INTERNET POLICY REVIEW
Journal on internet regulation

Volume 13 **Issue** 4

RESEARCH ARTICLE

OPEN ACCESS

PEER REVIEWED

Accountability protocols? On-chain dynamics in blockchain governance

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DOI: https://doi.org/10.14763/2024.4.1807

Published: 8 October 2024
Received: 14 December 2023 **Accepted:** 7 March 2024

Funding: This research is funded by the European Research Council (ERC) under the European Union's Horizon 2020 Research and Innovation Programme (Grant Agreements No. 865856).
Competing Interests: The author has declared that no competing interests exist that have influenced the text.

Citation: Nabben, K. & De Filippi, P. (2024). Accountability protocols? On-chain dynamics in blockchain governance. *Internet Policy Review*, *13*(4). https://doi.org/10.14763/2024.4.1807

Keywords: Blockchain, Accountability, Governance, Rule of code, Design

Abstract: Accountability refers to a relationship of responsibility, answerability, and enforceability between individuals and groups. In contrast to traditional institutions that rely on enforcement of accountability through traditional legal frameworks, blockchain systems rely on the "rule of code", i.e. the operation, governance, and transactions on a blockchain are governed by pre-written, transparent, and immutable rules that are expressed in software code. By empirically examining the case of the Ethereum blockchain and the Lido "liquid" staking services protocol, this paper analyses the formalisation of accountability mechanisms between protocols to ensure that Lido's proportionate share of staked ETH on the network does not pose a risk to the security and stability of Ethereum. The findings of this paper are threefold: (1) accountability on a blockchain is achieved through the implementation of checks and balances institutionalised via technological protocols ("on-chain accountability"); (2) accountability requires trade-offs, meaning that giving accountability to one type of stakeholders might actually reduce the accountability of the system for another category of stakeholder; and (3) end users of the blockchain are consumers of accountability, rather than influential participants in producing it. This research underscores the complex interplay of technical and governance considerations in ensuring accountability within blockchain systems, offering insights into the broader implications of on-chain accountability for stakeholders across blockchain ecosystems.

1. Introduction

Accountability is a core concern in legal, social, and technical systems. Accountability refers to the mechanisms and processes through which individuals or organisations are held responsible for their decisions and actions in relation to others. This is generally achieved via answerability to other stakeholders and enforceability of consequences for misbehaviour (Bovens, 2007; Mulgan, 2002). As a process or mechanism to foster better behaviour (Bovens, 2010), accountability creates trust and inspires confidence for actors to participate in a system (O'Neill, 2003). The question has been posed as to whether technology can help bridge accountability gaps by facilitating more effective interactions between stakeholder groups in governance settings (Gigler & Bailur, 2014).

As a novel field of technologically-driven private governance, blockchains are an interesting testbed for exploring new forms of algorithmic accountability that can be implemented in digital settings to foster trust and confidence (De Filippi et al., 2020). This paper explores the concept of accountability in the context of blockchain governance to investigate the extent to which accountability principles of the "rule of law" – which traditionally requires formal checks and balances and separations of power to ensure legitimacy – can be effectively be transposed in the realm of blockchain governance.

Blockchains facilitate organisational processes to aid human coordination (Berg et al., 2019; Brekke & Alsindi, 2021; Nabben, 2023). Some refer to the ethos of blockchain governance as a form of "governance minimisation", whereby stakeholders' reliance on code replaces the need for subjective rule-making and enforcement via bureaucratic governance arrangements (Ehrsam, 2020; Fischer & Valiente, 2021). Rather than relying on traditional legal frameworks to ensure the necessary checks and balances are in place and enforce accountability for participants, blockchain systems rely on pre-determined rulesets that are expressed in software code and automatically executed algorithmically (known as "rule of code" (De Filippi & Wright, 2019)). These encoded rules are *transparent,* i.e. available for all to see; *immutable,* in that historical data cannot be changed and a majority consensus is required to change the rules; and *decentralised*, as the operations of a blockchain are distributed among the network participants (namely, validators that are responsible for running software to validate transactions on the network and add transaction data to the blockchain).

Bovens' definition of accountability can be applied in algorithmic contexts, such as in relation to AI. This requires, *inter alia*, understanding who are the *actors* to be

held into account (i.e. who deployed the algorithm, who has control over it, and who needs to be held to account), the *forum* to whom account is directed (i.e. the group of users and stakeholders that the actors are accountable to), the *relationship* between the actors and the forum (i.e. what is expected from actors in terms of giving account), the *consequences* for not fulfilling the obligations they have toward the forum, and the mechanisms for the enforcement of such consequences (Wieringa, 2020). This theory has yet to be explored in the context of blockchain technology, which is both algorithmic and legal in nature.

In this paper, we build upon these previous authors to investigate the notion of accountability in the blockchain space – what we refer to as *on-chain accountability*. To do so, we focus on the case of the Lido protocol running on the Ethereum blockchain, and the negotiation of accountability mechanisms between these two protocols. This case was chosen as these are two major, interconnected blockchain infrastructures with complex interdependencies that have become the topic of heated debate among both communities.

Ethereum is governed through a distributed consensus protocol relying on "Proof-of-Stake" (Buterin, 2022), which enables network participants to validate transactions and produce new blocks based on the amount of cryptocurrency they have staked. To become a validator, a person must "lock up" 32 Ether (ETH) in a smart contract (a programme that runs on Ethereum) and run validator software. The Proof-of-Stake protocol ensures that validators will earn cryptocurrency rewards for each block they produce, but will potentially lose their stake if they fail to validate transactions or if they produce illegitimate blocks. This protocol thus serves as the "foundation of decentralised accountability" on Ethereum (Calvão, 2019).

Lido is a set of smart contracts deployed on the Ethereum blockchain, governed by a "Decentralised Autonomous Organisation" or DAO (Hassan & De Filippi, 2021). Lido provides "liquid" staking services on Ethereum. This means that rather than running a validator and maintaining hardware, software, and internet connectivity, users can deposit ETH into the Lido smart contracts, in exchange for a tradable (or "liquid") token called "staked ETH" (stETH). Similarly to the "mining pools" on Bitcoin, where users pool together their computing power in order to increase the chances of obtaining a block reward (even though the reward will be split amongst all participants to the pool, based on the amount of computing power they have contributed), Lido's protocol can be regarded as a "staking pool", in that it enables users to pool ETH together in order to earn rewards that will be split amongst all the participants to the pool, based on the amount of ETH they have effectively contributed. The liquid staking model thus promises users lower risk and more

flexibility to earn rewards, without requiring them to participate directly in the technical requirements, costs, or risks of Ethereum staking.

However, this evolution in market offerings towards pooling resources in PoS validators mimics previous trends in "Proof-of-Work" blockchains such as Bitcoin, which evolved from single computer mining to larger scale mining pools that manage significant resources and therefore also hold significant political influence in the Bitcoin network (Wang, et. al., 2020). According to some, "staking is getting financialized before our eyes" (Glisic, 2022a). Due to the proportion of staked Ethereum that Lido manages and controls, Ethereum community members are concerned that Lido is a threat to the integrity of Ethereum if the protocol were to fail due to a security bug or a large node operator behaving maliciously. Lido has been labelled by Ethereum core developers as a "threat to Ethereum's security, neutrality, and legitimacy" (Ryan, 2022). Thus, Lido must ensure it is accountable to Ethereum in order to maintain its legitimacy and continue to gain users in the Ethereum ecosystem. As such, liquid staking marks an important development for further investigation of its effects on the overall dynamics of accountability in blockchain governance.

1.1 Methodology

This paper adopts a case study approach of publicly available, digitally accessible information, and analyses the data in light of theoretical literature on accountability. Case study research is characterised as a method "that facilitates exploration of a phenomenon within its context using a variety of data sources" (Baxter & Jack, 2008, p. 544), with the aim of a reconstructing precise description of a case (Flick, 2015). A descriptive, case study approach is particularly useful for investigating emergent fields, including digital networks, as well as accountability relations between actors, institutions, and processes across multiple levels (Priya, 2021). Data was collected via publicly available materials on online channels (including the Lido governance forum, LidoDAO member preference signalling on the voting application "Snapshot", public debates on the social media platform "X" (formerly Twitter), publicly available podcasts and conference presentations on YouTube, project websites, and software code repositories on GitHub.

The context of the case study field site was informed by previous immersive participation in these networks. Prior to, and separate from, the data collection that this paper presents, one co-author was contracted by a professional services company to participate in a research project that was funded by a LidoDAO "LEGO" grant. This research was completed in 2022 (Nabben, et. al., 2022), with aspects of it

since published academically, with university ethics approval (Nabben, 2024). No funding is connected to this research paper.

The findings of this paper are threefold: (1) accountability on a blockchain is achieved through the implementation of checks and balances institutionalised via technological protocols ("on-chain accountability"); (2) accountability requires trade-offs, meaning that giving accountability to one type of stakeholders might actually reduce the accountability of the system for another category of stakeholder; and (3) end users of the blockchain are consumers of accountability, rather than influential participants in producing it. This research underscores the complex interplay of technical and governance considerations in ensuring accountability within blockchain systems, offering insights into the broader implications of on-chain accountability for stakeholders across the blockchain ecosystem.

The remainder of this paper is structured as follows: First, we conceptualise accountability to rules in the domain of blockchain governance by providing a theoretical framework for understanding the mechanisms and principles that underpin accountability in decentralised systems, drawing on academic definitions of accountability, as well as “rule of law” and “rule of code”. Next, we present the case study on Lido, Ethereum, and the Dual Governance proposal, which examines the practical applications of the theoretical concepts of accountability and highlights the complexities of enacting accountability in real-world scenarios. This is followed by an analysis of accountability trade-offs, whereby we scrutinise the operationalisation of accountability mechanisms within blockchain architectures, discussing both the benefits and limitations inherent to these systems. We then explore how accountability relates to fairness, focusing on how current approaches impact the equitable distribution of power and influence among various stakeholders, with particular attention to end users. Finally, the conclusion synthesises our findings, highlighting the complexity of designing for on-chain and off-chain accountability in blockchain governance and outlining areas for future research towards enhancing accountability in these systems.

2. Conceptualising accountability to rules in blockchain governance

Drawing upon insights from scholars such as Boven (2007, 2008, 2010) and Wieringa (2020) this section aims to conceptualise accountability within the context of blockchain governance, highlighting its relationship with the principles of the *rule of law* found in traditional legal systems.

As described in the previous sections, Boven's conceptualisation of accountability (2007) constitutes a useful framework to understand accountability within blockchain systems. According to Boven, accountability encompasses the social definition of *responsibility* (which pertains to the obligations of actors within a particular context), *answerability* (where individuals are expected to provide an explanation or justification for their actions), and *enforceability* (which refers to mechanisms to hold actors to account for their obligations). Weringa extends the discourse on accountability by discussing algorithmic accountability. She emphasises the need to identify the actors involved, the specific situations for which they are held accountable, and the mechanisms for ensuring transparency and oversight in algorithmic decision-making. While Wieringa's framework primarily focuses on accountability of algorithmic systems in general, its principles can be adapted to blockchain governance as well.

In particular, the rules expressed in a blockchain protocol establish a specific normative arrangement that can be compared to a legal system with automated enforcement. In traditional governmental systems, legitimacy – i.e. the acceptance of authority leading to voluntary obedience to its orders (De Filippi et al., 2022) – is achieved through a particular set of principles known as the "rule of law" (Bingham, 2011). The rule of law emphasises the supremacy of law over arbitrary power and ensures that all individuals, including government officials, are subject to and accountable under the law. It embodies several key principles, including separation of powers, checks and balances, and accountability mechanisms. While these principles have been conceived in the context of centralised governmental authorities, how they apply in the context of more decentralised governance systems remains to be better understood. This bears the question of how the accountability principles of the "rule of law" – which traditionally requires formal checks and balances and separations of power to ensure legitimacy – can effectively be transposed in the realm of blockchain governance.

The concept of the "rule of code" – introduced by De Filippi and Wright (2018) – illustrates how blockchain communities translate accountability processes of checks and balances into algorithmic mechanisms. Indeed, in the context of blockchain governance, accountability operates within a decentralised and transparent framework. Unlike traditional governance structures, where accountability mechanisms are often centralised and hierarchical (raising the question of "who watches the watchmen", a recurring challenge in governance (Paynter & Kearney, 2010; Siddarth et al., 2020), blockchain governance relies on a series of technological guarantees based on distributed consensus mechanisms and cryptographic protocols to

ensure accountability. These technological guarantees of blockchain systems can be classified into the three criteria of accountability identified by Boven:

1. Responsibility via *decentralisation* of *authority:* Instead of a central entity or group of people making decisions, decisions are taken in a distributed manner, according to a particular set of governance rules that are codified into a technical protocol (Bodó, et. al., 2021). This reduces the need for intermediaries and potentially increases transparency and confidence in the system;
2. Answerability via *immutability*: Once deployed on a blockchain, smart contracts and associated transactions cannot be changed or reversed. This means that the rules of the system are permanent and tamper-proof (assuming no bugs or flaws in the code itself). This contributes to fostering transparency and accountability, as all transactions are recorded on an immutable ledger accessible to all participants.
3. *Automated enforcement:* The operations and governance decisions in a blockchain are actioned through self-executing smart contracts where the terms of the agreement are directly enshrined into code. This stands in contrast with traditional platforms, where enforcement is done either through a centralised operator or external court orders.

In light of this, De Filippi and Wright (2018) suggest that, although blockchain technology could enable new forms of organisational structures that are less reliant on traditional state-based legal systems, these structures can also benefit from a form of accountability – albeit of a different kind than traditional legal structures. Yet, smart contracts can automate and enforce agreements, there may still be a need for legal recognition and frameworks that define how these digital contracts interact with traditional legal systems. Moreover, a significant critique of the "rule of code" (as opposed to the more traditional "rule of law") is that it lacks the flexibility of human judgement. Legal systems often need to interpret laws and contracts based on context, intentions, and changing circumstances. Code, however, is literal and cannot easily adapt to nuances or unforeseen situations unless explicitly programmed to handle such cases.

The section that follows elucidates the dynamics of blockchain governance and accountability in the case of Lido and Ethereum.

3. Case study: Lido's formalisation of accountability

3.1 Lido pooled staking

Lido is the first of a handful of "Decentralised Finance" (DeFi) protocols to emerge following Ethereum's transition to Proof-of-Stake to institutionalise staking, by

providing tokens in exchange for staked tokens, so users can earn staking rewards and trade. These derivatives that represent a share of staked tokens are known as "liquid staking derivatives" (LSDs) (Scharnowski & Jahanshahloo, 2023). Instead of staking 32ETH, this allows people to send smaller proportions to Lido smart contracts in exchange for the tradeable ("liquid") token "stakedETH" (stETH) and put that asset to work while still earning rewards on the portion being staked. Liquid staking also removes the operational burden of hardware, software, and internet connectivity for a person to maintain their own staking validator (Lido, 2021a). According to Lido, the protocol "lets users stake their ETH tokens in a non-custodial and transparent manner to contribute to the stability of the Ethereum ecosystem as a whole" (Lido, 2021b, n.p.). The Lido protocol is governed by Lido DAO, whose membership is determined by holding the free market asset "LDO" governance token (Lido, 2021b). LDO voting weight is proportional to the amount of LDO a voter holds. Large token holders (known as "whales'') include venture capitalists, initial contributors, and employees of the DAO (CoinMarketCap, n.d).

Contributors to the Lido ecosystem are adamant that Lido expands access to liquid staking, and that the interests of the Lido ecosystem are aligned with Ethereum. Lido's contributors claim democratic merits by enabling anyone to participate in securing the Ethereum network without having to have 32ETH, keeping Ethereum "decentralized, accessible to all, and resistant to censorship" (Yves Saint-Leger, 2023). Yet, concerns have been raised in the Ethereum ecosystem regarding the lack of accountability measures between Lido and Ethereum, including clear responsibilities from Lido towards Ethereum, sanctioning options in the case of node operator collusion, and recourse in the case of a hack or bug in the Lido smart contracts. This has provoked substantial public debate, as a marker of democratic processes.

3.2 Lido on Ethereum - Concerns

In March 2022, Ethereum core developer and employee of Ethereum Foundation Danny Ryan shared a post to outline the inherent risks of LSD protocols. Concerns relate to both on-chain and off-chain behaviour, including that Lido creates a "stratum of cartelization" in the way that a small subset of node operators validate the network, introducing "significant risks to the Ethereum protocol and to the associated pooled capital when exceeding critical consensus thresholds" (Ryan, 2021). The issue is that if any small number of validators that are known to one another in one LSD protocol, and that protocol holds an outsized proportion of staked Ethereum, then the protocol is subject to governance attacks and Ethereum protocol users are being underrepresented. If Lido has 255792 depositors (Lido Analyti-

cal, n.d.; Glisic, 2022b), 37 node operators, and around 30.2% of total staked ETH in 2023, this means that all PoS validators are controlled by 37 node operators entities that could collude to hike staking fees or attack the underlying Ethereum chain (Lido Analytical, n.d; Ethereum Mainnet Explorer, 2024). Ryan recommends that accountability to Ethereum can only be achieved if "Lido and similar LSD products self-limit for their own sake", and that users that allocate capital to stake Lido "should not allocate to LSD protocols exceeding 25% of total staked Ether due to the inherent and extreme risks associated" (2021, n.p.). Buterin has echoed concerns about cartelization and "price gouging" in a post on "X" (VitalikButerin, 2022). Although Lido is working to expand the validator set and automate the selection process (which is currently controlled by LidoDAO), the concern is that there are no clear consequences or enforceable accountability measures if Lido misbehaves against Ethereum.

The public response to from Hasu, a Strategic Advisor to Lido, is that stakers not representing users is a problem with the design of Proof-of-Stake consensus, that node operators are incentivised to maximise profit and thus act in Ethereum's interests, and thus liquid staking improves this alignment of interests, "So stakers, and especially LSD-stakers, are *very* aligned with the security of Ethereum'' (Hasu, 2022, n.p.). The other general argument made by LSDs, and Lido in particular, is that centralised exchanges will dominate the pooled staking market, leading to centralisation of cryptocurrency tokens, staking services, and rewards in antithesis to the ethos of public blockchains if liquid staking services fail to provide the service in a more decentralised and democratic way (Lido, 2021b).

At the time of writing, Lido has approximately 30.2% of the total Ethereum supply/ liquid staking on Ethereum providers deposited via its smart contracts (Tomeny, 2024), and $33 billion total value locked in the Lido protocol (Lido Analytical, n.d.). This creates a potential conflict of interest between Lido DAO's interests and responsibility to "govern Lido to maintain its ongoing efficiency and contribute to the overall growth of the Lido community" (Lido, 2021, n.p.), and Ethereum's need to remain decentralised, permissionless to participate in, and collusion resistant. Following a lengthy debate about the interests and concerns of "Lidonauts'' and "Ethereans" (Vsh, 2022), and in consultation with a number of Ethereum core developers, Lido DAO voted not to self-limit regarding stake. The Lido community argued that if it does not provide liquid staking-as-a-service, other more centralised staking services will fill its place (Lido Snapshot, 2022). In contrast, other competitor liquid staking protocols such as "Rocketpool" (which didn't have anywhere near as much share of staked ETH) voted to "self-limit" their percentage share of stak-

ing funds under management on Ethereum to below 33%, as recommended, so as to not be perceived as posing a risk to Etheruem (Rocket Pool, 2023). In other words, Rocketpool and others have committed to "damage itself before endangering the stability of Ethereum" (Rocket Pool, n.d.). The call for accountability from Ethereum to Lido has continued, with the debate becoming more and more polarised regarding whether or not Lido is a threat to Ethereum, and what should be done about it. One potential path forward being proposed for Lido and Ethereum is a proposal for an accountability mechanism called "Dual Governance".

3.3 "Dual Governance" as an accountability mechanism

The Dual Governance proposal reveals more about the nature of blockchain accountability in practice in the way that these communities seek to institutionalise accountability through protocol enshrined voting mechanisms, as well as highlighting the limitations of this approach. Danny Ryan's initial post (2022) included a proposal for a voting mechanism to grant Ethereans veto power in Lido governance decisions that change the "social contract" of good behaviour between the two, in that according to Lido, the two protocols are codependent on one-another and must both remain good actors (Skozin, 2022; Lido, 2022). Despite functioning as permissionless, technocratic systems, these public debates demonstrate concern for accountability of Lido to Ethereum.

The Dual Governance proposal is for a software enshrined institutional accountability mechanism to align interests between Lido and Ethereum. The goal of this paper is not to judge the viability of the specific mechanisms proposed but rather to analyse its function in relation to facilitating accountability between Lido and Ethereum. The aim of the mechanism is to create an enforceable arrangement that allows a portion of Ethereum stakers (i.e. holders of stETH, as a subset of all Ethereum stakers) to veto LDO Lido governance token holders from changing the social contract between LDO holders and stakers without their consent (Yves Saint-Leger, n.d.a). This could occur via an interactive process, in which 5% of stETH holders veto to extend a governance vote, 15% of stETH holders can veto a governance decision, and then negotiation is required between stETH holders and LDO token holders to reverse the veto state (Yves Saint-Leger, n.d.b). Diagram 1 and 2 (below) depict one design of how the Dual Governance mechanism may function.

The Dual Governance proposal seeks to function as an accountability mechanism, showing how blockchain checks and balances include concrete consequences for misbehaviour. In this case, anyone in the Ethereum community that acquires stETH

could contribute towards halting Lido's governance processes, even colluding to attack Lido if they do not approve of their conduct. Lido DAO team member and "governance whisper" Sacha states that "Unacknowledged power is unaccountable power. And unaccountable power almost inevitably leads to situations which are far from ideal over a long enough time horizon" (Yves Saint-Leger, n.d.b, n.p.). In previous posts, Lido has labelled how essential this accountability relationship between the two protocols is, stating: "we want to thank the entire community for continuously holding us accountable to the values of decentralization" (Core Lido & Hasu, 2022, n.p.). Although the proposal changes the accountability dynamics, it is unclear whether it really improves Lido's accountability towards Ethereum, and whether it undermines Lido's own functioning.

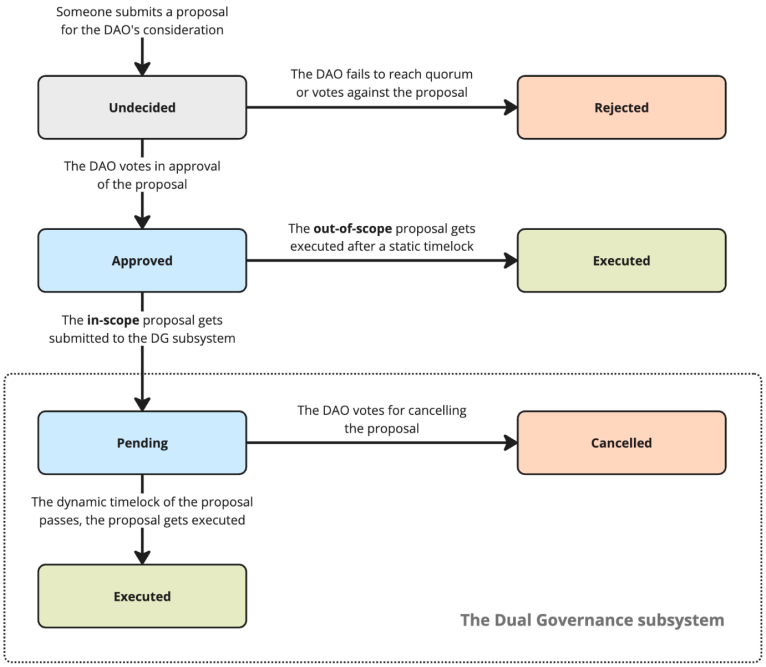

FIGURE 1: Proposal lifecycle (Lido Finance, n.d.).

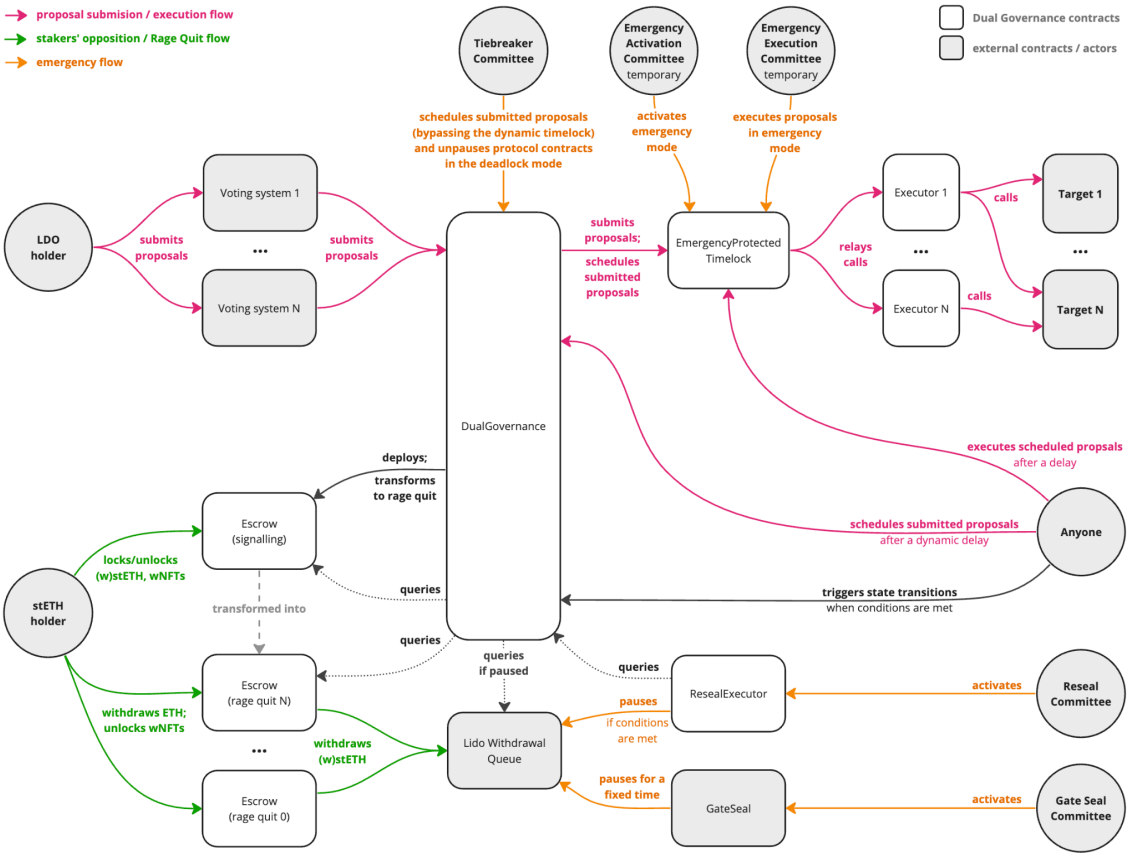

FIGURE 2: Executability of a critical governance decision (Lido Finance, n.d.).

4. On-chain accountability: Analysis & trade-offs

Instantiating accountability introduces trade-offs between different groups of stakeholders. Lido's preference in developing an accountability mechanism has been to resort to the "on-chain" (on the blockchain) Dual Governance mechanism that can be protocolised. This approach, which could be referred to as "on-chain accountability", attempts to reinstate the rule of code in the governance actions that can be executed by smart contracts, as a means to achieve legitimacy.

Based on the case study information, it is possible to analyse Lido's Dual Governance proposal against the theoretical frameworks on accountability set out in the previous sections (Bovens, 2007; Weiringa, 2020). The *actor* in the system (i.e. who deployed the algorithm, who has control over it, and needs to be held to account) is Lido (represented by LDO governance token holders). The *forum* to whom account is directed is Ethereum (as represented by stETH holders in the Dual Governance proposal). The *relationship* between the actors and the forum (i.e. what is expected from actors in terms of giving account) is that based on their percentage share of staked Ethereum under management, Lido does not create an attack vec-

tor that could undermine Ethereum consensus or security. The Dual Governance proposal aims to address this by allowing Ethereum stakeholders that acquire Lido's native token (stETH) to veto changes to the protocol proposed by LDO token holders via LidoDAO (including upgrading the Ethereum liquid staking protocol code, managing the list of the Ethereum consensus layer oracle committee members, changing how the stake is distributed among node operators, and changing the LDO governance structure (Lido Finance, n.d.). This veto puts Lido governance into a frozen state (called "veto signalling state" (Lido Finance, n.d.), in which the DAO cannot execute proposals. From here, the two main actions are: stakers can "rage quit", and withdraw their staked ETH en masse from Lido if they aren't able to resolve the points of disagreement, or transition to deactivation if a viable path forward is reached. The proposal also introduces a number of available actions for special committees in the event of a security exploit in protocol contracts, and a tie-breaker committee if contracts and governance processes are both deadlocked (Lido Finance, n.d.).

Under the current status quo governance arrangements, the *consequences* for Lido not fulfilling the obligations they have towards Ethereum, and the mechanisms for the enforcement of such consequences, are extremely limited. There are currently no enforceable consequences that Ethereum has towards Lido in the case that node operators collude, LDO governance token holders that control LidoDAO act against the interests of Ethereum, or a security incident occurs on Lido that affects Ethereum staking. Under the Dual Governance proposal, the power for stakers (represented as stETH holders) to negotiate with LidoDAO is introduced, with the goal of "Mitigating Lido protocol governance risk for Ethereum" (Yves Saint-Leger, 2024).

The Dual Governance proposal possesses each of the qualities of rule of code-based accountability explored above (responsibility via decentralisation of authority, answerability via immutability, and automated enforcement). Firstly, the proposal decentralises authority within LidoDAO by distributing decision-making power among more stakeholders. In this model, both LDO token holders and stETH holders play a role in Lido governance processes that pertain to protocol changes and node operators, ensuring that authority is not concentrated in the hands of a single group. This redistribution of authority enhances accountability within the system, as each group of decision-makers are held accountable to one another, and members of the Ethereum community have a clearer avenue to hold LidoDAO to account with the "timelock" function.

Secondly, by leveraging the LidoDAO for governance and decision-making, DAO-

wide decisions are enshrined on the Ethereum blockchain, creating a transparent and immutable record of actions taken by the various stakeholders. This transparency holds decision-makers accountable for their actions, enabling other stakeholders to scrutinise and verify the integrity of governance processes. Answerability occurs before a proposal goes to vote, as discussions are actively encouraged on the Lido governance forum, as well as social media platforms (such as "X" and blog posts) to amplify explanation and engagement (Lido Governance, n.d.). Governance debates typically play out in the open, between Lido and Ethereum community members.

Lastly, the Dual Governance proposal incorporates automated enforcement mechanisms for all governance decisions through the use of smart contracts. By automating the execution of governance actions, the potential for human error or manipulation is reduced. This enhances accountability by ensuring that governance decisions are implemented consistently and impartially by underlying technological infrastructure once consensus based rules are agreed on and protocolised.

However, despite its benefits, this approach of on-chain accountability also reveals certain trade-offs, as enhancing accountability for one stakeholder group may inadvertently diminish it for another. Awareness of this broader social, technical, economic, and legal context that DAOs operate in, as well as the vulnerabilities that certain decisions can introduce has been referred to as "DAO vulnerabilities" (Nabben, 2024). In the context of accountability, Lido has been required to trade off its own operational security in proposing accountability in this way by allowing stETH holders influence over their governance processes, thus creating a potential vector. The proposed Dual Governance mechanism proposed by Lido introduces a delicate interplay of accountability dynamics, where different stakeholders (namely LDO owners and stETH holders) have different powers and privileges within the same governance framework.

LDO owners are granted control over governance processes through the LidoDAO, enabling them to influence protocol upgrades, manage oracle committees, and determine treasury expenditures. The proposed Dual Governance mechanism aims to safeguard the interests of stETH holders, as representatives of the Ethereum community, by granting them limited veto privileges in the LidoDAO in order to ensure that Lido DAO proposals are not malicious to Ethereum security and consensus. Through the ability to veto proposals in the LidoDAO, stETH holders could prevent governance decisions that would negatively impact their stake in the network. Yet, this heightened accountability for stETH holders, and thus Ethereum at large, may come at the expense of the LDO holders own interests. Risks of Dual Governance

to LDO token holders include efficiency, effectiveness, and resilience. Hypothetically, stETH holders could use the veto power to significantly slow down the DAO's governance processes, making it difficult for them to function in an efficient or effective manner. Furthermore, Lido competitors could try to collude to acquire stETH tokens and veto decisions that aren't in their short-term, competitive interests to slow down Lido's governance processes (such as Lido onboarding new node operators to the validator set). The measures against some of these scenarios in the Dual Governance proposal fall back onto subjective, human inputs and "off chain" accountability, such as a "Tie-Breaker Committee" composed of different interest groups within the Ethereum community, including other DAOs, Ethereum Foundation, node operators, and early contributors (Lido Finance, n.d.).

Designing proper accountability mechanisms thus requires careful consideration of another trade-off – between *participation* and *expediency*. Indeed, as participation and consensus-building efforts unfold between the multiple groups of stakeholders within the Lido governance framework (including LDO token holders, stETH token holders, Ethereum more broadly, Node Operators, and users), the pace of governance actions may slow, potentially hindering the protocol's responsiveness to evolving market conditions. Thus, while empowering stETH holders with veto power and negotiation capabilities contributes to enhanced accountability from Lido towards Ethereum, it also introduces a series of complexities that may impede swift decision-making and overall operational efficiency.

As a result, mechanisms for state of exceptions or dispute resolution committees become essential to ensure the stability and resilience of the system amidst competing stakeholder interests. The Dual Governance proposal preserves existing provisions that allow for contracts to be paused for predefined durations in the case of exceptional circumstance. One example is "Gate Seal", a circuit breaker mechanism activated in the event of a zero-day vulnerability in the protocol contracts to allow a DAO elected committee to pause certain functionality (such as withdrawals from the protocol) for a predefined duration to allow the DAO to vote for a remediation (Lido Finance, n.d.). This system mitigates potential risks and stabilises the protocol during critical vulnerabilities by providing a controlled response mechanism through human oversight. Such measures demonstrate the limitations of on-chain accountability, revealing that a balance between automated governance and human oversight is crucial for maintaining operational integrity within blockchain governance.

Once a veto is in place, and if a resolution to an impasse cannot be agreed upon, stETH holders have the ability withdraw their staked tokens en masse (known as a

"rage quit"). This affordance is characteristic of a more market or exit based orders, meaning that individuals can choose to enter or exit, and costs of accountability can be considerably lower than bureaucratic approaches (Hirschman, 1972; Warren, 2011). Although exit costs exist, exit politics are native to blockchain systems, that are "permissionless", meaning they are non-excludable and participatory according to a given rule set (Nabben & Zargham, 2022), and the "root of trust" for the rules of the system is in software code, rather than third-party authorities. This "power of an exit" (Yves Saint-Leger, 2024, n.p.) is a significant accountability lever for stETH holders.

The case of Lido and Ethereum also demonstrates the difficulty in navigating when accountability should be instantiated via on-chain mechanisms, and when it is more appropriately institutionalised in the form of off-chain processes. Lido chose a difficult path in trying to design a veto mechanism that adequately represents stakeholders, demonstrates a commitment to accountability to Ethereum, and provides a pathway to enforce consequences. By choosing not to self-limit, Lido has chosen to take an approach whereby they retain influence, but accountability and responsibility is expanded so that everyone is to blame if something goes wrong with Ethereum. At the time of writing, Lido is also pursuing approaches other than Dual Governance to diversify its node operator set through local-scale community staking infrastructure, to reduce potential or perceived cartelization (Lido, 2024).

5. Accountability & fairness

The exploration of accountability mechanisms reveals significant insights into the distribution of power and the protection of stakeholder interests, especially in relation to end users of blockchain protocols. The case of the Ethereum protocol, particularly through the lens of LidoDAO, exemplifies a pivotal tension between the ideals of decentralised finance and on-chain accountability, against the practical realities of participation and influence within these systems. An obvious absence in the accountability mechanism being proposed is that of end users of the Ethereum protocol. LidoDAO team members state that, "It is our belief that well-designed on-chain DeFi protocols are able to put users ahead of token holders" (Yves Saint-Leger, 2024, n.p.). Yet, end users as a group of actors are dependent on engaged Ethereans to acquire stETH and participate in Lido's governance processes, in order to have their interests represented. The assertion by LidoDAO that well-designed DeFi protocols prioritise users over token holders raises critical questions about the actual mechanisms through which such prioritisation is

achieved – or, as noted, where it falls short. In the current governance models, end users lack direct representation in governance processes.

This raises important questions about fairness, representativeness, and inclusivity within the Lido governance system, as participation may be limited to those with the knowledge, resources, and technical proficiency to navigate DeFi protocols. More generally, the exclusion of end users from checks, balances, and decision-making power highlights three fundamental challenges in the nature of blockchain governance: (1) the *technocratic* nature of complex software systems that rely on the technical expertise of a relatively small group of developers to develop and maintain the protocols; (2) the largely *meritocratic* nature of participation in a blockchain system, that affords influence based on observable contributions and reputation within a specific blockchain community; and (3) the inherently *plutocratic* nature of token-based governance, which accounts for token holders that have financial value at stake in governance decisions. Some literature on blockchain governance describes these platforms as emphasising one of these specific characteristics (Werbach et. al., 2024). Yet, the co-existence of technocratic, meritocratic, and plutocratic dynamics within blockchain governance is one of the unique structural and operational characteristics of blockchain technologies. Some qualities can become more prevalent over others at various stages of a blockchain project's lifecycle. For instance, blockchain governance often favours a more technocratic approach when the underlying foundations and development of a project is occurring, which requires technical expertise. As a project matures, more meritocratic dynamics can occur as a community forms around the initial concept, creating scale and the need for labour to be distributed among contributors. Finally, plutocratic governance dynamics often enter with the representation of governance rights via tokenisation at the point of token distributions and venture capital fundraising. This is often justified on the grounds that those with more at stake financially are more likely to make decisions that benefit the network's long-term health.

The dynamics of technocratic, meritocratic, and plutocratic governance in blockchain systems can inadvertently lead to the exclusion of end-users – the very stakeholder who is often most affected by governance decisions – from meaningful participation in governance. Without substantial participation from a diverse range of users, those in governance roles may not be held accountable to all stakeholders, leading to decisions that do not adequately reflect or protect the interests of the broader community. The effective co-existence of these dynamics within a single blockchain governance system depends on designing mechanisms that al-

low each to contribute positively while mitigating potential downsides through accountability checks and balances. For example, projects can limit the absolute power of token-based voting with checks and balances from expert councils or input from operational personnel, or ensure that technical decisions are transparent and involve community input for a more balanced and inclusive governance structure that doesn't overly compromise efficiency. The Lido Dual Governance proposal does not (yet) attempt to address these considerations.

Although participation in many ways requires expert knowledge, this dynamic highlights the importance of ensuring accountability exists for these stakeholders who are significantly affected by decisions taken by other people in power. This also raises broader questions about the appropriateness of relying solely on on-chain accountability in blockchain governance. While these mechanisms can provide transparency, auditability, and automated enforcement, they may not adequately address measures of fairness, representativeness, and inclusivity. As a result, end users – particularly those who lack technical expertise or access to resources – may be marginalised within these decentralised governance processes, undermining the very principle of decentralisation.

6. Conclusion

This paper has analysed the nature and dynamics of accountability in blockchain governance, through the case of the Lido liquid staking protocol on Ethereum. It has shown how the need to foster the legitimacy of a DeFi protocol can be achieved through a set of on-chain accountability mechanisms based on the "rule of code". Yet, important trade-offs come into play when designing accountability mechanisms, as giving accountability to one group of stakeholders can reduce the accountability for another category of stakeholder. Moreover, accountability gaps may emerge, where certain classes of stakeholders (in particular, end users), are omitted from accountability processes, or must rely on informally delegating accountability to others. Thus, despite the benefits of on-chain governance, off-chain accountability processes that introduce human oversight and subjectivity may still be required to ensure a proper amount of fairness and representation, and account for what cannot be translated into software code. This nuanced approach underscores the complexity of designing accountability systems in blockchain systems, especially in determining what could or should be implemented on-chain through the rule of code, and what should remain off-chain and delegated to human discretion. This opens up further research directions into legitimate off-chain accountability processes that function harmoniously with on-chain mechanisms.

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