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Are Blockchains Really Decentralized? A Multimodal Perspective on Tokenized Decision Making and Venture Capital Investments in Web3

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Abstract

Decentralization in Web3 projects is a polarizing topic, with proponents and critics presenting divergent views on blockchain governance. To navigate these tensions, this study employs an exploratory design science research approach. It utilizes a multiple-case study methodology to develop a framework for tokenized decision making and analyze venture capital investments in Web3 projects. We enable researchers and practitioners to grasp the phenomenon in a structured manner and address a critical sub-field of information systems research, which focuses on power concentration in Web3 ecosystems.

Keywords: Blockchain, Web3, Decentralization, Venture Capital, Case Study

1. Introduction

Technological innovations involving blockchains and related distributed ledger technologies (DLTs) are at the center of the academic and public discourse. Praised as a 'trust machine' (The Economist, 2015) that replaces human trust with technological system properties and community-based governance (Beck & Müller-Bloch, 2017), researchers and practitioners have highlighted the disruptive potential and impact on society, businesses, and individuals (Hamady et al., 2022; Lacity, 2022). The technology is considered an anti-thesis and challenger to the dominance of digital platform titans and is discussed as a disruptive innovation reshaping business models and industries (Beck et al., 2018; Frizzo-Barker et al., 2020). At its core, this paradigm shift aims to democratize digital interactions and decentralize information systems (IS) through bilateral connections and cryptographic protocols governed by their users (Kölbel et al., 2023). Unlike the current internet landscape, which is characterized by the dominance of a few organizations, blockchain's decentralized design enables a network of participants to collectively agree on the state of a shared ledger without relying on human intervention or a central point of control. Thus, removing intermediaries through the design objective of *decentralization* is noted a pivotal aspect of blockchains (Chalmers et al., 2021; Kölbel & Kunz, 2020; Werner et al., 2020), paving the way for a plethora of applications that fall under the umbrella term *Web3* (Kölbel et al., 2022; Voshmgir, 2020).

However, the promising potential of decentralized socio-technical systems is accompanied by new challenges that impede the adoption and implementation of Web3 in various industries (Beck & Jain, 2023). This paper focuses on one specific, non-technical challenge that increasingly attracts interest from both academic and practical communities: the coordination efforts required for governing the polycentric Web3. Researchers perceive these systems as a combination of on-chain protocols and off-chain agents (Beck & Jain, 2023) aiming to provide a more democratic and inclusive alternative to corporate governance. Yet, they also highlight the need to examine the limitations of trust-free systems (Glaser et al., 2019; Hawlitschek et al., 2018). A notable example highlighting the fundamental challenges associated with decentralized governance is a tweet by serial entrepreneur Jack Dorsey, which sparked controversy and went viral. In the tweet, Dorsey suggests that users do not truly own Web3 and asserts that venture capital (VC) firms and limited partners (LPs) ultimately control it, casting doubt that a decentralized Web3 may be illusory as project funding leads to de facto centralization (Dorsey, 2021). This statement aligns with early research that

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questions the level of decentralization in Web3 systems (Feulner et al., 2022; Gochhayat et al., 2020; Schneider, 2019; Werner et al., 2022), suggesting *”the illusion of decentralization”*(Aramonte et al., 2021).

This study aims to explore these tensions between criticisms of decentralization and the claims made by Web3 movement proponents. As blockchain governance has been identified as lacking sufficient research, particularly in practical applications (Beck et al., 2018; Liu, Lu, Zhu, et al., 2023), we focus on this area. Typically, Web3 projects are governed by coders and unregistered token holders who facilitate tokenized decision making (TDM) utilizing governance tokens by following the principle of *one token, one vote*. VCs acquire tokenized decision rights (TDRs) within private token sales and are thus involved in governance. Consequently, the allocation of TDRs is crucial for determining the level of decentralization in Web3 systems (Liu, Lu, Zhu, et al., 2023). While decentralized governance has been explored in various aspects, research on TDM remains largely unexplored. Although some studies exist, particularly in the context of Decentralized Finance (DeFi) (Barbereau et al., 2022; Barbereau et al., 2023), there is a notable lack of empirically supported research on the impact of VC funding on the decentralization of Web3 projects. This is surprising considering the growth rate of VC investments in Web3 of over 700%, exceeding $25 billion in 2021 alone (Pitchbook, 2023), as investors receive TDRs in exchange for funding through private token sales. In response to this notable gap and Web3’s contested governance, our research objective is multimodal. After conceptually elaborating on the shadowy phrase of decentralization with a special emphasis on governance (Section 2), we first state our methodological approach (Section 3) to develop a framework for analyzing TDM in Web3 projects (Section 4), building on ongoing efforts to understand governance artifacts (van Pelt et al., 2021), and bridging the gap that *”little is known about what and how decisions are made and enforced in blockchain systems”* (Ziolkowski & Schwabe, 2019). Second, we empirically discuss our framework by examining the extent and manner in which VCs exert influence on blockchain governance (Section 5), potentially posing a threat to Web3’s decentralization. In summary, we address two research questions:

(1) *What conceptualizes TDM and which trajectories impact Web3’s decentralization?*

(2) *What influence do VCs have on TDM in Web3?*

Motivated by the topic’s novelty and the tension between decentralization and concentrated token power, we conducted an exploratory design science research (DSR) project with a multiple case study approach to develop our framework artifact. We therefore sourced both academic literature and qualitative data to derive knowledge about TDM entitlements and distribution strategies. Our study primarily addresses a critical sub-field of IS research, which focuses on power relations and critical, interdisciplinary research that studies socio-technical topics related to Web3 ecosystems.

2. Blockchain and Web3 Decentralization

The blockchain concept enables decentralized consensus among independent computing devices, referred to as nodes, without the need for a central authority. Nodes communicate in peer-to-peer (P2P) networks, where each peer acts as both client and server. Techniques such as time-stamping and cryptographic puzzles are employed to ensure the integrity of transactions and prevent double-spending. Smart contracts expand the functional capabilities of blockchain beyond cryptocurrencies, facilitating the development of decentralized applications (dApps) and decentralized organizations (DAOs). However, this ’decentralization’ is a non-binary and multimodal concept influenced by technical, social, political, and economic factors reshaping existing power dynamics (Bodó et al., 2021; Pfister et al., 2022; Sai et al., 2021).

Technical decentralization refers to the extent to which a system is distributed among interconnected nodes operating independently, without a central authority (Sunyaev et al., 2021). A high degree of technical decentralization is achieved when multiple nodes communicate and participate in consensus mechanisms with equal influence, geographical distribution, and client diversity (Buterin, 2017; Lee et al., 2021; Pfister et al., 2022; Sai et al., 2021). In Proof-of-Work (PoW) networks, miners are selected as block-proposing leaders based on their computational contribution, while in Proof-of-Stake (PoS) networks, validators are selected with a probability proportional to their economic capabilities, such as token stakes. Cryptoeconomic mechanisms incentivize nodes to join and contribute to the network by distributing block rewards (PoW) or staking rewards (PoS), incorporating principles of game theory (Lamberty et al., 2023).

Socio-political, economic decentralization refers to the extent of equal distribution of permissions and responsibilities among independent actors acting according to their individual incentives (Sunyaev et al., 2021). This aspect encompasses the decision making processes within DAOs, where improvement proposals determine the course of action (Barbereau et al., 2023;

Hassan & De Filippi, 2021). Ownership and TDM strongly influence this perspective of decentralization, as they describe the distribution of tokens among different addresses and ultimately assess the phenomena of wealth concentration, with high concentrations leading to centralization at the blockchain level (Liu, Lu, Zhu, et al., 2023; Sai et al., 2021).

3. Methodological Approach

Aligned with the blockchain research agenda of Treiblmaier (2019), our study adopts a DSR approach to develop a theoretically grounded and practically evaluated artifact that contributes to the understanding of blockchain governance. DSR is a pragmatic research paradigm that focuses on creating innovative artifacts to address real-world problems (Hevner & Chatterjee, 2010). In our case, the artifact takes the form of a conceptual framework for TDM, which captures the the various perspectives and trajectories impacting decentralization within the Web3 context. To ensure rigor and relevance in our study, we employ a twofold approach: *First*, we build on Smit et al. (2020), conduct a review of the existing knowledge base and incorporate state-of-the-art research on blockchain governance. This includes academic literature as well as qualitative data, such as project documentation, white papers, and grey literature. The findings from this review serve as iterative inputs in the development of our artifact. *Second*, to account for the topic's novelty and rapid technological developments, we follow the recommendations of Smit et al. (2020) and adopt a multiple case study approach. Given that our focus is on assessing the impact of VCs on Web3 decentralization, we align with the recommendations of Yin (2009) for case study designs, specifically employing the 'Gaps and Holes' approach. Our rationale for selecting the case study design is as follows: Decentralization depends both on technical and socio-political perspectives. Technical decentralization involves analyzing infrastructure properties like consensus mechanisms and blockchain nodes, while socio-political decentralization entails examining processes like developers' improvement proposals and token holders' wealth concentration (Beck et al., 2018; Pfister et al., 2022). Decision-making in blockchains has evolved into a collaborative process with delegative decision-making, where governance mechanisms allocate TDRs to participants based on token ownership (Barbereau et al., 2022; Smit et al., 2020). These governance mechanisms can impact both technical decentralization (e.g., consensus mechanism) and socio-political decentralization (e.g., improvement proposals), with the distribution of TDRs determining the level of centralization (Liu, Lu, Zhu, et al., 2023). VCs have the ability to acquire and exercise TDRs, thereby influencing the decentralization of blockchain networks.

Case Selection. We conducted an embedded case study design on Web3 projects receiving VC investments, employing multiple units of analysis to develop inductive theory (Yin, 2009). The units of analysis were identified as 'elements influencing decentralization'. By selecting multiple cases, we aimed to achieve a suitable level of generalization, eliminating single-case bias, and enabling transparent observation of emerging relationships and constructs. To ensure adequate sampling, we utilized the purposeful sampling technique (Yin, 2009) based on the following criteria: (1) *Capital:* Projects with high funding (at least $150 million) and low funding (below $20 million). (2) *Market Relevance:* Projects ranked within the top 30 by market capitalization. (3) *Blockchain Heterogeneity:* Projects utilizing different blockchain networks.

Through various levels of analysis, including projects from Layer 1 (L1) and Layer 2 (L2) blockchains, DAO-governed and non-DAO governed projects, infrastructure and application projects, and variations in market capitalization and VC funding, we were able to triangulate findings with insightful results (Yin, 2009). In total, we analyzed four distinct projects:

(1) *Polygon:* A DAO-governed project that raised $450 million in funding through a private sale in February 2022. It is an Ethereum L2 scaling solution that utilizes sidechains while ensuring asset security and decentralization through PoS validators.

(2) *Solana:* Completed a $314.15 million private token sale in June 2021, led by VCs such as Andreessen Horowitz (a16z) and Polychain Capital. Solana's developments are driven by Solana Labs Inc. It is a L1 chain that aims for fast transactions at low network fees.

(3) *Uniswap:* A DeFi application known as the first non-custodial crypto-exchange to surpass $100 billion in trading volume (Barbereau et al., 2022). Unlike other projects, Uniswap did not provide governance tokens to investors in exchange for their capital. Instead, equity was sold to Uniswap Labs LLC, which launched the native network token and airdropped 15% of the total supply to early users and liquidity providers.

(4) *Cosmos Hub:* A PoS-based project that develops a blockchain ecosystem with multiple interconnected and independent networks. As the Cosmos project only raised $17.6 million of VC funding, it is included for comparative purposes, providing contrasting results by examining this low-funded project.

Data Collection. We collected both qualitative and quantitative data. Qualitative data includes official project documentation and white papers. Quantitative data was obtained from publicly available sources like the projects' blockchain explorers for node information and information on VC funding. To analyze the current holdings of VC firms, the 'Arkham intelligence blockchain analytical tool' was utilized as well. The data collection period spanned from March - May 2023.

Data Analysis. By an exploratory approach combining within-case and cross-case analyses, we followed an iterative process without initial hypotheses. Each case was individually examined, and the gathered information was documented and organized for comparative analysis. The preliminary theories were tested using replication logic (Yin, 2009), comparing empirical patterns with theoretical assumptions in the design artifact. The iterative process continued until theoretical saturation was reached, indicating that further iterations would not yield additional insights. We thereby exposed 'Gaps and Holes', which inform the refinement of the design artifact. This process, guided by the pattern-matching logic (Yin, 2009), ultimately led to the TDM framework (see Section 4).

4. Tokenized Decision Framework

Our TDM framework (Figure 1) provides a conceptual understanding of blockchain governance, specifically focusing on decision-making mechanisms that influence decentralization in Web3 projects. The framework dissects TDMs into two components: **decision management rights (DMR)** and **decision control rights (DCR)**, which respectively encompass the rights for creating and implementing proposals, and the rights for approving and monitoring proposals (Beck et al., 2018; Pfister et al., 2022; Smit et al., 2020). These DMR and DCR rights are granted through three major decision-making governance mechanisms: (1) *Block proposal* voting on the consensus layer (Filippi et al., 2018; Pfister et al., 2022). (2) *Improvement proposal* voting on the protocol layer (Azouvi et al., 2019; Beck et al., 2018). (3) *Governance proposal* voting on the protocol and application layer (Barbereau et al., 2023).

4.1. Layers and Spheres

DMR and DCR are distributed among multiple stakeholders operating on different layers within a blockchain system's governance structure (Filippi et al., 2018; Notheisen et al., 2017; Reijers et al., 2021).

The **on-chain governance sphere** refers to the rules that are directly encoded into the blockchain infrastructure and are executed through formal mechanisms (Filippi et al., 2018). This sphere involves actors such as miners, validators, and token holders, who operate within their respective layers. In contrast, the **off-chain governance sphere** encompasses all other actors who operate on the agent layer and the environment layer rather than at the technical level (Filippi et al., 2018; Reijers et al., 2021). These actors include (software) developers who implement code, the legal entity or DAO of a project, application providers or complementors who offer services that support the ecosystem, and users who form the most decentralized group among all actors (Buterin, 2017; Liu, Lu, Zhu, et al., 2023). On-chain governance, embedded in the technology itself, follows the 'rule of code' and is hard to bypass (Filippi et al., 2018). Compared to off-chain governance, which relies on informal procedures and social norms, on-chain governance is more transparent, verifiable, and auditable (Filippi et al., 2018).

Both spheres are governed by rules that can be endogenous or exogenous (Filippi et al., 2018). In the off-chain sphere, *endogenous rules* pertain to decision-making on protocol changes, including the decision to fork a network or implement a proposals, originating from the agent layer and enforced in the on-chain sphere (Beck & Jain, 2023). Improvement proposals are created off-chain by developers and implemented on-chain through formal voting. The off-chain decision-making process can be supported by a community voting scheme. *Exogenous rules*, on the other hand, consist of technology standards or regulations imposed by third parties such as regulators (Filippi et al., 2018; Reijers et al., 2021).

Our framework further captures multimodal **blockchain layers**, that are interdependent and form a hierarchy. The protocol layer dominates the consensus and application layers by establishing the on-chain rules (Rauchs et al., 2018). The agent and environment layers are off-chain and considered exogenous to the blockchain. The on-chain layers can be enhanced by connecting dependent, interfacing, or external systems, such as dApps (Rauchs et al., 2018). We incorportae the following elements: (1) users' and developers' DMRs on the agent layer, (2) regulatory restrictions on the environment layer, (3) decision-making within smart contract-based applications on the application layer, (4) decision-making within the consensus mechanism on the consensus layer, and (5) decision-making in the form of proposals on the protocol layer.

4.2. Governance Mechanisms affecting Web3 Project Decentralization

Next, we highlight the impact of distinct TDM elements on the decentralization of Web3 projects. Our

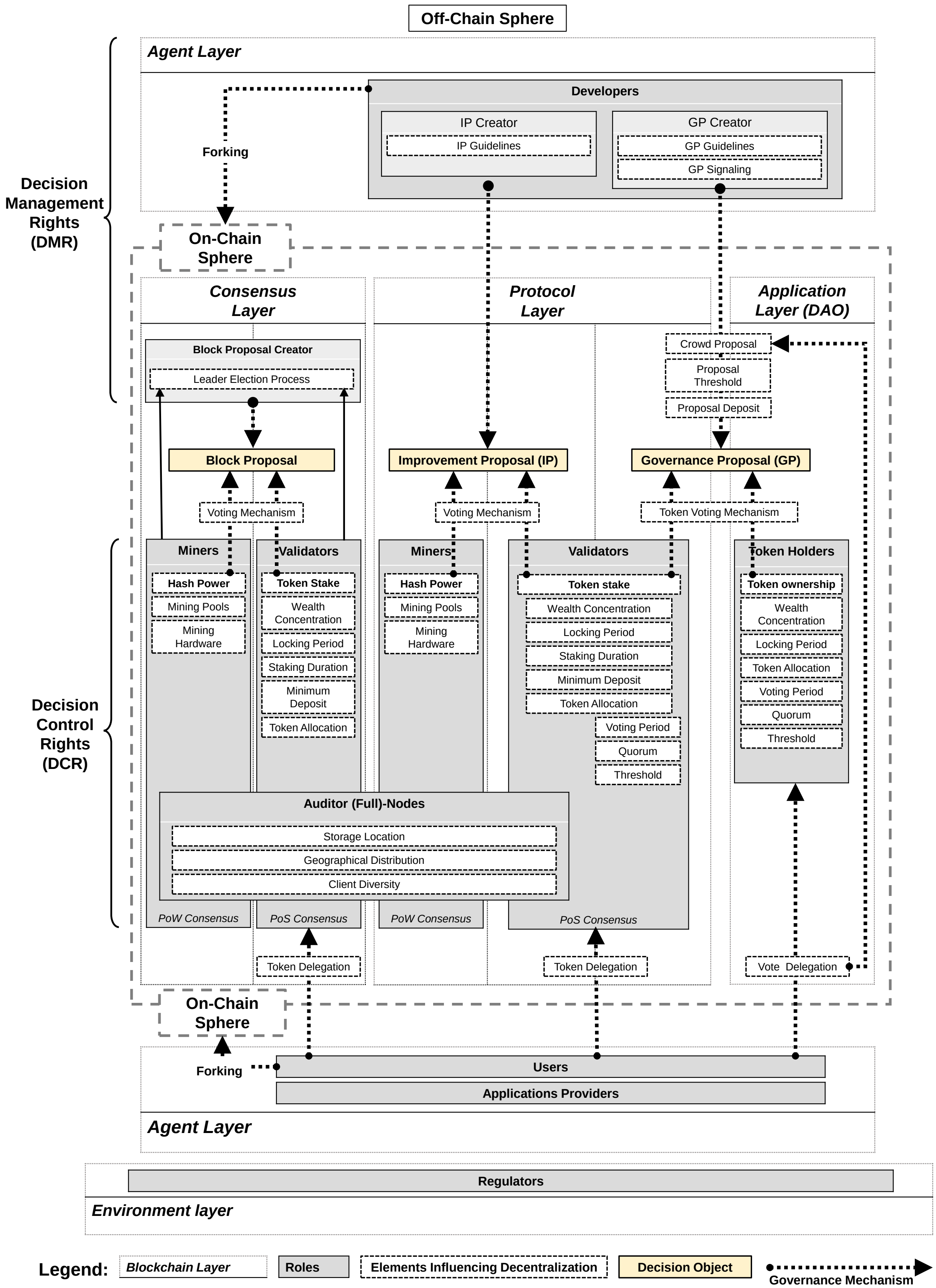

Figure 1. Tokenized Decision Making Framework

analysis centers on the influence of network actors on TDM's mechanisms and concepts. Specifically, we examine the role of miners' hash power (PoW) and validators' token stake (PoS) at both the application and protocol layers, as well as the wealth concentration of token holders at the application layer. The concept of 'one token, one vote' allocates more TDM rights to top validators and token holders in proportion to their holdings, thereby impacting decentralization dynamics.

Block Proposal Voting on the consensus layer determines the assignment of DMRs to the creator of a block proposal (Kannengießer et al., 2020). The decentralization of auditor (full-)node thereby depends on the storage location of their hardware and software components (Gochhayat et al., 2020), their geographical distribution (Lee et al., 2021; Sai et al., 2021), and their client diversity (Buterin, 2017).

In the PoW consensus, miners may further influence decentralization through three factors: (1) DCRs are allocated to miners based on their *hash power*, along with the auditor (full-)node role responsible for storing and verifying proposed blocks (Pfister et al., 2022). (2) *Mining pools* consolidate computing resources of multiple miners, distributing a fraction of the block reward to participants based on their hash power within the pool (Gochhayat et al., 2020; Lee et al., 2021). VCs can acquire hash power either by controlling a mining pool provider or by establishing their own mining pool through investments in hardware and node operations. (3) Specialized *mining hardware* designed for efficient hash function calculations can serve as a potential single point of failure and requires significant capital investment. Notably, it is estimated that a single company, Bitmain, manufactures 75% of Bitcoin mining hardware (Arnosti & Weinberg, 2022).

In the PoS consensus, decentralization may be influenced by six factors: (1) The *token stake* held by a validator determines their likelihood of being selected as a block proposal creator. Validators with higher token stakes have a greater chance of being chosen as leaders granted with DMR. (2) The *wealth concentration* captures the distribution of token stakes, which can often be concentrated among a few entities. A more evenly distributed token wealth leads to greater decentralization (Werner et al., 2022). (3) The *initial token allocation* at launch of a project determines the number of addresses that initially exert control over the project and the corresponding voting power possessed by these wallet addresses (Barbereau et al., 2023). (4) The *validators' staking duration* can impact the leader election process in PoS. (5) The *locking period* that ensures the validators' commitment to a network for specific time period (Liu, Lu, Yu, et al., 2023). (6) The *minimum deposit* refers to the threshold for the minimum stake that must be locked. A lower minimum deposit threshold allows for more participants to join the validator role, thereby enhancing decentralization. However, it also poses a potential risk to network security if only a small amount of token stake is contributed.

Improvement Proposal Voting involves the distribution of TDM across on-chain and off-chain spheres. In this mechanism, DMRs are distributed among off-chain proposal creating developers and on-chain record producing DCRs at the protocol layer. This means that off-chain governance influences on-chain governance (Filippi et al., 2018). While anyone with sufficient technical knowledge can submit a DMR proposal in governance forums, DCRs are typically assigned to auditor (full-)nodes, who independently decide whether to perform a client upgrade to accept a proposal (Kannengießer et al., 2020; Pfister et al., 2022).

Governance Proposal Voting involves the distribution of power among token holders (Barbereau et al., 2022). These token holders have exclusive voting rights and vote for or against governance proposals (Barbereau et al., 2023). Their influence on a project's decentralization differs between DMRs and DCRs.

Factors affecting DMR include: (1) *Guidelines* established on governance forums or social communities like GitHub. (2) *Signaling procedures* that gather sentiment through off-chain polling applications, allowing for discourse and enhancing decentralization. (3) *Proposal thresholds* required to submit a proposal. (4) *Autonomous crowd proposals*, created by small token holders through smart contracts, which can be used to meet the proposal threshold when other token holders delegate their voting rights. (5) *Proposal deposits*, which may be required to enter the voting process and serve as protection against spam and a potential barrier for less wealthy proposal creators.

Factors affecting DCR include: (1) *Token ownership* on the application layer, determining the voting rights and influence of token holders. (2) The *duration* of the voting period, which provides more opportunities for voters to recognize proposals and cast their votes. (3) The *quorum*, which represents the minimum percentage of voting power required for a proposal to have a valid result, ensuring a minimum level of participation. (4) The *threshold* of 'yes' votes needed for a proposal to pass, highlighting the potential concentration of power in a single token holder to pass a proposal.

Above all, the **Token & Vote Delegation** mechanism allows for the assignment of proxy votes to community members (Brekke et al., 2021;

Liu, Lu, Zhu, et al., 2023). Tokens can be delegated to either validators in the consensus layer or other token holders in the application layer, depending on the protocol's permissions. On the *consensus layer*, when users delegate their tokens to validators, they become delegators and receive a proportionate share of the staking reward. The delegators' responsibility to vote is (temporarily) transferred to the validator. On the *application layer*, users delegate their tokens to representatives and their voting rights are executed by invoking the corresponding delegation smart contract of the DAO. Delegators, in this case, do not receive any reward for their vote delegation and are not required to evaluate proposals. Overall, token delegation has the potential to enhance the effectiveness of governance decisions and increase the participation of token holders. However, it may also contribute to token concentration among top validators and representative token holders, posing centralization risks.

5. Discussion

Motivated by calls for research on blockchain decision rights (Beck et al., 2018; Liu, Lu, Zhu, et al., 2023), we contribute to the theorizing about decentralized system governance by providing a conceptual perspective on the dual nature of blockchain governance, both as an object of TDM and as an instrument for executing governance. Our framework specifically focuses on the governance of the blockchain itself rather than governance through the blockchain. Previous research on blockchain governance has recognized the importance of decision rights but has not systematically differentiated between DMR and DCR. Additionally, there has been a lack of a comprehensive framework encompassing the various cooperative and competitive governance mechanisms used in Web3 projects. To address these gaps, our framework dissects the nature of decision rights and the mechanisms that grant these rights, thereby influencing decentralization. We consider project-based and community-based characteristics and acknowledge the interdependency between social and technical aspects by examining internal and ecosystem factors influencing governance decisions. This analysis considers two interconnected spheres: the on-chain and off-chain spheres. Actors within these spheres primarily influence three decision objects in TDM: a) block proposals, b) improvement proposals, and c) governance proposals.

Employing an exploratory multiple case study approach, our multimodal perspective further analyzed VC investments in Web3 projects. By combining qualitative and quantitative data and applying our framework, we studied TDM in four projects: Polygon, Solana, Uniswap, and Cosmos. Our interpretation of the findings is descriptive and non-evaluative. The principal findings reveal that the ownership structures of TDM impact blockchain governance and play a crucial role in determining the level of decentralization in Web3 projects. Contrary to the notion of distributed governance in Web3, our analysis indicates that TDM, as part of blockchain governance mechanisms, tends to concentrate power among a select few, resulting in quasi-oligopoly dynamics. Our findings align with Chainalysis (2022) study, which analyzed the governance token distribution of DAOs and finds that *"less than 1% of all holders have 90% of the voting power"*. For instance, our study on the distribution of tokens shows that VCs exert influence by acting as validators or holding substantial amounts of tokens. We thereby support Barbereau et al. (2022) that major protocols exhibit an uneven distribution of voting power, with large token holders exerting strong influence while the concentration of token wealth arises from substantial initial token allocations during private funding sales. In the case of Solana, VCs obtained 35.4% of SOL tokens while receiving 3.8% in Polygon and 12.1% in Cosmos. Polygon further limits validators to 100, while Cosmos limits them to the top 175 stakers, making it difficult or costly for new validators to join. As a result, further token delegation to validators occurs, leading to wealth concentration. Centralized exchanges operate the top validators on Polygon and Cosmos. Interestingly, Solana stands out as the only network without caps or limitations on validators. Its Nakamoto coefficient of 33 indicates greater decentralization among validators. Token and vote delegation mechanisms further strengthen VCs' voting rights, limiting project decentralization. Regarding political decentralization, validators hold voting rights in block proposal voting and improvement proposal voting mechanisms. The allocation of voting rights is proportional to the token stake, with most VC validators in the Solana network. However, quorum minimums primarily consider the number of tokenized voting rights engaged rather than the number of voters, intensifying the influence of token-holding VCs. The top five token holders' addresses in Uniswap possess enough tokens to achieve the quorum required to pass proposals. Among them, the VC firm a16z owns 15 million UNI tokens, with other VCs such as Jesse Walden and Gauntlet also holding large amounts. Collusion among the top five token holders could grant access to the Uniswap DAO, which has a treasury value of $1.6 billion. In this vein, a16z's voting power played a role in a controversial governance proposal in June 2021, where the VC single-handedly passed a proposal to create a 'DeFi Education Fund' by allocating $20 million from the Uniswap treasury.

While our case study analysis aligns with the assertion of the *"illusion of decentralization"* (Aramonte et al., 2021), we see a potential **trajectory towards decentralization**. In general, achieving a high level of decentralization in blockchain networks involves trade-offs, as these networks can only prioritize two out of three properties: decentralization, security, and scalability (Kannengießer et al., 2020). Bitcoin and Ethereum, for instance, prioritize decentralization and security over scalability on their core L1 layer (Barbereau et al., 2023). However, high socio-political decentralization can lead to delays in governance decision making (Filippi et al., 2018). To address this, we propose a trajectory for socio-political decentralization, starting with low decentralization during the project's creation phase and gradually moving towards a desired high decentralization during the operational phase (Pfister et al., 2022; Sunyaev et al., 2021). Early-stage projects often require a 'founder dictatorship' to facilitate efficient decision-making and address code vulnerabilities (Beck et al., 2018; Buterin, 2017). This role is often fulfilled by founders and core developers (Liu, Lu, Yu, et al., 2023). In some cases, venture capitalists, like Multicoin Capital in the Solana project, may also act as benevolent dictators. During the operational phase, vulnerabilities can be addressed by transitioning towards decentralized stakeholder governance and utilizing on-chain governance mechanisms (Pfister et al., 2022). Alternative voting mechanisms, such as quadratic voting, can facilitate further decentralization. For example, DAOs could employ quadratic voting, where the number of votes is determined by the square root of the number of tokens held (Barbereau et al., 2023; Liu, Lu, Yu, et al., 2023). This approach reduces the influence of wealthier token holders as the cost of additional votes increases quadratically.

Regulators can employ our framework to structure, establish, and monitor Web3 projects that encompass the diverse mechanisms involved in TDM. By considering regulatory characteristics such as anti-trust, anti-monopoly, and anti-concentration laws, rules and compliance systems can be developed to govern both the on-chain sphere, as an IT artifact, and the off-chain sphere, encompassing the social system with its associated rules and practices influencing Web3. Moreover, developers are provided with guidance on addressing decentralization in the design and implementation of their systems.

Limitations & Research Avenues. When interpreting our results and despite carefully selecting multiple units of analysis, specifying decentralization is challenging. Thus, our findings' generalizability and external validity (Yin, 2009) are inherently limited, providing avenues for future research. First, the selected cases are subject to frequent changes, particularly in project documentation. Therefore, the validity of our qualitative data depends on the extraction time, and any subsequent implementation of proposals may undermine our findings. Thus, our results are context-specific and time-specific. Consequently, our findings should not be regarded as exhaustive or universally applicable to every Web3 project, as our theoretical contribution is descriptive and does not establish causality. However, our framework can be applied to a broader range of cases. By utilizing the TDM framework as a common thread, governance patterns can be identified among different cases. Second, while the authors of this paper have mapped characteristics per mechanism, drawing from relevant literature and discussing any deviations, empirical testing is crucial to evaluate the robustness of conceptual research. Validation research can involve techniques such as surveys, interviews, and focus groups, ideally triangulated for a comprehensive understanding of the framework's validity and applicability. Feedback from these methods can contribute to the incremental refinement of the framework. Third, it is worth noting that our research primarily focuses on governance within the specific context of Web3 projects, and further investigation is needed to explore the effects of laws and regulations on blockchain governance. Additionally, existing literature on blockchain governance often centers around public permissionless networks, whereas our selected cases do not differentiate between public and private permissioned blockchains. Comparing the results when applying the framework to both types of blockchains can provide valuable insights into the differences in governance. Finally, an intriguing area for future research would involve defining criteria for *good* decentralization in Web3 projects. As our study demonstrates, the definition of good decentralization can vary depending on the context and various quality properties, such as project level, transparency, efficiency, and balance of power.

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