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PART 1
What are DAOs?

PART 2
Benefits and Costs of Decentralization

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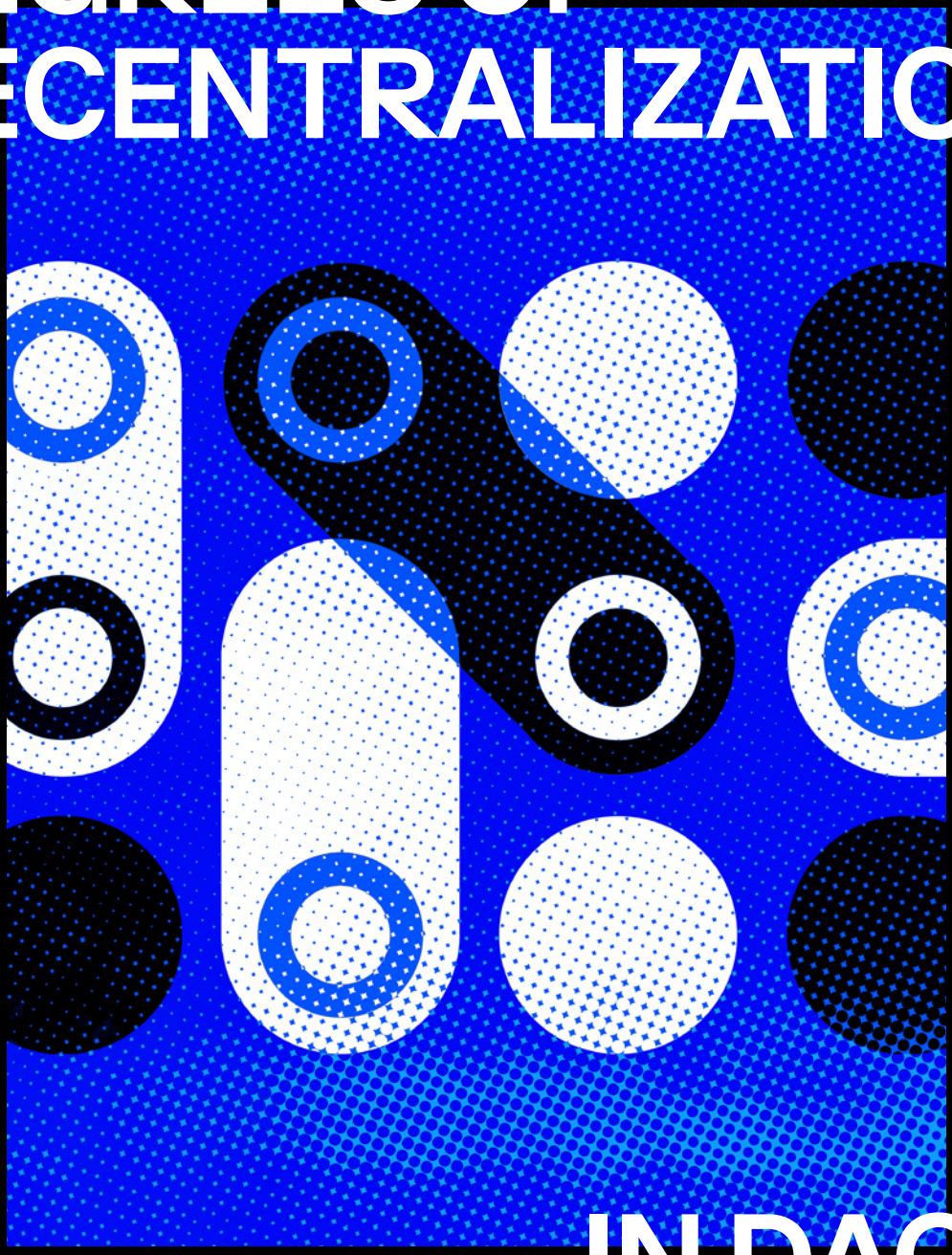
How the Technology Behind DAOs Alters the Benefits and Costs of Decentralization

PART 4
How Decentralized are DAOs Really? And Should They Be?

DEGREES OF DECENTRALIZATION IN DAOS



TL;DR:

- A decentralized autonomous organization (DAO) is a new type of organization that is user-owned and user-governed. DAOs aim to build more cohesive, transparent, equal, and democratic communities by lowering agency costs, empowering users, and enhancing trust through decentralization.
- At the same time, decentralized decision making also has its costs, including lower levels of expertise, weaker protection of trade secrets and confidential information, and challenges in coordination.
- Thus, how decentralized should DAOs be? Decentralization happens on a spectrum. It depends on how the technology behind the DAO alters the tradeoff between costs and benefits in specific contexts. Organizers of DAOs thus have to carefully decide which decisions are taken as a group, which ones are delegated to representative agents, to strike the most appropriate balance for their situation and achieve better outcomes.

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Introduction

More than half of economic output in the U.S. is produced by public companies where owners delegate control to boards of directors and executive managers. Such delegation raises several critical issues including that: (i) managers' incentives are not always aligned with the interests of shareholders, causing significant problems from merger decisions, to CEO compensation, and to capital investments; and (ii) shareholders and other groups (e.g., customers, employees) may not feel empowered and included in the decision making process, and thus do not develop a sense of belonging and identity with the company, an invaluable feature of an organization's success.

With the rise of cryptocurrencies and decentralized ledgers, a new organization – the decentralized autonomous organization (DAO) – is now possible.

DAOs allow for more direct control of the decision making process to all members of the organization, promising to drastically reduce the agency and empowerment issues raised by delegation. However, DAOs also have important challenges that need to be recognized and addressed including potentially higher coordination costs, lesser expertise in decision making, and fewer confidentiality protections, amongst others. Understanding how to balance these considerations is not easy, but it is essential because many consider DAOs to be important components of a web3 economy and society.

The following paper engages in this critical inquiry. First, we briefly define what a DAO is, and its goals and characteristics. Second, we illustrate the general benefits and costs of decentralization independent of DAOs. Third, we discuss how the technology behind DAOs promises to tip the scale of costs and benefits toward enabling a more decentralized, equal, and democratic organization. Finally, we discuss whether current DAOs are fully decentralized and whether they should be. We argue that recent events enhance our understanding of how DAOs might work best in the future, and why they indicate that DAOs are more likely to reflect differing degrees of decentralization consistent with the costs and benefits varying with context.

1

What are DAOs?

A decentralized autonomous organization, or DAO, is an organization that operates based on rules or protocols that are agreed upon by the participants, are encoded on a blockchain, and are executed through smart contracts.[1] DAOs allow people to pool resources toward a common goal and share in value creation with the promise of less hierarchy and centralization, more transparency and efficiency, and more cohesive communities than current organizations.

DAOs are in theory decentralized because, unlike traditional corporations or limited partnerships that delegate most decision making exclusively to a board of directors or general partner, DAOs are governed collectively by their members, without a central authority. DAOs are also autonomous because their protocols rely on smart contracts stored on a blockchain that automatically runs once certain predetermined conditions are met – to execute agreed-upon decisions. Thus, DAOs, like smart contracts, are transparent, publicly auditable, and do not rely on a single or central authority to function. This arrangement facilitates what is known as a "trustless" system, which is often thought to be essential for the proper functioning of a decentralized, digitally-native community. This leads many to consider DAOs to be important components of a web3 economy and society.

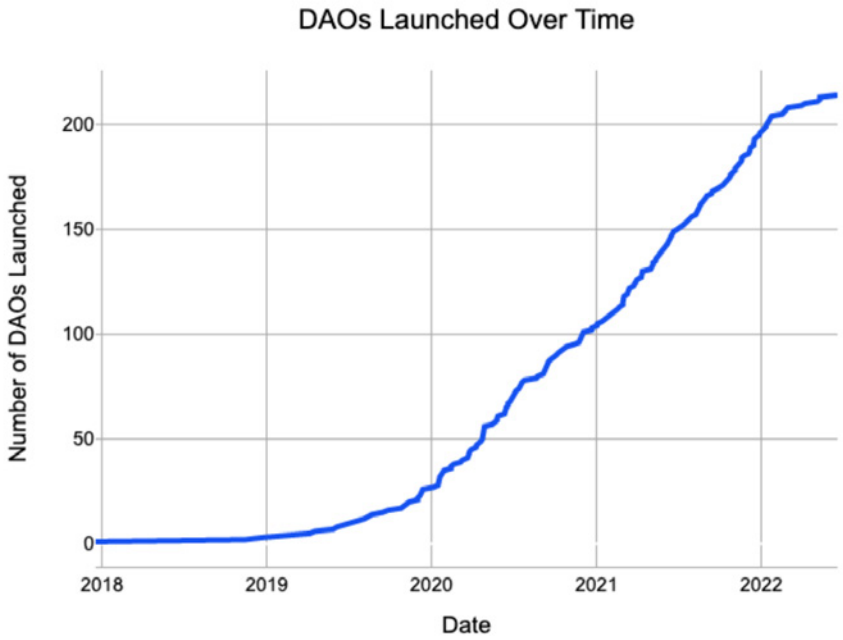
Indeed, we have already witnessed a rapid rise in the popularity of DAOs. As of July 2022, there are over 4,835 DAOs, 217 of which have some traded governance tokens.[2] Figure 1 shows that the number of traded DAOs has been rising rapidly over the last two years.[3]

[1] Linda Xie, A beginner's guide to DAOs https://linda.mirror.xyz/Vh8K4leCGEO06_qSGx-vS5lvgUqhqkCz9ut81WwCP2o; David Shuttleworth, What Is A DAO And How Do They Work? https://consensys.net/blog/blockchain-explained/what-is-a-dao-and-how-do-they-work/.

[2] Data comes from DeepDAO (https://deepdao.io). Analysis by the Coinbase Institute. For replication purposes, the code for all the analysis in the paper can be found at the Coinbase Institute Github page: https://github.com/Coinbase-Institute/DAO-Primer.

[3] We use the date of the first proposal available on DeepDAO as the launch date for each DAO.

Figure 1: Number of DAOs with traded tokens



Although the growth has been impressive, it is important to note that all DAOs are not the same – they vary tremendously along many dimensions including where they are used and how their internal governance is designed. For instance, we can group DAOs into several general categories based on their primary uses, such as Protocol DAOs, Investment and Grant DAOs, Service and Social DAOs, and Media DAOs.

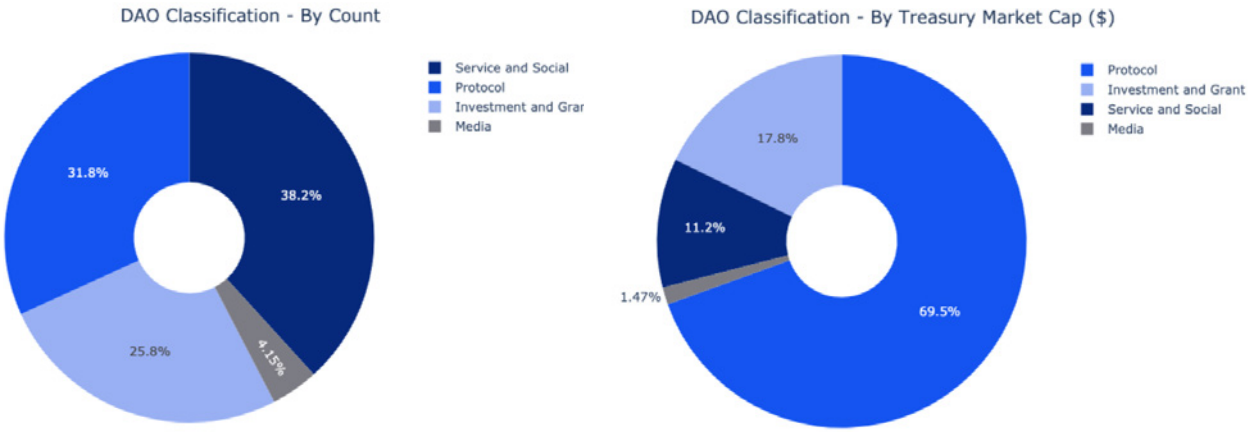
Table 1: Types of Decentralized Autonomous Organizations

DOAs	Definition	Examples
Protocol	Protocol DAOs use tokens as the voting metric for implementing any changes in a protocol. These DAOs are used primarily to bring DeFi services to users.	MakerDAO, generally considered the first protocol DAO and the first DeFi service to achieve widespread adoption, used the DAO structure to launch and steward the DAI stablecoin. Decentralized exchanges SushiSwap and Uniswap, which grant governance tokens to contributors to their liquidity pools, and decentralized borrowing.
Investment and Grant	Investment DAOs issue tokens in exchange for capital to fill the DAO's treasury. Tokenholders use the token to debate, propose, and vote on how to use the capital and then share in the upside. Accordingly, investment DAOs provide a crypto-native investment vehicle that can provide web3 projects with efficient access to funding. Grant DAOs allocate capital philanthropically, without the expectation of financial return.	bitDAO is the largest investment DAO, which invests its over $2.5 billion treasury in a broad range of DeFi projects. Collector DAOs, such as Flamingo and PleasrDAO, which pool capital to acquire NFTs. GitDAO and MolochDAO support grants for critical open source infrastructure that may otherwise have difficulty getting funded.
Service and Social	Service and social DAOs operate like talent agencies for the crypto ecosystem, bringing together strangers from around the world to build digitally-native products and services. Users can issue bounties for tasks in areas such as development, legal, creative, and treasury management. Individual contributors receive the bounty, from which the DAO takes a portion, and governance tokens.	Prominent examples of service DAOs include projects such as Raid Guild and DxDAO. The leading example of a social DAO is Friends With Benefits and its $FWB token. To join, members must submit an application and acquire 75 FWB tokens. Entry comes with access to a community full of prominent crypto builders, artists, and creatives as well as exclusive events.
Media	Media DAOs are decentralized media outlets that, rather than relying on advertising revenue like traditional media, use token incentives to reward producers and consumers for their time spent on the platform. Members then use these tokens to vote on key proposals.	An example of decentralized media is BanklessDAO, an Ethereum-focused media outlet that drives adoption and awareness of decentralized money systems.

Of these categories, service and social DAOs are the most common DAOs with traded tokens, followed by protocol DAOs (see figure 2). However, protocol DAOs are by far the most valuable, when considering the monetary value of their treasuries, which account for nearly 70% of all DAO treasury amounts.[4]

[4]Data from DeepDAO. Classification performed manually by the Coinbase Institute through web searches.

Figure 2: DAO Classification by Count (Left) and by Treasury Market Capitalization (Right)



There is also considerable variation (and experimentation) with DAO governance and voting. For instance, if members want to make any changes to the DAO, they must submit a proposal to the membership for a vote. Whether a proposal is accepted or rejected is determined by the voting mechanism adopted by the DAO in the underlying smart contract. The most straightforward voting mechanism is token-based quorum voting, which requires a certain threshold of votes to approve a proposal (for example, greater than 50 percent). Other voting mechanisms include: quadratic voting, which reflects the relative intensity of voters' preferences; holographic consensus, which grants decision making power to any subset of voters, under certain conditions; and conviction voting, whereby proposals are approved based on the aggregate preference of community members expressed over time. There is no "one-size-fits-all" DAO governance and voting structure, which reflects the complex balance of costs and benefits associated with DAOs.

2

Benefits and Costs of Decentralization

To more deeply appreciate these costs and benefits we begin by examining a critical characteristic of DAOs – their ability to operate in a decentralized manner, without a formal central authority or delegation. This is in contrast to public companies, where shareholders delegate most decisions to a board of directors and an executive team. Indeed, this contrast between decentralized and centralized (or more hierarchical) structures is one that permeates many social, economic, and political institutions. In this section, we examine important pros and cons of a decentralized decision making process, versus a more hierarchical one, in the context of business structures.

There are two main advantages of decentralized decision making. First, it can reduce agency problems. Second, it allows broader engagement with an organization's stakeholders, such as employees and customers, and thus can strengthen the sense of identity and belonging to the organization, and improve information flow.

1. **Agency Problems:** Delegating decisions creates a principal-agent relationship, and the incentives of the agent are almost never perfectly aligned with those of the principal. For example, when we hire a financial advisor to manage our investments, we want the advisor to allocate funds in the way that maximizes our wealth, but the advisor may have incentive to invest in high-fee fee products that earn a lower return. Similarly, agency problems are pervasive in public companies, from negotiations with labor, to CEO compensation, merger decisions, and capital investments. These sorts of problems could be significantly reduced when all owners are directly involved in the decision making process, like in a DAO.

2. **Sense of Belonging and Involvement:** Often a company's shareholders are also consumers of its services and products. They have direct experience with the quality, strengths, and weaknesses of the company's offerings and can provide very helpful feedback. This is usually invaluable for the success of the organization. Furthermore, when customers are also owners, they develop a sense of belonging and identity that spurs loyalty, coordination, and alignment of incentives. This is a common feature for credit unions and cooperatives, and also of DAOs. On the other hand, when organizational structures are centralized, the users are not directly in control of the company, and may not feel as empowered to contribute to the diffusion of information, and to optimal governance.

Decentralized decision making also has important drawbacks: weaker expertise, weaker confidentiality protections and leakage of trade secrets, potentially greater coordination costs, and concerns about how quickly decisions might get made.

1. **Expertise:** Making a decision is not costless; it involves learning about all available options, and carefully weighing the pros and cons of each, which takes time and effort. Decentralized decision making requires members to incur these costs individually. This is highly inefficient, which is why companies centralize the decision making process by hiring managers with significant experience to work full time on making the best decisions for all owners. Relative to a CEO and expert team,decision making by decentralized owners or group members is likely to be less informed and without commensurate understanding of the consequences of their decisions.

Merit Circle DAO recently faced a governance issue with a major investor, Yield Guild Games (YGG). In May 2022, Merit Circle DAO members proposed "refunding" YGG's investment, alleging that YGG was not adding enough value as an investor. But the DAO contract contained no legal mechanism for returning an investment. Instead, DAO members naively voted to terminate the relationship with YGG and buy out the $175,000 investment for $1.75 million (in stablecoins). The lack of expertise and understanding of the legal and reputational consequences of actions like these can cause lasting damage to the reputations of all DAOs, and in the long-run, prevent DAOs from raising capital effectively.

2. **Confidentiality and Trade Secrets:** Many corporate decisions are intended to be confidential, and unknown to current or future competitors. Companies go to great lengths to keep their data and strategic plans private to maintain their competitive advantage. A decentralized decision making process requires the information to be widely accessible (so that all members have access to it in order to make a decision) making it harder to keep information hidden relative to a hierarchical or more centralized organization.

3. **Coordination Costs:** Making an informed decision takes time and effort. If multiple people are involved in a decision making process where everyone benefits equally from the outcome, then each individual has little incentive to become informed, relying on others to figure out the right decisions. This is called the "free rider problem." In equilibrium, there is underprovision of effort, and sub-optimal decision making. For example, in Austin, Texas, a popular attraction is the pub crawler (Fig. 3), where up to 12 people cycle around downtown drinking beer.

Figure 3: Pub crawlers in Austin, TX.

Each one shares the common goal of sightseeing while drinking beer. However, how fast and hard each person pedals is unobservable, so there is an incentive for each rider to pedal as little and drink as much as possible. The end result is that the crawler does not go very far, people are overly drunk and participants do not see much of the city. Coordination toward a common goal across a widely decentralized organization is hard as it is difficult to incentivise each individual when inputs are unobservable. A centralized organization on the other hand, reduces the free-rider problem, as decision making is in the hands of only a few people, who can be held directly accountable.

4. **Acting Quickly:** Organizations sometimes have to make timely decisions. Decentralized organizations have to put proposals up for a vote, and leave time for all governance token holders to learn about the possible course of action and vote. Centralized organizations instead are commonly better able to make rapid decisions, as only a few people need to be involved in the process.

Given the pros (reduction in agency problems and greater empowerment) and cons (expertise, confidentiality, coordination, and speed), a spectrum of decentralization and delegation is possible. In fact, even in the most hierarchical organizations, like public companies where the separation between ownership and control is the largest, shareholders can still influence the strategic decisions, for example, by voting on mergers, managerial compensation, nominating directors, and other shareholder proposals. And decentralized organizations, like DAOs, also have important centralized aspects, including large token-holders and influential core developers.

These tradeoffs have been recognized by members of the DAO community. For example, in October 2022, a majority vote at MakerDAO (the protocol responsible for minting and maintaining the largest decentralized stablecoin DAI) approved a series of proposals that appear to radically alter operations at MakerDAO. One key proposal approved – MIP83 – will create subunits within the MakerDAO community to govern different aspects of MakerDAO's operations. Instead of the having all MakerDAO token holders vote on every proposal, separate "MetaDAOs" will specialize in specific decisions and only the token holders of the specific MetaDAOs (each MetaDAO will get its own specific tokens) will vote on the issues within that MetaDAO's jurisdiction.

Some believe these enhancements will improve productivity for individuals and core units in MakerDAO, which in essence is an argument in favor of more centralization (and expertise) in decision-making. There were a number of other proposals (many related to internal governance) that passed and the entire process has generated a great deal of both positive and negative commentary.[5] Nevertheless, it is clear that the costs and benefits of decentralization are likely to vary with context and perhaps even over time as this example suggests.

[5] Liam J. Kelly, MakerDAO Splits in Two Over Founder's 'Endgame' Proposal, Oct. 28, 20222, Decrypt, https://decrypt.co/113118/makerdao-splits-endgame-proposal.

3

How the Technology Behind DAOs Alters the Benefits and Costs of Decentralization

With an understanding of the costs and benefits of decentralization, it is fair to ask how DAOs offer to change the balance of these considerations. Is the technology behind DAOs enabling organizational structures that were not possible before? Might the technology lower the costs of decentralized governance so that the scales tip toward a less hierarchical, more engaged, and more inclusive economy?

DAOs are intrinsically connected to cryptocurrencies because smart contracts are executed on blockchains like Ethereum or Polkadot. Many of the benefits of cryptocurrencies thus apply naturally to DAOs, such as enhanced trust and transparency over traditional organizational structures, greater flow of value on-chain, and potentially more cohesive communities through information sharing. Moreover, the underlying technology can also alter the costs and benefits of decentralization.

- **Further Reductions in Agency Costs:** DAOs may facilitate a reduction in agency costs by reducing the scope of agent discretion. First, more actions are automated and require less agent discretion to execute. Second, greater transparency may facilitate better monitoring of behavior, which theoretically decreases the likelihood of core contributors or majority token holders engaging in fraudulent activity. Finally, DAOs may also enable simpler ways to block some problematic behavior. For instance, DAOs could include restrictions on what core contributors may do or on what majority token holders may do, so that they do not take advantage of other token holders. In this way, the boundaries of agency relationships within the DAO can be hardwired into the code of the DAO itself, prohibiting violations from occurring in the first place, which could significantly limit agency costs. Of course, current companies could write such limitations into their charter or bylaws, but enforcement of them requires going to court or to a proxy battle, whereas in DAOs enforcement is easier in that it relies on smart contracts to implement the restrictions.

- **Enhancing Compliance:** The smart contracts underlying DAOs can often easily comply with regulatory strategies by incorporating their prescriptive regulatory requirements, and are a potential advantage of the DAO structure.

- **Enhancing Rapid Implementation:** Although decentralized decision making implies greater need for coordination (and hence less speed) in coming to a decision, once that decision is made the smart contracts in DAOs can enable much more rapid implementation of the decision. For example, ConstitutionDAO pooled and deployed nearly $47 million in five days to bid on an early copy of the U.S. Constitution. A similar grass-roots effort would have taken months to organize. Here the technology behind DAOs reversed one of the cons of decentralization (slower speed) by enabling more rapid implementation.

While DAOs have important technological advantages, they also have significant limitations that need to be considered and potentially addressed.

- **Incomplete Contracting:** Any contract, smart or traditional, cannot ex-ante encompass how to respond to all possible future situations, and sometimes it is optimal to renegotiate ex-post. In traditional finance, renegotiations occur on a daily basis. In decentralized finance, ex-post renegotiations are generally not allowed and raise difficult questions. For example, in June 2022, Solend, a borrowing and lending platform on the Solana chain, noticed that a single liquidity provider had borrowed a very sizable amount of stablecoins, posting SOL as collateral. Solend developers were concerned that as the collateral value dropped, a sudden liquidation of such a large position could make the pool undercollateralized, destroying value for all liquidity providers. The developers, after unsuccessfully trying to get in touch with the investor, submitted and passed a proposal to unwind the position to limit the risk. While the concern was reasonable, it attracted a lot of attention in the crypto community, because it was seen as an attempt to rewrite the code, and the proposal was later reversed. The event highlights the fact that smart contracts bring a lot of efficiency by automatically executing transactions, but on the other hand they are inflexible tools when unforeseen events occur. As the sector matures and learns about the possible outcomes,, we will expect smart contracts to be more comprehensive and thus with less need for renegotiation.

- **Code Errors:** Although smart contracts are immutable, errors in the code can be identified and exploited. The most infamous example of this is The DAO Attack. The DAO, launched in 2016, was a venture-style DAO that crowdfunded $150 million worth of ETH in about three weeks. Shortly after the fundraise, an attacker identified a vulnerability in the code and siphoned $60 million from The DAO. Though the funds were eventually restored to investors, The DAO example shows that developers cannot guarantee the security of DAOs.

- Legal Uncertainty: DAOs operate in a highly uncertain legal environment. Fundamentally, DAOs are not recognized as legal entities. Through legal registration, corporations and LLCs can limit their members' personal liability, but DAOs generally lack the ability to provide that protection. A few states allow DAOs to register as a special form of limited liability company, and some DAOs already register under legacy LLC statutes, but it is unclear how these statutes will apply in practice. In addition, because DAOs are not legal entities, it is unclear how tax laws apply to DAOs and their members. This uncertainty could lead to significant tax liabilities for members. Furthermore, DAOs that issue tokens could risk violating securities regulations, which may apply to such offerings. President

Biden's recent Executive Order on digital assets may address some of these issues, but in the meantime, the legal uncertainty surrounding DAOs could discourage their use, hamper innovation, and limit their efficacy. For example, SushiSwap appeared to respond to these types of concerns when it restructured in late October 2022 – it will now be organized as three separate entities going forward (one Cayman Island based and two Panama based).[6] This came hot on the heels of the Ooki DAO settlement with the CFTC, which seemed to underscore the liability risks faced by DAO members when the DAO in not incorporated.

[6] Parikshit Mishra, Crypto Exchange SushiSwap Approves Restructuring, Will Create 3 Firms for DAO, CoinDesk, Oct. 26, 2022, https://www.coindesk.com/business/2022/10/26/crypto-exchange-sushiswap-approves-restructuring-will-create-three-firms-for-dao/.

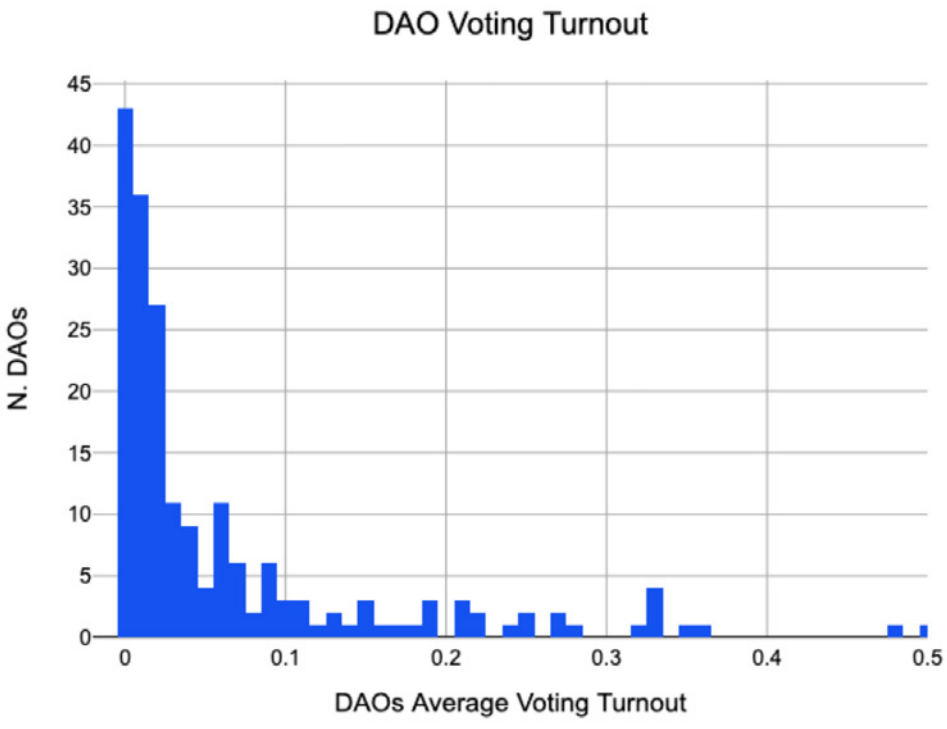
4

How Decentralized are DAOs Really? And Should They Be?

DAOs can alter the benefits and costs of decentralization compared to traditional organizational structures. But that doesn't mean that all DAOs should be fully decentralized. Because the benefits and costs are likely to vary across context we might expect to see differing degrees of decentralization across DAOs. Furthermore, the technology underpinning DAOs can also be used by centralized entities, to make them more efficient, without decentralization. In this section, we explore whether DAOs are truly fully decentralized and whether DAOs should be more decentralized.

Some complain that DAOs currently are not truly fully decentralized. This is true. Most DAOs are for the most part effectively controlled by large token holders, or core developers, or influential individuals in the organization. Indeed, figure 4 highlights that very few of the token holders vote for proposals, the key governance mechanism of DAOs.

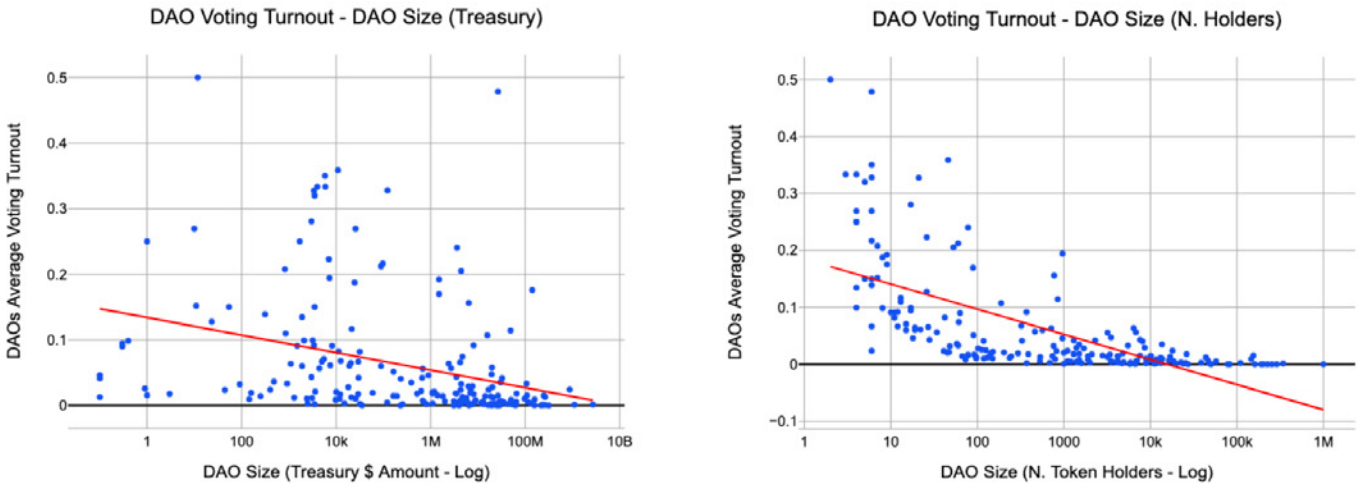
Figure 4: DAO Voting Turnout



The average participation in a governance proposal is only 6.5%.[7] Almost 50 percent of DAOs have an average voting turnout of less than 2%. Furthermore, as a DAO gets bigger, the free-rider problem worsens, and thus people are less likely to participate. In fact, there is an inverse relationship between voting turnout and DAO size, proxied by the size of the DAO's treasury and by the number of token holders. DAOs with large communities of token holders experience very low levels of engagement in the voting process. In the scatter plot below, each blue dot is a DAO, and we plot the relationship between voting turnout and DAO size.

[7]We collected data from DeepDAO.io, and selected only DAOs with positive treasury amounts. That resulted in 217 DAOs. For each DAO, we then defined Voting Turnout as the overall number of votes across all proposals, divided by the number of token holders * number of proposals.

Figure 5: Relationship between Voting Turnout and DAO size, proxied by Treasury $ Amount (Left) and N. of Token Holders (Right)



The voting pattern of DAOs is in stark contrast with shareholders' proxy votes in public corporations, where 80% of the entire shareholder base votes. The high voting participation for public companies' proposals is in part due to the fact that many institutional investors, who hold about three quarters of shares, have a fiduciary duty to vote. But even among retail investors, who have discretion on whether to vote or not, over 32% of them vote.[8]

[8]https://corpgov.law.harvard.edu/2019/11/19/retail-shareholder-participation/

Low voting turnout in DAOs is not surprising; carefully considering each proposal requires a lot of time and effort and many DAO members may not have the time or background to fully appreciate the underlying smart contracts. The very low voting participation of DAOs is evidence that weak expertise and challenging coordination are severe costs of decentralized organizations. But that does open a question on why voter participation in DAOs is so much lower than for retail shareholders in publicly traded U.S. companies. Furthermore, DAOs present issues of efficiency and representativeness. For instance, the majority voting process used by most DAOs raises the question of protections for minority members. These protections are readily available in partnerships and corporations, but are as of now largely absent in DAOs. Low voting participation increases the risk that a small number of members can extract value from the organization. For example, in May 2021, Harvard Law Blockchain & FinTech Initiative, a student-run organization, submitted a Consensus-Check proposal on the UniSwap DAO to use the UNI treasury to finance a $20m DeFi Educational Fund, managed by the club, with little transparency on the use of the funds. The organization was also in control of a large block of UNI tokens, and their votes on the proposal accounted for 99% of the votes. The proposal was then revised to include more supervision after a large community and media uprising, accusing the organization of conflict of interest. At the end, the proposal passed with fewer than 8% of votes cast, with crucial support from student organizations.

However, just because DAOs are not fully decentralized does not mean that they are betraying their core principles. As explained above, even decentralized organizations like DAOs have to weigh the benefits and costs of a decentralized decision making process. Public companies sometimes delegate too much power to their CEOs, and pay heavy costs in terms of empire-building, short-termism, and tunneling. Likewise, DAOs incur similar costs when they choose structures that are too decentralized.

Indeed, some might argue that if traditional companies found it valuable to be more open, engaged with communities, and transparent, they would do so, because it would be in their best interest. This is true, but they are not built this way, and it would probably be costly for them to adapt. In other words, companies likely choose the optimal organizational structure given the technology that they have. Traditional companies are built to function in a non-digitally-native world, and thus organize in a way that is more centralized and hierarchical. DAOs instead use blockchain technology to enhance trust, enable greater transparency, allow flow of value on chain, and build more cohesive communities through information sharing. These technology-enabled features may lower agency and other costs and offer to tip the scale toward enabling a more decentralized, equal, and democratic organization. However, the exact balance of costs will vary with context which suggests that we should expect to see differing degrees of decentralization in DAOs – more of a spectrum of approaches rather than one-size-fits-all.

The analysis thus demonstrates that, while a decentralized decision making process has clear advantages in terms of reduced agency problems and increased user participation, it also has important disadvantages that DAOs have to carefully consider. DAOs do not need to be fully decentralized: it ultimately depends on how the technology behind the DAO alters the tradeoff between costs and benefits in specific contexts. A hybrid structure where some decisions are taken as a group, and other decisions are delegated to representative agents, could often achieve better outcomes. Indeed, DAOs are currently not as decentralized as we might think. Given current technology and experience, this is a feature, not a bug.