to single-signature arrangements.

[5] Layer 2 refers to a set of solutions built on top of existing blockchains that aim to improve transaction speed and reduce costs by processing transactions off the main blockchain while maintaining some of its security guarantees.

[6] The framework is also useful for understanding blockchain governance more broadly, but our focus here is on treasuries. For our application of this framework to blockchain-based dispute resolution see Allen et al. (2020).

[7] There are of course other types of costs associated with algorithmic governance, such as what Bayern (2024) refers to as formalization costs: "the cost that participants in the system incur because they must adhere to an algorithm even though that algorithm did not account for future conditions." Such costs can themselves be interpreted as a form of dictatorship costs (where those rules are utilized for the advantage of states), or disorder costs (where those rules are utilized for the advantage of private parties).

[8] In multisignature contracts, multiple pre-defined parties are required to sign to execute a transaction. For instance, a minimum of three of five signers might be required to execute a treasury spend.

[9] This distinction is largely semantic to aid the reader and provide conceptual clarity. In the same way disorder costs are those costs not imposed by those in positions of authority, so are disorder costs.

[10] For instance, quadratic voting is a system where votes are allocated based on the intensity of voter preferences rather than in a linear way (such as one-person-one-vote). See Posner and Weyl (2019). On quadratic voting in blockchain see, for example, Allen, Berg, and Lane (2019), Allen et al. (2020), Wright (2019).

[11] https://blog.uniswap.org/uni.

[12] https://blog.uniswap.org/uni.

[13] https://app.uniswap.org/#/vote/3.

[14] https://app.uniswap.org/#/vote/3.

[15] https://x.com/DuneAnalytics/status/1428250340139356164?t=YOCIzwTi9spQCcMNDy47sQ&s=19.

[16] https://gov.uniswap.org/t/consensus-check-uni-should-fund-a-political-defense-organization-for-decentralized-finance/12700.

[17] https://app.uniswap.org/#/vote/1/1.

[18] See https://thedefiant.io/sale-of-usdc-raises-concerns-regarding-newly-formed-defi-education-fund/.

https://cointelegraph.com/news/concern-as-uniswap-backed-defi-education-fund-dumps-10m-worth-of-uni.

[19] Transaction on Etherscan: https://etherscan.io/tx/0x00eb240abcc7c5e8d322e8ce545c7d32f21204f81c437a1d40c12c2962ceee68.

See also https://blog.makerdao.com/what-will-maker-governance-look-like-after-complete-decentralization/.

[20] See https://thedefiant.io/maker-foundation-transfers-funds-to-dao-in-decentralization-push/.

[21] See https://blog.makerdao.com/the-maker-foundation-returns-dev-fund-holdings-to-the-dao/.

[22] See https://forum.sky.money/t/the-endgame-plan-parts-1-2/15456.

References

Allen, D. W. E. 2024. "Crypto Airdrops: An Evolutionary Approach." *Journal of Evolutionary Economics* 34: 849–872.

Allen, D. W. E., and C. Berg. 2017. "Subjective Political Economy." *New Perspectives on Political Economy* 13, no. 1–2: 19–40.

Allen, D. W. E., and C. Berg. 2020. "Blockchain Governance: What We Can Learn From the Economics of Corporate Governance." *Journal of the British Blockchain Association* 3, no. 1: 1–11.

Allen, D. W. E., C. Berg, and A. M. Lane. 2019. *Cryptodemocracy: How Blockchain Can Radically Expand Democratic Choice*. London: Rowman & Littlefield.

Allen, D. W. E., C. Berg, and A. M. Lane. 2023. "Why Airdrop Cryptocurrency Tokens?" *Journal of Business Research* 163: 113945.

Allen, D. W. E., C. Berg, A. M. Lane, and J. Potts. 2020. "Cryptodemocracy and Its Institutional Possibilities." *Review of Austrian Economics* 33, no. 3: 363–374.

Allen, D. W. E., A. M. Lane, and M. Poblet. 2020. "The Governance of Blockchain Dispute Resolution." *Harvard Negotiation Law Review* 25: 75–101.

Alston, E. 2019. "Constitutions and Blockchains: Competitive Governance of Fundamental Rule Sets." *Case Western Reserve Journal of Law, Technology and the Internet* 11: 131.

Alston, E. 2020. "Constitutions and Blockchains: Competitive Governance of Fundamental Rule Sets." *Case Western Reserve Journal of Law, Technology and the Internet* 11, no. 1: 131–171.

Alston, E. 2024. "Norms, Institutions, and Digital Veils of Uncertainty—Do Network Protocols Need Trust Anyway?" *Regulation and Governance*: 1–18.

Alston, E., W. Law, I. Murtazashvili, and M. Weiss. 2021. "Can Permissionless Blockchains Avoid Governance and the Law?" *Notre Dame Journal of Emerging Technology* 2, no. 1: 1–32.

Alston, E., W. Law, I. Murtazashvili, and M. Weiss. 2022. "Blockchain Networks as Constitutional and Competitive Polycentric Orders." *Journal of Institutional Economics* 18, no. 5: 707–723.

Anheier, H., and J. Kendall. 2002. "Interpersonal Trust and Voluntary Associations: Examining Three Approaches." *British Journal of Sociology* 53, no. 3: 343–362.

Azouvi, S., M. Maller, and S. Meiklejohn. 2018. "Egalitarian Society or Benevolent Dictatorship: The State of Cryptocurrency Governance." In *International Conference on Financial Cryptography and Data Security*, 127–143. Berlin, Heidelberg: Springer.

Bayern, S. 2024. "Trusting Organizational Law." *Regulation & Governance*: 1–13.

Beck, R., C. Müller-Bloch, and J. L. King. 2018. "Governance in the Blockchain Economy: A Framework and Research Agenda." *Journal of the Association for Information Systems* 19, no. 10: 1–40.

Berg, C. 2021. "Rent Seeking in Blockchain Governance: The Awkward Transition From Market Decision Making to Non-market Decision Making." Working paper available at SSRN 3801103.

Berg, A., C. Berg, and M. Novak. 2020. "Blockchains and Constitutional Catallaxy." *Constitutional Political Economy* 31, no. 2: 188–204.

Bergstrom, T., L. Blume, and H. Varian. 1986. "On the Private Provision of Public Goods." *Journal of Public Economics* 29, no. 1: 25–49.

Bertrand, E. 2006. "The Coasean Analysis of Lighthouse Financing: Myths and Realities." *Cambridge Journal of Economics* 30, no. 3: 389–402.

Bodon, H., P. Bustamante, M. Gomez, et al. 2022. "Ostrom Amongst the Machines: Blockchain as a Knowledge Commons." *Cosmos + Taxis* 10, no. 3: 1–15.

Brennan, G., and J. M. Buchanan. 1985. *The Reason of Rules: Constitutional Political Economy*. Cambridge, NY: Cambridge University Press.

Buchanan, J. M. 1965. "An Economic Theory of Clubs." *Economica (London, England)* 32, no. 125: 1–14.

Buchanan, J. M. 1975. *The Limits of Liberty: Between Anarchy and Leviathan*. Chicago, IL: University of Chicago Press.

Buchanan, J. M., and G. Tullock. 1962. *The Calculus of Consent: Logical Foundations of Constitutional Democracy*. Michigan: University of Michigan Press.

Buterin, V. 2021. "The Most Important Scarce Resource is Legitimacy." Blog Post. Accessed March 23, 2021. https://vitalik.ca/general/2021/03/23/legitimacy.html.

Candela, R. A., and V. Geloso. 2019. "Why Consider the Lighthouse a Public Good?" *International Review of Law and Economics* 60: 105852.

Candela, R. A., and V. J. Geloso. 2018. "The Lightship in Economics." *Public Choice* 176: 479–506.

Coase, R. H. 1937. "The Nature of the Firm." *Economica* 4, no. 16: 386–405.

Coase, R. H. 1974. "The Lighthouse in Economics." *Journal of Law and Economics* 17, no. 2: 357–376.

Davidson, S. 2021. "From Corporate Governance to Crypto Governance." Working Paper. Available at the Social Science Research Network. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3844304.

Davidson, S. 2024. "Corporate Governance in a Crypto World." SSRN.

Davidson, S., P. de Filippi, and J. Potts. 2018. "Blockchains and the Economic Institutions of Capitalism." *Journal of Institutional Economics* 14, no. 4: 639–658.

Davidson, S., and J. Potts. 2016. "A New Institutional Approach to Innovation Policy." *Australian Economic Review Policy Forum: Research and Innovation* 49, no. 2: 200–207.

De Filippi, P., and B. Loveluck. 2016. "The Invisible Politics of Bitcoin: Governance Crisis of a Decentralised Infrastructure." *Internet Policy Review* 5, no. 3: 1–28.

De Filippi, P., M. Mannan, and W. Reijers. 2020. "Blockchain as a Confidence Machine: The Problem of Trust & Challenges of Governance." *Technology in Society* 62: 101284.

De Filippi, P., and G. McMullen. 2019. "Governance of Blockchain Systems: Governance of and by Distributed Infrastructure." Research Report, Blockchain Research Institute and COALA.

De Filippi, P., W. Reijers, and M. Mannan. 2024. *Blockchain Governance*, 248. Cambridge, MA: MIT Press.

De Filippi, P., and A. Wright. 2018. *Blockchain & the Law: The Rule of Code*. Cambridge, MA: Harvard University Press.

Dekker, E., and P. Kuchař. 2021. *Governing Markets as Knowledge Commons*. Cambridge, UK: Cambridge University Press.

Djankov, S., E. Glaeser, R. La Porta, F. Lopez-de-Silanes, and A. Shleifer. 2003. "The New Comparative Economics." *Journal of Comparative Economics* 31, no. 4: 595–619.

Dul, J., and T. Hak. 2008. *Case Study Methodology in Business Research*. Oxford, UK: Butterworth-Heinemann.

Easterbrook, F. H., and D. R. Fischel. 1981. "Corporate Control Transactions." *Yale Law Journal* 91: 698.

Eghbal, N. 2020. *Working in Public: The Making and Maintenance of Open Source Software*. San Fransisco, CA: Stripe Press.

Finck, M. 2018. *Blockchain Regulation and Governance in Europe*. Cambridge, UK: Cambridge University Press.

Gambetta, D. 1988. "Can We Trust Trust?" In *Trust: Making and Breaking Cooperative Relations*, edited by D. Gambetta, 213–238. Oxford: Basil Blackwell.

Garimindi, P., S. D. Kominers, and T. Roughgarden. 2022. "DAO Governance Attacks, and How to Avoid Them." a16z Crypto Blog. 28 July. https://a16zcrypto.com/posts/article/dao-governance-attacks-and-how-to-avoid-them/.

Hansmann, H. B. 1980. "The Role of Non-Profit Enterprise." *Yale Law Journal* 89, no. 5: 835–901.

Haque, R. S., R. S. Silva-Herzog, B. A. Plummer, and N. M. Rosario. 2019. "Blockchain Development and Fiduciary Duty." *Stanford Journal of Blockchain Law & Policy* 2, no. 2: 139–188.

Hardin, R. 2002. *Trust and Trustworthiness*. Russell Sage Foundation.

Hayek, F. A. 1945. "The Use of Knowledge in Society." *American Economic Review* 35: 519–530.

Hofman, D., Q. DuPont, A. Walch, and I. Beschastnikh. 2021. "Blockchain Governance: De Facto (x) or Designed?" In *Building Decentralized Trust*, 21–33. Cham: Springer.

Hofman, D., V. L. Lemieux, A. Joo, and D. A. Batista. 2019. "The Margin Between the Edge of the World and Infinite Possibility." *Records Management Journal* 19, no. 1/2: 240–257.

Holcombe, R. G. 1997. "A Theory of the Theory of Public Goods." *Review of Austrian Economics* 10, no. 1: 1–22.

Hsieh, Y. Y., J. P. Vergne, and S. Wang. 2018. "The Internal and External Governance of Blockchain-Based Organizations: Evidence From Cryptocurrencies." In *Bitcoin and Beyond: Cryptocurrencies, Blockchains and Global Convergence*, edited by M. Campbell-Verduyn, 48–68. London, UK: Routledge, Chapter 3.

Johnson, S., R. La Porta, F. Lopez-de-Silanes, and A. Shleifer. 2000. "Tunneling." *American Economic Review* 90, no. 2: 22–27.

Kelly, L. 2022. "Build Finance DAO Falls to Governance Takeover" Decrypt, February 15, 2022. https://decrypt.co/92970/build-finance-dao-falls-to-governance-takeover.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer, and R. Vishny. 2000. "Investor Protection and Corporate Governance." *Journal of Financial Economics* 58: 3–27.

Lindsay, C. M., and W. R. Dougan. 2013. "Efficiency in the Provision of Pure Public Goods by Private Citizens." *Public Choice* 156: 31–43.

Liu, Y., Q. Lu, L. Zhu, H. Y. Paik, and M. Staples. 2021. "A Systematic Literature Review on Blockchain Governance." arXiv preprint arXiv:2105.05460.

Luhmann, N. 2000. "Familiarity, Confidence, Trust: Problems and Alternatives." In *Trust: Making and Breaking Cooperative Relations*, edited by D. Gambetta, 94–107. Oxford: Department of Sociology, Blackwell.

Lumineau, F., W. Wang, and O. Schilke. 2021. "Blockchain Governance—A New Way of Organizing Collaborations?" *Organization Science* 32, no. 2: 500–521.

Madison, M. J., B. M. Frischmann, and K. J. Strandburg. 2009. "Constructing Commons in the Cultural Environment." *Cornell Law Review* 95: 657.

Mannan, M. 2018. "Fostering Worker Cooperatives With Blockchain Technology: Lessons From the Colony Project." *Erasmus Law Review* 11: 190–203.

Mohan, V., P. Khezr, and C. Berg. 2024. "Voting With Time Commitment for Decentralized Governance: Bond Voting as a Sybil-Resistant Mechanism." *Management Science* 70, no.12: 8217–9119.

Murtazashvili, I., J. B. Murtazashvili, M. B. Weiss, and M. J. Madison. 2022. "Blockchain Networks as Knowledge Commons." *International Journal of the Commons* 16, no. 1: 108–119.

Nair, M., and D. Sutter. 2018. "The Blockchain and Increasing Cooperative Efficacy." *Independent Review* 22, no. 4: 529–550.

North, D. C. 1981. *Structure and Change in Economic History*. New York, NY: W. W. Norton.

Pazaitis, A., P. De Filippi, and V. Kostakis. 2017. "Blockchain and Value Systems in the Sharing Economy: The Illustrative Case of Backfeed." *Technological Forecasting and Social Change* 125: 105–115.

Pelt, R. V., S. Jansen, D. Baars, and S. Overbeek. 2021. "Defining Blockchain Governance: A Framework for Analysis and Comparison." *Information Systems Management* 38, no. 1: 21–41.

Posner, E. A., and E. G. Weyl. 2019. *Radical Markets*. Princeton, NJ: Princeton University Press.

Rajagopalan, S. 2018. "Blockchain and Buchanan: Code as Constitution." In *James M. Buchanan. Remaking Economics: Eminent Post-War Economists*, edited by R. Wagner, 359–381. London, UK: Palgrave Macmillan.

Rennie, E., and J. Potts. 2024. "Contribution Systems: A New Theory of Value." Available at SSRN.

Rikken, O., M. Janssen, and Z. Kwee. 2019. "Governance Challenges of Blockchain and Decentralized Autonomous Organizations." *Information Polity* 24, no. 4: 397–417.

Rosser, J. B., and M. V. Rosser. 2008. "A Critique of the New Comparative Economics." *Review of Austrian Economics* 21, no. 1: 81–97.

Rozas, D., A. Tenorio-Fornés, S. Díaz-Molina, and S. Hassan. 2021. "When Ostrom Meets Blockchain: Exploring the Potentials of Blockchain for Commons Governance." *SAGE Open* 11, no. 1: 21582440211002526.

Samuelson, P. A. 1954. "The Pure Theory of Public Expenditure." *Review of Economics and Statistics* 36, no. 4: 387–389.

Shleifer, A. 2005. "Understanding Regulation." *European Financial Management* 11: 439–451.

Smit, K., J. el Mansouri, S. Saïd, J. van Meerten, and S. Leewis. 2020. "Decision Rights and Governance Within the Blockchain Domain: A Literature Analysis." In *Twenty-Fourth Pacific Asia Conference on Information Systems*, 1–14. Dubai, UAE: Association for Information Systems.

Spence, M. 1973. "Job Market Signaling." *Quarterly Journal of Economics* 87, no. 3: 355–374.

Sun, X., F. R. Yu, P. Zhang, Z. Sun, W. Xie, and X. Peng. 2021. "A Survey on Zero-Knowledge Proof in Blockchain." *IEEE Network* 35, no. 4: 198–205.

Talamas, R., and M. Nystrom. 2021. "A Crisis in Protocol Treasury Management And How to Solve It" Messari. May 13, 2021. https://messari.io/article/a-crisis-in-protocol-treasury-management-and-how-to-solve-it.

Tiebout, C. M. 1956. "A Pure Theory of Local Expenditures." *Journal of Political Economy* 64, no. 5: 416–424.

Van Zandt, D. E. 1993. "The Lessons of the Lighthouse: 'Government' or 'Private' Provision of Goods." *Journal of Legal Studies* 22, no. 1: 47–72.

Walch, A. 2019. "In Code (Rs) We Trust: Software Developers as Fiduciaries in Public Blockchains." In *Regulating Blockchain*, 58–82. Oxford, UK: Oxford University Press.

Walden, J. 2020. "Progressive Decentralization: A Playbook for Building Crypto Applications." Future From a16z. January 9, 2020. https://a16z.com/2020/01/09/progressive-decentralization-crypto-product-management/.

Williamson, O. E. 1975. *Markets and Hierarchies: Analysis and Antitrust Implications*. New York: Free Press.

Wright, D., Jr. 2019. "Quadratic Voting and Blockchain Governance," *University of Missouri-Kansas Law Review* 88: 475–496.

Zachariadis, M., G. Hileman, and S. V. Scott. 2019. "Governance and Control in Distributed Ledgers: Understanding the Challenges Facing Blockchain Technology in Financial Services." *Information and Organization* 29, no. 2: 105–117.

Zhang, B., R. Oliynykov, and H. Balogun. 2018. *A Treasury System for Cryptocurrencies: Enabling Better Collaborative Intelligence*. Cryptology ePrint Archive.