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Who to regulate? Identifying actors within DeFi's governance

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Abstract

Decentralised Finance (DeFi) emerged in 2021 as a fast-growing crypto segment, attracting policymakers' attention due to its innovative approach of delivering financial services without relying on centralised intermediaries. This paper assesses DeFi governance arrangements for regulating and supervising DeFi using a comprehensive dataset. We find that governance token holders of four protocols (Aave, MakerDAO, Ampleforth, Uniswap) are highly concentrated with around half or more holdings linked to the protocols themselves or exchanges. Top voters are mostly delegates, who, in many cases, could not be identified nor linked to token holders. The study offers insights for policymakers regarding the implementation of policy measures aimed at bringing relevant entities under the regulatory umbrella. The difficulty in identifying holders and voters using public data may make it hard to rely on some of the regulatory anchor points often put forward in the policy debate such as governance token holders, developers or centralised exchanges.

JEL codes: G18, G23, G28, O33

Keywords: Decentralised finance, governance, financial stability risks, regulation

Non-technical summary

Decentralised Finance (DeFi) emerged as a fast-growing segment in the crypto-asset universe in 2021. Due to its innovative approach of delivering financial services without relying on centralised intermediaries, it quickly captured the attention of policy makers. For many DeFi projects, governance is structured in the form of a decentralised autonomous organisation (DAO). DAOs are designed to operate through governance tokens, which grant holders voting rights to participate in key decisions regarding protocol upgrades, fee structures, and overall strategy.

This working paper investigates whether DAOs, as a governance mechanism, achieve meaningful decentralisation or whether power remains concentrated among a limited number of participants. In particular, the paper investigates the degree of centralisation of holders of governance tokens as well as voters on governance proposals in DeFi protocols and sheds light on voting behaviour in DeFi. It also studies the implications of DeFi's governance arrangements for the regulation and supervision of DeFi to inform the policy discussion on possible regulatory anchor points.

The findings challenge the perception that DAOs are inherently decentralized and raise important questions about their governance structure and implications for the broader DeFi ecosystem. First, the results reveal that governance token holdings are concentrated. While these tokens are technically distributed across a large number of unique blockchain addresses, a small number of entities holds a majority of the supply. These dominant holders can be attributed to either the protocols themselves or to centralised and decentralised crypto exchanges. The holdings associated with the protocols themselves could belong to the founders and developers or the protocol treasury. However, with the available data, it is not possible to further pin down these holdings.

Second, our analysis of the top voters shows that they are mostly delegates, indicating that smaller token holders delegate their voting power to others, often amplifying the influence of already large token holders. The study finds that the identities of top voters – those who participate most actively in governance – are often obscured due to the pseudonymous nature of blockchain addresses. This lack of transparency complicates efforts to assess accountability and reinforces concerns about the concentration of power. In addition, we observe that the concentration of governance power remains stable over time.

Overall, our study offers valuable insights for policymakers to implement policy measures aiming at bringing relevant entities under the regulatory umbrella. The results have implications for the discussion on regulatory anchor points.

1 Introduction

When Decentralised Finance (DeFi) emerged as a fast-growing segment in the crypto-asset universe in 2021, it quickly captured the attention of policy makers due to its innovative approach of delivering financial services without relying on centralised intermediaries. However, it soon became apparent that the vulnerabilities, though at times manifesting differently, are not so different from those in the traditional financial system. At the same time, the novel technology may create additional vulnerabilities (see for example Financial Stability Board, 2023). The policy community has since made good progress in developing frameworks to regulate crypto-asset activities with the FSB framework published in July 2023 and the implementation of the Markets in Crypto-assets (MiCA) regulation in the EU since 2024.¹ However, applying these rules to DeFi poses challenges for policymakers. Traditional regulatory frameworks typically rely on centralised intermediaries who are subject to regulations and can be held accountable. Conversely, DeFi's purported decentralised governance, and its opaque structure and pseudonymous nature make it challenging to effectively regulate and supervise DeFi protocols.² Often, it remains unclear who is ultimately responsible to address issues of a protocol and whether any issues can be addressed in a timely fashion. This includes cases when the technology is impaired due to smart contract errors or bugs.

Against this background, this paper explores the implications of DeFi's governance arrangements for regulating and supervising DeFi with the goal of informing policy discussion on possible regulatory anchor points. We do so by assessing the degree of centralisation of holders of governance tokens as well as voters on governance proposals in DeFi protocols and shed light on voting behaviour in DeFi. More specifically, we analyse the distribution of holders of governance tokens as well as voters on governance proposals for four DeFi protocols (Aave, MakerDAO, Ampleforth and Uniswap) to identify the largest actors. We then go one step further than what has been done in the literature so far by not only documenting the distribution, but also specifically identifying the largest actors. In this process we also systematically analyse and classify governance proposals into different categories to better understand what the governance token holders can vote on and how they shape the protocols.

In a first step, we compile our data set on governance token holders, voters and delegates³, and governance proposals by relying on different techniques such as web scraping, manual data gathering, and accessing public sources. Building our sample required considerable manual effort to link and verify observations across the different data sources, in particular to uncover the identities of the involved stakeholders. This included manually tracing pseudonyms or Ethereum

¹ [Regulation \(EU\) 2023/1114](#) of the European Parliament and of the Council of 31 May 2023 on markets in crypto-assets.

² See for example the discussions in OECD (2022) and IOSCO (2023).

³ Governance token holders can instead of voting themselves delegate their vote to so-called delegates which will vote on their behalf. How this works depends on the specific rules of the protocol and is further explained in Box 3.

names/addresses through web searches, given that data-related barriers in DeFi are particularly high due to the pseudonymous nature of these activities. We collect this data for two time periods, November 2022 and May 2023. This allows us to not only trace holding and voting behaviour for a specific point in time but also to assess whether the general holding and voting distributions are stable over time.

In a second step, we use our hand-collected dataset to analyse the distribution of governance token holders and voting patterns as well as to provide an overview on governance proposals. Our findings on the distribution of governance tokens align with previous research which highlight that governance in DeFi is concentrated (see for example, Aramonte et al, 2021; Nadler and Schär, 2020 or Jensen, von Wachter, and Ross, 2021). This is an important factor because it implies that a small group of token holders could exert substantial influence or even alter the protocol by strategically capitalizing their voting power. More specifically, our analysis reveals that governance token holdings are not only highly concentrated but also remain relatively stable over time. While the governance tokens are held by a five or six digit number of unique addresses, the top 100 holders account for over 80 percent of all token holdings for the four protocols.

Assessing who is behind these governance token holders, we find that for some of the protocols we study, the majority (or slightly below half of all holdings) can be attributed to either the protocols themselves or to centralised and decentralised crypto exchanges. The holdings associated with the protocols themselves could belong to different groups, for example the protocol's founders, developers, or its treasury. However, with the available data, it is not possible to further pin down these holdings. The implications for the governance of the protocol and regulatory anchor points may nevertheless differ depending on whether governance tokens are held by the developers or by the treasury. Another large share of the holdings can be attributed to centralised and decentralised crypto exchanges with shares ranging from 3 percent for Uniswap to 22 percent for Aave in October 2022. Among centralised trading platforms, the largest share of governance tokens is held by Binance. These findings must be interpreted keeping in mind that the data used does not allow us to distinguish between the amount of tokens held by the centralised exchanges themselves and those that they hold on behalf of their customers.

The systematic categorisation we apply to our sample of governance proposals shows that the most relevant category in terms of number of proposals is the category "risk parameter", covering a range of topics relevant for shaping the risk profile of the protocol.

Analysing the top voters, we find that interestingly these top voters are mostly delegates. We explore several sources to trace their identities and associations which involved large manual effort. This exercise revealed the difficulty in discovering the identities of these delegates as some remain fully anonymous or pseudonymous without any hint concerning their identity. Specifically, we are not able to identify around one third of the top voters in our sample. The dominant group of those voters we can identify are individuals, followed by Web3 companies. Other prominent categories include university students' blockchain societies and venture capital firms.

Overall, our study offers valuable insights for policymakers to implement policy measures aiming at bringing relevant entities under the regulatory umbrella. In the debate around regulatory anchor points often governance token holders, developers or centralised exchanges have been put forward as entry points. However, as our results show, whether these are the relevant entry points may depend on the individual DeFi protocol and may require additional information not publicly available so far. Specifically, our results show that it is not always clear who in the end is responsible or can be held accountable based on publicly available data.

Our paper contributes to the growing literature on DeFi in three ways. First, we add to the literature that specifically looks at the level of decentralisation in DeFi structures, where an increasing number of studies corroborates the presence of centralisation in DeFi governance. We contribute to this line of research by analysing the governance systems of decentralised autonomous organisations (DAOs) across four key protocols, which account for a significant share of DeFi activity and were among the most relevant in terms of total value locked (TVL) at the time of data collection. In particular, our study expands on previous work by assessing whether top voters delegate their voting power, mapping the type of proposals, and analysing their impact on the voting distribution, with particular attention to the identities behind voters. More specifically, Nadler and Schär (2020) extensively study holder distribution and ownership concentration across a large number of DeFi tokens⁴ and find that the majority of the tokens are held by a few individuals. We add to their work by not only shedding light on the distribution and concentration of governance token holders, but by also looking at the entire governance process and voting behaviour. Similarly, Sun et al. (2024) provide evidence for the existence of centralized voting power in the MakerDAO protocol. They establish several measures of centralized voting which show that voters are centralized in a small group of members, and the largest voters contribute a significant portion of votes to the winning options. We complement their work, going one step further by trying to identify voters and delegates. Fritsch et al. (2024) document comparable results for Compound and Uniswap. Jensen et al. (2021), who measure the statistical dispersion of the governance token distribution of Balancer, Compound, Uniswap, and Yearn Finance, show that the token distribution for all four protocols is relatively concentrated and that the initial token allocation may impact the concentration of voting power in the medium-term. Barbereau et al. (2023) claim that token distribution strategies in DeFi protocols, including Uniswap, Aave and MakerDAO, fail to achieve meaningful decentralisation. This failure results in a form of minority rule where a few large token holders, or "whales," exert substantial influence over governance decisions and even less of those whales actively vote.

Another strand of literature provides evidence on the level of decentralisation by taking a more conceptual approach. For instance, Sims (2024) highlights that the spectrum of decentralisation for DAOs ranges between partially decentralized and Decentralized In Name Only (DINO). Aramonte et al. (2021) argue that all DeFi platforms have an element of centralisation which typically revolves around

⁴ They analyse a total of 18 DeFi tokens, but the only token overlapping with our analysis is MKR the governance token for Maker DAO. However, we study a different time period and as indicated provide a more holistic view of the governance system.

governance frameworks and the tendency of blockchain consensus mechanisms to concentrate power. This is also confirmed by Allen (2022) who shows that the DeFi ecosystem comprises a large number of intermediaries contesting the idea of perfect disintermediation of financial services. Ferreira and Li (2024) show that the optimal governance structure of an autonomous organization is centralized which is also supported by Bena and Zhang (2023) who illustrate the complexities involved in designing an effective decentralized governance scheme given the multitude of influencing factors.

Second, we contribute to the literature on regulatory anchor points by offering new insights on the traceability of voters' and delegates' identities. Previous work – often taking conceptual and interdisciplinary methodological approaches – shows how regulatory hooks could be established based on the DeFi architecture. For instance, by providing an overview of possible “centralisation vectors”, Schuler et al. (2024) propose relevant regulatory instruments taking a legal and technological point of view. Turillazzi et al. (2023) offer a framework for possible policy and regulatory approaches by systematically categorising existing work considering approaches that span, for example, operational, economic, legal aspects or emergent aspects.⁵

Third, we contribute to the literature describing DeFi governance and DeFi voting behavior and discussing similarities and differences of DeFi with traditional finance. More specifically, we extend and complement the work of Fritsch et al. (2024) who point to the existence of similarities between DeFi governance systems and shareholder meetings, where only a small number of large investors manage to effectively represent their interests in the decision making process. We extend this work by focusing on voting power of delegates and their role in overturning votes in addition to tracing the identities of delegates. Similarly, Aquilina et al. (2024) demonstrate that the risks to intermediation in decentralized finance (DeFi) closely resemble those in traditional finance, as many of the underlying functions are comparable. As a result, Aquilina et al. (2024) propose that the regulatory frameworks governing services in DeFi could largely be adapted in a manner similar to those applied in traditional finance. We contribute to this line of research by comparing the governance structure and decision-making process of prominent DAOs with publicly listed companies and by systemically looking at governance proposals.

The rest of the paper is organised as follows. In section 2, we describe the key governance features of DeFi protocols, with a particular focus on DAOs, the main risks that are associated with these governance features and give an overview of the current debate of its regulatory coverage. Section 3 describes our main methodology and data used, while also showing summary statistics. In section 4 we present our main results, while discussing the implications of our results in Section 5. Finally, section 6 concludes.

⁵ For example, Turillazzi et al. (2023)'s overview suggests that “specialised regulatory and government units “consisting of qualified experts could be established (operational perspective), that “tokens can be designated as securities by regulatory authorities” (economic perspective), that regulatory sandboxes could be established (legal perspective) or that “regulatory requirements can be technically embedded into the authorization process and design of DeFi systems” (emergent perspective).

2 Governance and associated risks in the DeFi ecosystem

This section provides an overview of the key governance features of DeFi protocols, with a particular focus on decentralised autonomous organisations (DAOs). It examines the vulnerabilities stemming from the specific governance structures of DeFi protocols and provides an overview of the ongoing debate on whether and how DeFi and DAOs are covered in legislation.

2.1 Key governance features of DeFi protocols and DAOs

Governance refers to the process through which changes are introduced to a protocol's features, parameters or rules. DeFi employs novel governance arrangements that proponents claim to be decentralised, thereby addressing the principal-agent problem outlined by Meckling and Jensen (1976). By eliminating the need to place trust in any specific actor or institution, these mechanisms aim to foster a trustless environment and mitigate agency-related inefficiencies.

Governance structures of DeFi protocols come in various forms. For many DeFi projects, governance is structured in the form of a decentralised autonomous organisation (DAO), although other structures, such as multi-signature wallets, are also used.⁶ Our main focus will be on DAOs as these constitute the majority of DeFi protocols. This is evident when comparing the market capitalisation of the most prominent governance tokens – crypto assets required for DAO membership – with the overall total value locked (TVL)⁷ in DeFi protocols (see Chart 1).

DAOs are a blockchain-based system that enables decentralized decision-making and community-driven governance through rules encoded as programs, known as smart contracts (Naudts, 2023). These smart contracts are programmed to execute if and when predetermined criteria, decided by the DAO stakeholders, are met. The vision of a DAO is to create decentralized organisations that lack a central authority or control and that are run in the interest of and governed by its members. In other words, DAOs aim at creating organizations that are decentralized, autonomous, and transparent while spurring innovation and collaboration among their members (Wright, 2021). Interestingly, while DAOs are designed to promote transparency and decentralized decision-making, they are not immune to challenges such as asymmetric information, where certain members may have access to more or better information than others. This phenomenon, which is also observed in traditional

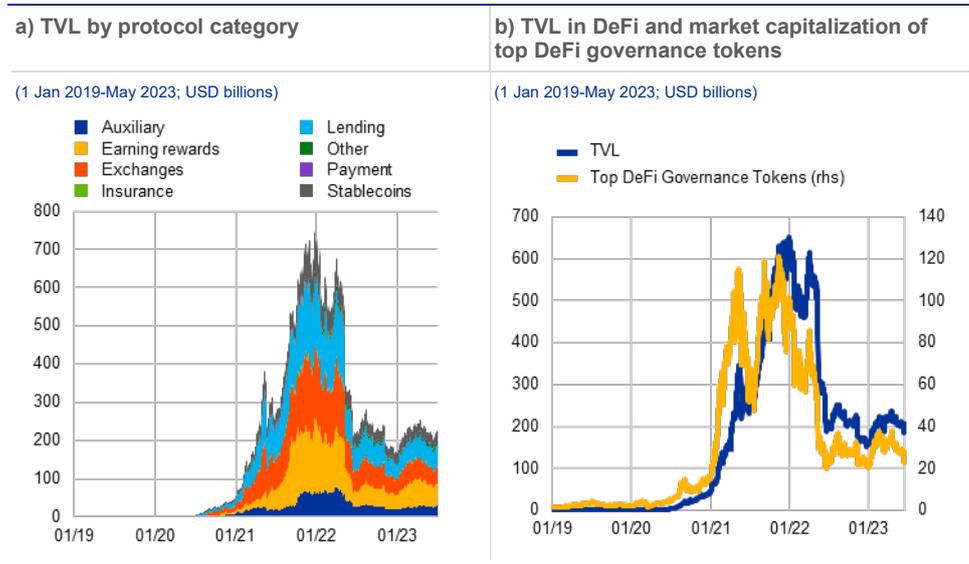
⁶ A multi-signature wallet is a crypto-asset wallet that requires multiple private key signatures to validate and execute each transaction. Protocols like Gnosis Safe use multi-signature wallets to store tokens and manage protocol upgrades, requiring a defined threshold of signers to authorize any changes or transactions.

⁷ TVL is an industry-reported measure of the total value of assets deposited in a DeFi protocol (Financial Stability Board, 2023).

companies, has been explored by Allen et al. (2024), who highlight the implications of such information imbalances within DAO governance structures.

Chart 1

Crypto-assets deposited in DeFi protocols (TVL) and the market capitalisation of the top DeFi governance tokens



Sources: a) Defi Llama, b) Defi Llama, Coingecko CoinMarketCap and ECB calculations.
 Notes: Panel a: TVL in all of DeFi. TVL represents the sum of all assets deposited in DeFi protocols earning rewards, interest, new coins and tokens, fixed income, etc. The categories include (i) Assets, including derivatives, synthetics, options, indices, algorithmic stablecoins, and protocols that mint their own stablecoins or launch new projects and coins; (ii) Auxiliary, protocols that allow users to bet on future results, that bridge tokens from one network to another or allow for the interoperability among different blockchains, and that support DeFi services (incl. gaming and NFT mining); (iii) Credit, protocols that allow users to borrow and lend assets and that pay a reward for the liquidity provision or aggregate yield from various protocols, as well as protocols that use reserves of assets to issue and back their native tokens; (iv) Insurance, protocols that offer coverage against losses caused by events typically in the DeFi ecosystem, such as hacking, malfunctioning of exchanges or smart contracts; (v) Payments, protocols that allow users to pay/send/receive crypto-assets; (vi) Staking, protocols that reward for staked assets with crypto-assets; and (vii) Trading, protocols that allow users to swap and trade crypto-assets. Note that TVL might be overestimated due to token re-usage. The protocols examined in this study represent the leading protocols across the various categories shown in the chart. Panel b: DeFi governance tokens include the ten largest DeFi governance tokens by market capitalisation as of mid-June 2024 according to CoinMarketCap: Avalanche, Chainlink, Uniswap, Internet Computer, Stacks, Maker, The Graph, Injective, Lido DAO, Theta Network.

DAOs, regarded by organizations like the World Economic Forum as a new business model suited for the digital era (World Economic Forum, 2022), have gained popularity in recent years, expanding beyond DeFi. There are different types of DAOs with different objectives. Examples of DAOs include Protocol DAOs, which operate the majority of DeFi protocols and are the main focus of this paper. Other DAOs focus on Grant, Philanthropy, Social, Venture, Media, to name a few (see Naudts, 2023 and Alchemy, 2022 for a full typology). Some of the largest DAOs by treasury are Protocol DAOs, for example those governing DeFi protocols like Uniswap, Aave and Maker. As of May 2023, the total assets available to DAOs within their treasuries stood at around \$21.5 billion, while there were about 2.2 million active voters and proposal makers participating.⁸

To become a member of a DAO, users need to have governance tokens, which are crypto-assets that grant voting rights on proposals shaping the functions and specific elements of the DAO and the DeFi protocol it governs. The voting power is proportional to the amount of governance tokens held, depending on the exact

⁸ This is based on data from DeepDAO from 2023.

structure of the DAO and the related DeFi protocol. This system of governance, however, often reflects a timocratic structure, where power is concentrated in the hands of those with greater token holdings, as highlighted by Barbereau et al. (2023) and described in our subsequent analysis. In addition to enabling participation in the governance process, governance tokens can also be used to earn rewards by securing the functioning of the protocol. For example, Aave governance token holders can stake their governance tokens in a “Safety Module”, providing liquidity in case of a security breach or liquidity squeeze, and earn rewards called “Safety Incentives”.⁹ More details on the supply of governance tokens, their distribution, and how the issuance mechanisms can have a direct impact on the effectiveness and fairness of governance in each protocol are highlighted in Box 1.

The extent to which members of DAOs or governance token holders can influence how the DAO or the DeFi protocol operates depends on the specific governance framework. In some cases, the governance framework restricts who can propose changes to certain aspects of the DeFi protocol. For example, Uniswap’s governance framework limits the ability to make proposals to those who have a sufficient number of Uniswap governance tokens (UNI) delegated to them. Specifically, at least 1% of the total UNI supply must be delegated to an address to submit a proposal. Meanwhile, any UNI token holder can participate in voting on proposals. This system aims to ensure that only well-supported proposals are brought forward, while still allowing broad participation in the voting process from the entire community of UNI holders.¹⁰ In other cases, entities such as the initial core team of developers or the venture capital investors retain veto rights over the voting process on proposals. While explicit veto powers are not typically advertised, many DeFi protocols include mechanisms that enable core teams to intervene in governance proposals, particularly to protect the protocol from malicious activities or to retain some level of control over the functioning of the protocol. For example, Aave enables, under certain circumstances, the Aave team or entities closely associated with the protocol to exercise significant influence over decisions, especially in critical situations.¹¹

As DeFi protocols mature they often move towards decentralisation, but in practice, such a decentralisation trend tends to be more of an ambition or claim than a fully realized reality. The transition is typically gradual, with core teams maintaining some degree of influence, especially during the early stages of a protocol’s development (see Truchet, 2022). For example, Aave started as ETHlend, a relatively centralized lending platform. Over time, it rebranded to Aave and introduced its governance token, AAVE. This token allowed the community to participate in the governance, decide on protocol upgrades, risk parameters, and more. The shift to more decentralized governance helped distribute control and align the protocol more closely with DeFi principles.¹² However, as previously indicated several studies contest the idea of full or even partial decentralisation (see, for example, Nadler and

⁹ For further information see: <https://app.aave.com/safety-module/>

¹⁰ See Uniswap’s [Beginners' Guide to Voting](#).

¹¹ See Aave’s [Documentation](#).

¹² Further information on Aave can be found for example on Coindesk: [Aave: Understanding the Crypto Lending Platform](#).

Schär, 2020; Sun et al., 2024; Barbereau et al., 2023; Fritsch et al., 2024) suggesting that some exhibit characteristics of "fake DeFi," where centralisation remains hidden behind a facade of decentralisation (see, for example, Anker-Sørensen and Zetsche, 2021).

Generally, DAO proposals can cover a wide range of topics and initiatives, from governance to technical aspects, such as changes to membership requirements or protocol security measures, and from fundraising to investment initiatives, including the launch of new products or the acquisition of new tokens. To better understand the governance process of DAOs, this paper systematically categorizes the governance proposals for the four DeFi protocols studied (see section 4.2).

Box 1

Issuance and supply control of selected DAOs governance tokens

Governance tokens are distributed to stakeholders, granting them voting rights that allow them to influence the protocol's decisions.¹³

Initial Allocation of Governance Tokens, Issuance and Control Over New Supply

Each DeFi protocol distributes governance tokens in different ways, often determined by the protocol's specific goals for decentralisation, incentives, and stakeholder participation. Protocols manage the issuance of governance tokens differently, depending on whether their supply is fixed or flexible. Fixed-supply tokens, like UNI and AAVE can incentivize participation in governance since the tokens can potentially increase in value over time if the protocol succeeds and there is demand for the governance token – and the protocol's services more generally. Flexible-supply tokens, like FORTH and, to a lesser extent, MKR (due to the minting mechanism), allow token holders to control the expansion of the token supply, which can be used to fund development or incentivize participation in case the governance tokens have a value attached to it in the market.

Aave: The AAVE token has a fixed total supply of 16 million tokens, of which 13 million tokens were allocated to holders of the LEND token (Aave's predecessor token) during a migration in 2020, and the remaining 3 million allocated to Aave's treasury. This treasury use is governed by the community, which can vote on its usage for protocol improvements, liquidity mining, or other incentives. With a fixed supply, AAVE tokens could increase in value if there is demand for these governance tokens – for example because the protocol grows in popularity and usage.

Ampleforth: Ampleforth governs its protocol through the FORTH token, which has a protocol-enforced maximum annual inflation rate of 2%. The DAO controls new emissions of the FORTH token by governance votes, giving token holders control over the supply of new FORTH tokens each year. The protocol's token holders can decide to mint up to this amount each year or forgo the minting altogether. The proceeds from minting new FORTH tokens can be used as decided by the DAO.

¹³ Information of Box is based on (1) [Aave governance forum](#), (2) [Ampleforth technical documentation](#), (3) [MakerDao technical documentation](#), (4) [Uniswap blogs](#).

MakerDAO: The total supply of MKR tokens fluctuates due to its Burn-and-Mint policy. MKR is burned (decreasing supply) when stability fees¹⁴ are paid by users of the Maker protocol. These stability fees are collected in DAI and are used to purchase MKR from the market and burn them, which reduces the total supply of MKR. Taken demand as given this would benefit existing token holders increasing the price of their holdings. MKR can also be minted (increasing supply) if the protocol needs to cover losses, such as in the event of an undercollateralized vault. This would dilute existing holders but ensure that the protocol remains solvent. This dual nature aligns the interests of MKR holders with the long-term health of the protocol. The Burn-and-Mint policy provides a mechanism for token redistribution over time, as new MKR can be issued to new holders if required by the protocol.

Uniswap: The total supply of UNI tokens is capped at 1 billion tokens which were issued on September 16th, 2020. Upon its launch, 15% of the tokens were distributed to the Uniswap community via airdrops, while 40% were allocated to team members, investors, and advisors, and 45% of the total supply locked in the community treasury to be governed by UNI holders. This large allocation to the community treasury incentivizes ongoing governance participation, as token holders vote on how to deploy these funds for development and strategic partnerships.

Impact on Governance

The supply of governance tokens, their distribution, and the issuance mechanisms have a direct impact on the effectiveness and decentralisation of the governance in each protocol.

Incentives for Participation: Protocols with flexible governance tokens like Ampleforth can use token issuance as a way to incentivize continued participation. Fixed-supply tokens like AAVE and UNI rely on governance incentives tied to treasury allocations, which can motivate token holders to engage in governance.

Voting Power and Centralisation: The concentration of governance tokens in a few hands can diminish the decentralisation goal of DeFi protocols. For instance, Uniswap's large upfront allocation to insiders raised concerns about the centralisation of power. Some protocols offer delegation mechanisms, where smaller token holders can delegate their voting power to trusted parties, helping to reduce the risks of inactive governance while at the same time carrying the risk of further concentrating voting power.

2.2 DeFi governance benefits and vulnerabilities

Proponents of DeFi and decentralised structures have touted DAOs as offering multiple advantages over traditional organizations, however their set-up also comes with a number of risks, which in the case of DeFi protocols could potentially have financial stability implications.¹⁵

Potential benefits of DAOs include the following aspects: First, there is potentially less trust needed among parties. Traditional organizations require a lot of trust in the

¹⁴ The stability fee is a risk parameter designed to address imbalances in supply and demand for the DAI token which could result from periods of low or negative growth in the crypto-asset market.

¹⁵ This paper focuses in particular on the vulnerabilities stemming from DeFi governance, for an overview of DeFi benefits and risks more broadly see Born et al., 2022 and Financial Stability Board, 2023.

people running them while DAOs are allegedly trustworthy in the sense that smart contracts help to ensure that DAOs operate in compliance with their rules. The trust in the smart contracts is facilitated by their existence on the blockchain which makes the data accessible to everyone and completely transparent and publicly verifiable. In addition, smart contracts enable DAOs to automate many functions usually performed by traditional entities or intermediaries and to be run without the considerable overhead costs of traditional organizations, leading to enhanced efficiency and lower costs.¹⁶ Moreover, DAOs lack a hierarchical structure which means that any member can put forward innovative ideas through a decentralized and consensus-based approach so that DAOs can flexibly adapt to the community's needs over time, fostering collaboration (see, for example, Bellavitis et al, 2023).¹⁷

However, DAOs and its associated governance of DeFi protocols also expose these structures to inherent risks, mostly related to their legality, lack of accountability and security. First, regarding legal aspects, DAOs can be spread across numerous jurisdictions with no legal framework underpinning them. Hence, any legal issues that may occur would require members to deal with multiple different laws.

Second, in addition to DAOs lacking clear legal status, DAOs face accountability challenges due to the lack of formal corporate structures and the absence of individual liability for their members (see, for example, Borgogno and Martino, 2024 and Bhambhwani, 2025). More specifically, traditional organizations issue equity that establishes a legal relationship with shareholders, whereas DAOs issue governance tokens that provide holders with governance and economic rights, but without any formal legal framework or relationship.¹⁸ In particular, centralisation in DeFi governance can give rise to governance risks as this may be at odds with the decentralisation claim. While theoretically all governance token holders act in the best interest of the protocol for it to succeed and grow, their incentives are not always completely aligned (see Carter and Jeng, 2021). There could be collusion, and other unfair practices or flaws in the governance design which could be exploited to take over the protocol and its funds. The concentration of decision-making power in the hands of a few token holders may allow them to influence the protocol's key characteristics for their financial gain. This behaviour could be detrimental to other participants in the protocol.

Third, regarding security aspects, DAOs' smart contracts can be vulnerable to hacks and cybersecurity breaches, which due to decentralised governance may be hard to address in a timely manner (see, for example, Werner et al., 2023). For example, in 2023, hackers stole approximately \$1.1 billion from DeFi protocols with the number of hacking incidents increasing slightly from 219 in 2022 to 231 in 2023 (Chainalysis, 2024). Furthermore, the process of proposing and implementing changes to a smart

¹⁶ Functions performed include both internal processes such as treasury management, operational processes but also external such as insurance related processes where smart contracts can automatically process insurance claims based on predefined conditions and data inputs.

¹⁷ Further sources explaining how DAOs work include for example: Defiway: [What Are DAOs and Why Do They Matter?](#), MIDAO: [DeFi DAOs: How Aspects of DAO Governance Benefit the DeFi Ecosystem](#), KuCoin: [Everything You Need to Know About DAOs \(Decentralized Autonomous Organizations\)](#).

¹⁸ The Security Exchange Commission (SEC) had previously indicated that DAO-issued tokens will be considered "securities" and thus be subject to the registration regime of the U.S. securities laws. See SEC (2017).

contract is susceptible to attacks. Typically, participants are required to hold a minimum number of governance tokens to submit a proposal for modifying the protocol, which can create vulnerabilities and potential points of exploitation. An attacker may amass a large amount of governance tokens, often through flash loans, to propose and execute malicious contract code and steal funds.¹⁹ Similarly, smart contracts might contain errors or bugs resulting in losses for the investors.²⁰ Such flaws or loopholes might be difficult to fix quickly even after they have been identified given the perceived lack of an accountable and centralised actor that would be capable of making swift decisions and taking decisive action. For instance, DAOs typically require members to vote on all changes, including those needed to fix a bug, which can significantly delay the resolution process. This challenge extends beyond addressing bugs or errors; it can hinder timely responses during crises (see Box 2) and complicates matters for regulators seeking clarity on who is accountable for ensuring compliance with regulatory requirements.

Box 2

SVB Collapse Sparked Stablecoin Turmoil: MakerDAO's Emergency Measures Amid USD Coin (USDC) Crisis

This box provides an example on the need for DAOs to act fast in a crisis situation.

In March 2023, the failure of Silicon Valley Bank (SVB) caused significant turmoil in the stablecoin market, with USDC being notably impacted. Circle, the issuer of USDC, had approximately \$3.3 billion of its reserves held in SVB.²¹ The collapse led to concerns over the availability of these funds, resulting in a drastic loss of confidence and a large-scale sell-off of USDC. As a consequence, its value dropped to as low as 87 cents, breaking its peg to the U.S. dollar.

In the context of this instability, MakerDAO, which manages the DAI stablecoin, faced a critical challenge due to its substantial exposure to USDC. MakerDAO had approximately \$3.1 billion in USDC as part of its collateral strategy, utilizing USDC's liquidity to support the issuance and management of DAI.²² The collapse of SVB, however, prompted MakerDAO to take significant steps to mitigate a potential fallout and stabilize its ecosystem. Specifically, MakerDAO's Risk Core Unit proposed a series of emergency measures that were rapidly voted on and enacted by the MakerDAO community within 48 hours.²³ Such measures included the reduction of the debt ceilings on certain types of collateral to zero, which was intended to limit risk exposure by restricting the amount of DAI that could be borrowed against these assets.

Additionally, MakerDAO decided to cut the daily minting limit of USDC within its Peg Stability Module from 950 million DAI to 250 million DAI, a move aimed at managing liquidity and reducing

¹⁹ For an example of such a hack see CoinDesk, 17 April 2022, "[Attacker Drains \\$182M From Beanstalk Stablecoin Protocol](#)".

²⁰ Examples include Coindesk, 2 February 2022, "[Blockchain Bridge Wormhole Suffers Possible Exploit Worth Over \\$326M](#)" and Coindesk, 27 October 2022, "[Crypto Launchpad Team Finance Suffers \\$14.5M Exploit](#)".

²¹ The reserve that Circle held at SVB represented about 8% of the total USDC reserves of around \$40 billion, see Circle (2023).

²² See for example Cointelegraph, 11 March 2023, "[Circle's USDC Instability Causes Domino Effect on DAI, USDD Stablecoins](#)".

²³ See [Emergency Proposal: Risk and Governance Parameter Changes](#), which was posted on the Sky Forum 11 March 2023.

reliance on USDC. The minting fee for converting USDC to DAI was also raised to 1% to discourage excessive minting during the instability period. Furthermore, MakerDAO took steps to eliminate its exposure to Curve Finance and Aave, platforms where USDC was utilized, in order to further insulate itself from the volatility of USDC.

Finally, to bolster stability, the debt ceiling for Paxos Dollar (PAX) was increased to 1 billion DAI, providing a more stable collateral alternative and lessening dependence on USDC.

2.3 Current debate on legal and regulatory coverage of DeFi protocols and DAOs

Most DAOs have thus far operated outside the regulatory perimeter, despite performing functions that are similar to regulated financial institutions and market infrastructures. Importantly, DAOs often operate on a global scale without a centralized location, often involving participants from multiple jurisdictions. These organizations challenge traditional legal frameworks, which are typically based on geographic boundaries. The lack of a physical presence complicates the application of laws, making it difficult for any single jurisdiction to exercise complete legal authority over them. Different jurisdictions may have varying interpretations and regulatory approaches to DAOs, leading to potential conflicts and legal uncertainty. Consequently, DAOs may find themselves subject to multiple legal frameworks simultaneously, complicating compliance and operational legitimacy. This geographic spread necessitates a comprehensive understanding of the regulatory environments in the regions they operate to avoid potential legal issues and ensure smooth operations (see Law Commission, 2024).

At the same time, the rapid evolution of technology and the unique operational structures of DAOs necessitate continuous assessment and adaptation of existing regulations. Traditional regulatory models, developed with conventional, centralized organizations in mind, may not be fully applicable to decentralized entities like DAOs. For example, regulations that assume a clear hierarchical structure with identifiable responsible parties may struggle to address the decentralized decision-making processes and pseudonymous participation typical of DAOs. As a result, one key area for potential regulatory development is the clarification of the legal status and accountability mechanisms for DAOs. Given that DAOs often operate without a central authority or traditional corporate structure, determining who is responsible for compliance with financial regulations can be complex. Future regulations may need to more clearly define how accountability and responsibility are assigned within these decentralized systems. This clarity is crucial not only for protecting investors and maintaining market integrity but also for providing legal certainty and stability to the operations of DAOs (see Law Commission, 2024).

At present, to tackle the legal challenges associated with DAOs, regulatory authorities are evaluating how existing laws and regulations may apply to DAOs, and whether new regulations may be needed to address the unique features and decentralized nature of such organizations (see Naudts, 2023).

Three US states have already enacted laws related to DAOs. The state of Wyoming passed a DAO law in July 2021 that officially recognized Decentralized Autonomous Organizations (DAOs) as a new type of legal entity called a Decentralized Autonomous Organization Limited Liability Company (DAO LLC).²⁴ This legislation provides a legal framework for DAOs, ensuring they operate within a regulated environment while maintaining the flexibility and decentralized nature of blockchain technology. A key objective of the law is to limit the liability of DAO members, protecting token holders from being indiscriminately held accountable for the DAO's actions and debts. The law acknowledges smart contracts' roles in DAO operations and governance, integrating them into the legal framework to automate and decentralize decision-making processes. To gain legal status, a DAO must register with the state of Wyoming, detailing its operations, governance mechanisms, and use of smart contracts. While DAOs benefit from limited liability, the law ensures transparency and accountability to maintain trust within the ecosystem.

In April 2022, Tennessee enacted legislation allowing DAOs to register as a distinct form of limited liability company known as a Decentralized Organization (DO). Rather than creating a completely new entity type, the Tennessee statute amends the state's Limited Liability Company (LLC) Act to allow an LLC to elect 'decentralized organization' status through its articles of organization. Similar to Wyoming's approach, the law recognises governance by smart contracts and permits member-managed or algorithmically managed structures, while extending standard LLC limited-liability protections to participants. Although closely aligned with Wyoming's framework, Tennessee's law uses slightly different terminology and imposes its own disclosure requirements, offering DAOs an additional U.S. jurisdiction for establishing legal personality within an LLC-based structure.

In addition, the Utah Decentralized Autonomous Organizations (DAO) Act,²⁵ enacted in 2023, provides a legal framework for DAOs within the state of Utah. It formally recognizes DAOs as distinct legal entities, granting them legitimacy and requiring their registration with the state. This registration necessitates providing detailed information about their structure and governance mechanisms. The Act acknowledges the use of smart contracts in DAO governance and operations, defining how they integrate into the legal framework. Furthermore, the Act specifies the liability and accountability of DAO members and developers, aiming to protect both the organization and its participants from legal uncertainties. It also sets guidelines for DAO governance, including transparent and fair voting rights and decision-making processes, and includes provisions for resolving disputes to address internal conflicts and external legal challenges. Thus, Utah takes a more distinct approach by creating a dedicated entity type, the Limited Liability Decentralized Autonomous Organization (LLD), which is treated as legally equivalent to an LLC but recognised as a separate DAO-specific form, thus with more explicit recognition of autonomous, smart-contract-based governance.

Furthermore, the U.S. Securities and Exchange Commission (SEC) until 2024 used to actively provide guidelines and enforce actions concerning DeFi projects,

²⁴ See Wyoming Legislature (2021), SF0038 – [Decentralized Autonomous Organizations](#).

²⁵ See Utah Legislature (2024), HB0318 – [Decentralized Autonomous Organization Act Amendments](#).

particularly focusing on the issuance of tokens and their potential classification as securities under the Howey Test (see SEC, 2019). This test is used to assess whether a transaction constitutes an investment contract. If a token is classified as a security, it must adhere to strict regulatory standards, including registration and disclosure obligations. The SEC's efforts aim to safeguard investors and maintain market integrity, addressing projects that claim decentralisation to circumvent securities laws while operating similarly to conventional financial instruments.

When it comes to Europe, the Markets in Crypto-Assets (MiCA) Regulation introduced a new regulatory framework for crypto-assets. However, most tokens issued by DAOs, DeFi intermediaries and DAOs do not fall within the scope of MiCA as the regulation does not apply to services provided in a fully decentralized manner without any intermediary. However, as already highlighted earlier it seems that DAOs often only claim to be decentralised. Thus, the Danish Financial Supervisory Authority suggested a number of principles to better understand when a DAO could be considered decentralised (see Danish FSA, 2024). An activity can be considered decentralized if users cannot identify a specific counterparty to enter into an agreement for service provision. This situation arises when the activity is facilitated by software that no single entity controls or if the control over the software is organized in such a way that it obscures the identification of any counterparty with whom users could form a contract. At the same time, the level of decentralisation can change over time, often beginning centrally with the intention to decentralize eventually. Once an offering becomes decentralized, there would be no legal entity to impose licensing obligations upon, for example, if the entity holding the license is dissolved or loses control. Smart contracts, which perform actions based on pre-programmed logic, cannot independently constitute legal entities or enter into binding agreements. They implement the will of others, such as the legal or natural person controlling the software. The degree of control over decision-making processes is also key in assessing whether a regulated activity is truly decentralized. This involves examining how decision-making powers are distributed among the entities involved in the activity. These powers can be concentrated within a single legal entity, indicating a centralized structure and being subject to MiCA obligations for providing regulated activities or within individual actors or groups who might be part of a DAO or might be external entities hired to perform specific roles. DeFi participants must thus be aware that stringent criteria need to be satisfied for an offering to be deemed truly decentralised.

3 Methodology, data and summary statistics

To assess the concentration of governance token holders and offer insights on the governance process within major protocols, we provide a comprehensive picture of the network of these actors across four major protocols. By employing a combination of qualitative research methods and hand-collecting data, we are able to distil a representative sample of token holders and voters. Our goal is to uncover the patterns and dynamics of decision-making in the DeFi space, including how these evolve over time.

In the following subsections, we first outline our methodological approach (Section 3.1) in which we explain how the interactions among governance token holders, governance proposals, voters and delegates in the network shape the information we collect for our analysis. Next, we describe the data in more detail and present key summary statistics (Section 3.2). In particular, we elaborate on the criteria that guided our selection of the protocols as well as the governance token holders (Section 3.2.1) before shedding more light on the data sources employed and providing details about the data extraction process (Section 3.2.2).

3.1 Methodology and general data generation

In this section, we describe our empirical approach to assessing the degree of centralisation of governance token holders as well as voters on governance proposals in DeFi protocols. We rely on enhanced data generation skills to gather our data and employ both quantitative and qualitative research methods. First, for data compilation and collection, we rely on web scraping, manual data gathering, and accessing of public sources. Second, we apply qualitative and quantitative approaches, such as descriptive statistical techniques, to analyse and visualize the collected data.

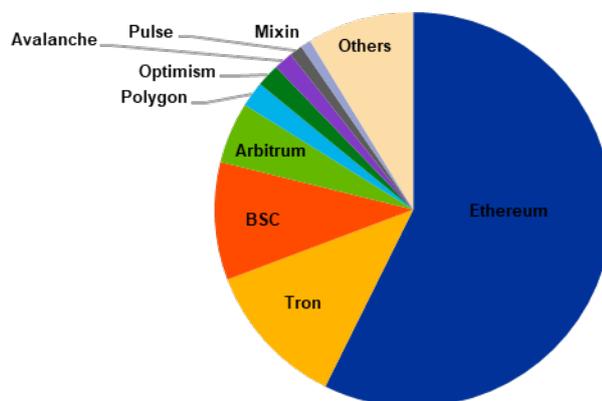
More generally, our analysis employs techniques such as frequency distributions, percentages, and averages to explore the distributions and characteristics of top governance token holders and voters. We examine voting patterns to understand the dynamics of decision-making within these protocols. We also explore potential interlinkages between top token holders and top voters. Finally, we study the content of governance proposals and establish a systematic categorization method.

In detail, to explore the governance process in DeFi protocols, we create a database of governance token holders that is representative and close to presenting the population of the selected protocols to be able to infer on voting procedure/behaviour in DeFi and gauge the universal behaviour patterns of all participants of a subset of relevant protocols. To this end, we first hand-collect information on token holders across major protocols, focusing only on the Ethereum blockchain. This choice is

guided by the fact that more than half of the share of Defi activity, measured as total value locked (TVL), is located on the Ethereum blockchain in May 2023 (see Chart 2). In particular, this blockchain alone hosts about 57 percent of the TVL in DeFi. In our sample, we focus on four DeFi protocols: Aave, Ampleforth, MakerDAO, and Uniswap which represent about 32 percent of the TVL locked in the DeFi ecosystem.²⁶ Second, we collect information on governance token holders, voters/top voters as well as proposals that these voters can vote on. In addition, we gather information on voters that defer their voting decision to a so-called delegate.

Chart 2

Share of Defi TVL by chain (as of May 2023)



Sources: DeFillama, own calculations

In total, we collect data for the top 100 token holders and top 20 voters for each of the different protocols on the Ethereum blockchain.²⁷ These voters have voted on a total of 1051 proposals. For our analysis on the governance proposals, we are able to include 248 proposals (see Table 2). For three (Aave, Ampleforth, and Uniswap) out of the four protocols, our sample spans the entire population of proposals. For MakerDAO, we include 100 proposal which makes up 11% of all proposals observed until May 2023.

We collect this data for two time periods, November 2022 and May 2023. This allows us to not only trace holding and voting behaviour for a specific point in time but also to assess whether holder structures and voting decisions are stable over time. More specifically, by analysing intertemporal distribution changes in token holdings and voting statistics, we seek to identify the most active and influential participants and examine how they contribute to shaping the future of specific protocols and the overall DeFi ecosystem through participation in governance voting polls.

Gathering this data for our analysis required an extensive data search and collection process. In fact, building our sample required manual effort to link and verify observations across the different data sources, in particular to uncover the identities

²⁶ However, we are unable to estimate the TVL for one of the protocols (Ampleforth).

²⁷ Due to data availability issues, we are only able to collect the top 10 voters for MakerDAO for both November 2022 and May 2023; 10 top voters for Ampleforth for May 2023, and 18 top voters for Uniswap in November 2022.

of the involved stakeholders. This meant that we needed to manually trace pseudonyms or Ethereum names/addresses using web search given that data-related barriers in DeFi are particularly high due to the pseudonymous nature of DeFi activities.

While our data collected from public sources provide novel insights, it is subject to limitations, such as potential inaccuracies or missing information. For example, in our analysis, we intended to include additional protocols, such as Curve and dYdX, which are the top decentralised trading platform for stablecoins and the top decentralised trading platform for derivatives trading. These protocols could have provided valuable insights and enriched our study. However, due to insufficient data, we were unable to conduct a comprehensive analysis of these protocols, leading to their exclusion from this study.

As a consequence, our analysis only focuses on selected protocols and does not capture the full scope of the DeFi ecosystem. Yet, we are confident that given the representativeness of the protocols on the Ethereum blockchain, results can uncover the patterns and dynamics of decision-making in the DeFi space. In any case, given the diversity of setups and the distinct governance structures of many protocols (see Box 3), generalizations beyond the protocols studied should be made with caution.

Box 3

Delegation and voting in Defi protocols studied

In Decentralized Finance (DeFi), governance plays a crucial role in the development and management of protocols. Token holders typically participate in governance by voting on proposals, but due to constraints such as time, expertise, or engagement, delegation becomes an essential mechanism. Through delegation, token holders can assign their voting power to trusted individuals or entities (delegates). This summary explores the delegation and voting systems of the four major DeFi protocols we study in detail: Aave, Ampleforth, MakerDAO, and Uniswap, emphasising their unique technical structures and governance mechanisms.

Delegation mechanism: AAVE, Maker DAO's, Ampleforth, and Uni token holders can delegate their voting power to another address without transferring ownership of their tokens. Once delegated, the voting power is controlled by the delegate until it is revoked or changed. Delegation is done through the governance interface, and the voting power is updated on-chain via smart contracts. The delegation is recorded on-chain, ensuring that the protocol transparently tracks voting power.

Weighted voting: For all protocols, voting power is proportional to the amount of tokens delegated to the voter or governance tokens directly held by them. Weighted voting system ensures that stakeholders with larger investments in the ecosystem have greater influence over decisions.

Proposals, progressive consensus and voting rules: For all protocols, protocol modifications, for example, changes to risk parameters, adding new assets, or modifying incentives are implemented following a formal two step voting procedure, which slightly differs per protocol. For Aave, before becoming executable, proposals must go through the Aave improvement proposal process, which involves community discussion, submission, and voting. Delegates cast votes on behalf of AAVE holders, and voting outcomes are determined by the majority of weighted votes.

Once a proposal reaches the on-chain voting stage, it requires majority approval based on the weighted votes (delegated votes included). A proposal passes only if it achieves the required quorum of votes, ensuring a broad consensus across the community. Similarly, for Maker DAO a two-step voting procedure applies: First, on-chain polls which are non-binding votes to gauge community sentiment on specific issues. MKR holders or their delegates can vote directly through the voting portal. Poll votes can be batched into a single transaction to reduce Ethereum transaction costs. Second, executive votes, which are binding decisions, are executed through smart contracts, directly altering the protocol's parameters. Only MKR staked in the governance contract can participate in these votes. For Ampleforth, the process is similar to Aave for governance changes (e.g., to monetary parameters or incentive programs). They follow a two-step process in which proposals are first discussed and signalled off-chain (e.g., via forums and external voting platforms) and, if they gain sufficient support, are then executed on-chain through the protocol's governance contracts or designated multi-signature wallets. Eventually, Uniswap similarly uses a two-step procedure: proposals must first pass an off-chain "temperature check" and "consensus check" (typically via Snapshot) before being submitted as on-chain governance proposals executed through the Uniswap Governor contracts.

Particularities per protocol:

- **Aave** allows delegation not only for voting but also for proposition power, meaning delegates can propose governance actions if granted sufficient delegated power. This dual delegation system increases the efficiency of protocol management, giving knowledgeable delegates greater involvement.
- **MakerDAO** uses a continuous approval voting model, where executive proposals remain open indefinitely until they gather enough MKR votes. This system means that delegates need to constantly monitor ongoing proposals to manage the protocol's risk parameters, collateral types, and other critical aspects.
- **Uniswap** governance controls a community treasury that holds 45% of the initial UNI supply. Delegates can vote on how to allocate these funds for grants, partnerships, or governance initiatives. This provides a powerful incentive for active participation in governance, as large financial resources are at stake.

3.2 Data and summary statistics

In this section, we provide a detailed description of the selected DeFi protocols, offering insights into the criteria used for choosing the tokens and the proposals that were subject to voting.

3.2.1 Choice of protocols and tokens

Our sample of DeFi protocols includes Aave, Ampleforth, MakerDAO, and Uniswap. The selection is driven by data availability, unique features of the protocols and/or representation of different aspects of the DeFi ecosystem (for an overview see Table 1). In particular, our aim is to create a database that represents the universe of all

possible activities in DeFi while at the same time focusing on protocols that are most relevant in terms of TVL across these different activities. Specifically, we picked Aave and MakerDAO because they represent the largest lending protocols by total value locked and Uniswap as it is the largest decentralized exchange by trading volume. Studying a lending protocol like Aave the largest lending protocol at the time of data collection is particularly important, as lending platforms play a central role in the DeFi ecosystem by facilitating token borrowing for various purposes. Analysing transaction-level data to study investors' motivations, Cornelli et al. (2024) provide evidence for Aave V2 showing that investors primarily borrow tokens for speculative reasons. At the same time, investors are also led by governance motives, accruing more significant governance rights, to influence protocol decisions. Ampleforth was included due to its distinctive feature of claiming to be the first rebasing token.²⁸

Table 1
TVL and main characteristics of the selected set of protocols (as of May 2023)

Protocol	Selection feature	No. Of Blockchains	TVL	TVL on Ethereum	% of total TVL on Ethereum blockchain	Included in sample
Aave	Largest lending protocol	8	\$5.36bn	\$4.42bn	82.5%	Yes
Ampleforth	First rebasing token long term goal to create an alternative to central-bank money	2	-	-	-	Yes
MakerDAO	Second largest lending protocol	1	\$6.49bn	\$6.49bn	100%	Yes
Uniswap	Top DEX by trading volume	6	\$4.18bn	\$3.57bn	85.4%	Yes

Sources: Defilama, own calculations

Notes: The TVL in the Ampleforth protocol is not explicitly provided on major platforms, likely due to the unique nature of Ampleforth's design. Ampleforth's TVL can fluctuate significantly because of its elastic supply model, where the supply of AMPL tokens automatically adjusts in response to market demand to target a stable price. This elasticity therefore affects how TVL is calculated and reported.

In our analysis, we focus exclusively on the governance tokens of the selected protocols, i.e., tokens granting voting rights to the holders (see Chapter 2). The governance tokens of Aave, Ampleforth, MakerDAO, and Uniswap are AAVE, MKR, FORTH, and UNI, respectively. While all selected protocols, except for MakerDAO, are deployed on multiple blockchains, as indicated we limit our analysis to the governance tokens on the Ethereum blockchain.

3.2.2 Data sources and detailed data extraction

To gain insights into token holders and identify top voters, we rely on several data sources, such as (1) Etherscan, a public blockchain explorer, (2) Sybil.org, (3)

²⁸ Ampleforth is an elastic supply token, also known as a rebase token, which automatically adjusts its circulating supply based on changes in its price. This process, called rebasing, involves algorithmically increasing or decreasing the token's supply depending on its current price. See <https://docs.ampleforth.org/learn/about-the-ampleforth-protocol>

tally.xyz as well as (4) the governance forums or decentralized applications (DApp) of the DeFi protocols.

First, we gather on-chain data on *governance token holders* from Etherscan, where each token holder corresponds to a unique wallet address listed on etherscan.io. For the top 1000 holders of each token, Etherscan offers information on the public tags associated with wallet addresses, where available, which we rely on to identify the holders. For our analysis, we limit the sample to the top 100 holders of governance tokens from the selected DeFi protocols. We deem this limit suitable because, for each protocol, the top 100 addresses hold more than 80 percent of the governance tokens (see Table 3). To identify the top governance token holders, we examine the names mentioned in the public tags of their wallet addresses. While some names clearly point to identifiable token holders, others require further investigation through web searches to trace the holder. In particular, we trace holders through several channels including X/Twitter, Arkham, or Reddit forums to gather more information. In cases where different addresses point to the same owner, we bundle these addresses together.²⁹ For example, in the case of Binance, we aggregate the token holdings of nine addresses with the public tags pointing to Binance, which include Binance 7, Binance: Binance-Peg Tokens, Binance 28, Binance 8, Binance 14, Binance US 2, Binance 16, Binance 15, and Binance US 3. Using the Aave tokens as an example, the aggregate holdings of Binance amount to 10.14% (Chart 5). We do the same exercise for 14 large, centralised trading platforms as well as 4 decentralised exchanges.

Second, when compiling data on governance proposals and voters, we collect information not only on direct voters but also on instances where voters delegate their decision-making power. Information on delegates is available on Sybil which maps on-chain wallet addresses to digital identities of delegates. Tally, a platform for on-chain DAOs, allows users to manage protocols, delegate voting power, and participate in proposal voting. We gather information on Aave and Uniswap on Sybil and on Uniswap and Ampleforth from Tally. Information on proposals and voters for MakerDAO are made available directly by the protocol on their governance platform.

In total and as indicated, we include 248 governance proposals in our sample. To understand the specific aspects of the DeFi protocol that the governance token holders can vote on, we thoroughly reviewed each of the 248 proposals. We then cluster the proposals by topic. To this end, we assign each proposal to one of fourteen categories based on a best-fit approach. These categories, which emerged as a result of our detailed screening, include key themes such as protocol modification, risk parameters, team modifications and budgets, governance parameters (see also Table A.1. in the Annex for the full typology).

More specifically, our sample comprises governance proposals for AAVE, FORTH, and UNI, starting in November 2020, December 2020, and November 2021, respectively and captures all governance proposals of AAVE, FORTH, and UNI until

²⁹ The information available does not allow us to further distinguish between these addresses belonging to centralised exchanges (for example whether they belong to different entities within the group or whether they hold tokens on behalf of clients or for the exchange itself). Therefore, we decided to add them all together.

December 2022. For MKR, for which a total of approximately 1000 proposals is available at the time of the data collection, we include the 100 latest proposals. Our sample of MKR proposals spans the time between May 2022 and December 2022. For each proposal, we compile information on the timestamp of the proposal, where available, and the voting outcome of the proposal (e.g., defeated, executed, etc.), as well as the execution date, where applicable.

Data on *voters* are compiled in two steps. As a first step, we collect available statistics on the top voters from governance forums, DApps, Sybil and Tally. The top voters are ranked based on their participation history in governance voting. The statistics on top voters include a pseudonym or an Ethereum name or address as the identity of the top voter. In addition, we gather information on the number of delegators delegating their votes to each top voter. In the next step, we attempt to link the pseudonym or the Ethereum name/address to the identity of the top voter. By identity, we mean that we can allocate the voter to a specific group, such as individuals, venture capitalists or university groups as described in the next section. This has been the most time-consuming exercise in building our sample, involving intense manual work. We use a combination of curated search techniques to reveal as many real identities as possible. In particular, we:

- i. Run the pseudonyms and Ethereum names/addresses through the Google search engine and follow the resulting links for any clues.
- ii. Search through the discussions on governance forums of the DeFi protocols, screen the comments and proposals, if any, posted by the pseudonym or Ethereum name/address of our interest.
- iii. Search for the pseudonym or Ethereum name/address on GitHub, which is a code hosting platform where programmers collaborate and network and screen their contributions and conversations.
- iv. Scan social media (e.g., Twitter and Instagram) and professional forums (e.g., LinkedIn). In case a profile exists with the respective pseudonym or Ethereum name/address, we study the content they post, and the posts and profiles they engage with.
- v. Make use of Crystal Intelligence tags to identify the ultimate owners of wallets solely used for transfers. Crystal Intelligence allows us to track chains of transaction, this helped further identify addresses that could not be identified in previous steps.

The use of various search techniques, combined with the indicated sources, enabled us to uncover the identities of a number of the top voters – though not all – and verify findings across different sources/platforms.

Table 2

Overview of total and selected proposals per protocol

	Total proposals	No. included	As % of total proposals
Aave (AAVE)	119	119	100%
Ampleforth (FORTH)	9	9	100%
MakerDAO (MKR)	893	100	11%
Uniswap (UNI)	20	20	100%
Total	1051	248	24%

Sources: Governance forums, DApps of the DeFi protocols, sybil.org and tally.xyz. Notes: Includes all governance proposals between November 2020 and December 2022 except for MakerDAO, for which 100 proposals from July 2022 to December 2022 are included. Excludes cancelled proposals.

4 Results

Based on our hand-collected dataset, we analyse the distribution of governance token holders, the distribution of votes and provide an overview on governance proposals. First, we present results on the distribution of the governance token holdings while also investigating who is behind the top governance token holders by attributing them to specific holder categories (Section 4.1). Second, we apply a systematic categorisation to our sample of governance proposals to provide an overview of the most relevant categories voters vote on (Section 4.2). Third, we present results for top voters on these proposals and shed more light on the role of delegates in the voting process (Section 4.3).

4.1 Top governance token holders

In a first step, we study the distribution of the governance token holdings to shed more light on the concentration of holdings. Table 3 reports the share and distribution of governance tokens held by the top 100 token holders of our 4 selected DeFi protocols for two time periods.

We find that governance token holdings are very concentrated. While the governance tokens are held by a five or six digit number of unique addresses, the top 100 holders account for over 80 percent of all holdings for the four protocols. For Aave and Uniswap, the top 5 holders already capture almost half of all token holdings in 2022. For Ampleforth, the concentration is even higher, with top 5 holders accounting for almost 60 percent of all token holdings in the same period. MakerDAO is the only exception, where the top five holders account for around 36 percent. The statistics for May 2023 reveal a similar pattern, i.e., much of the value is captured by a small number of actors. These findings indicate that the distribution of governance token holdings is highly concentrated and relatively sticky over time.

Table 3
Distribution of governance tokens – Shares of top 100 token holders

(shares as percentage points)

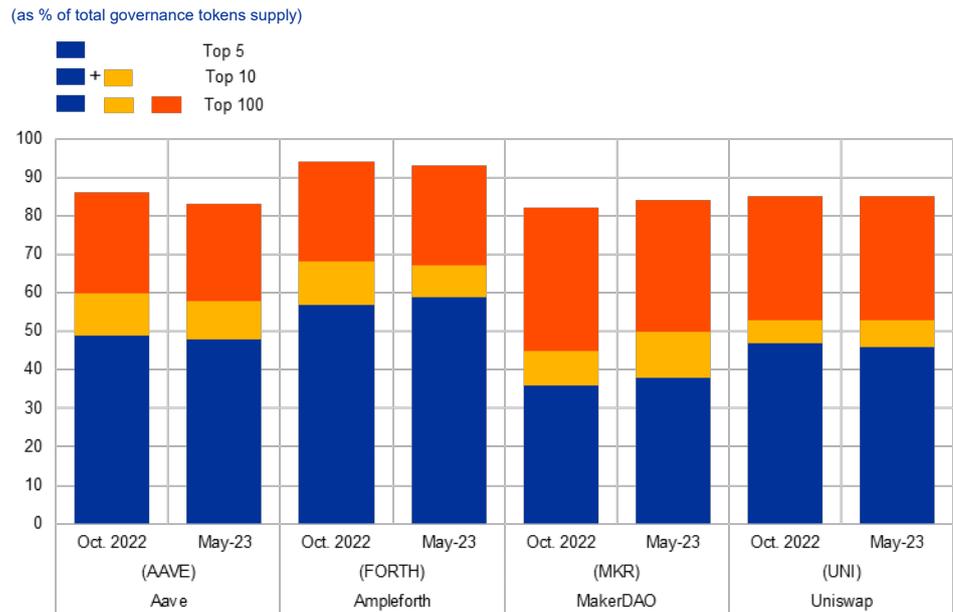
Protocols (governance token)	Aave (AAVE)		Ampleforth (FORTH)		MakerDAO (MKR)		Uniswap (UNI)	
	October 2022	May 2023	October 2022	May 2023	October 2022	May 2023	October 2022	May 2023
No. of unique addresses	122,052	160,973	25,885	26,271	87,838	94,766	324,704	369,611
Tokens held by	As %		As %		As %		As %	
Top 5	49	48	57	59	36	38	47	46
Top 10	60	58	68	67	45	50	53	53
Top 100	86	83	94	93	82	84	85	85

Sources: Etherscan, own calculations

The findings show that the ability to influence protocol changes could lie in the hands of a small set of token holders if they leverage their voting power (see Chart 3). Our results on the distribution of governance tokens confirm findings from previous literature that governance in DeFi is centralised (see for example Aramonte et al., 2021; Nadler and Schär, 2020 or Jensen et al., 2021).

Chart 3

Voting power of the top 100 token holders



Sources: Etherscan, own calculations

In a second step, we aim to identify the top governance token holders to understand who is behind the concentrated holdings. By categorising the holders, we focus in particular on tokens held by the protocols themselves and by centralised or decentralised exchanges. Assessing who is behind these governance token holders, we find that for some of the protocols, the majority (or slightly below half of holdings) can be attributed to either the protocols themselves or to centralised and decentralised exchanges (see Chart 4).

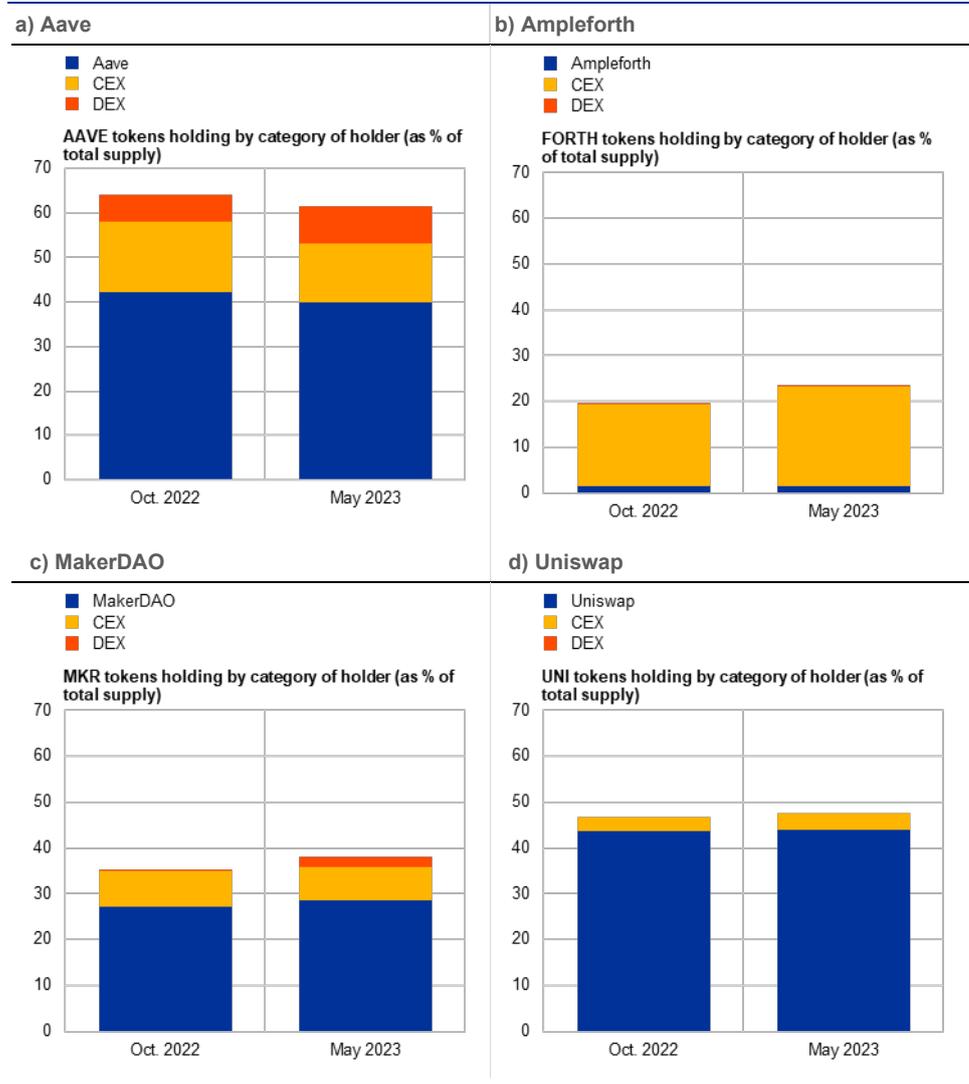
More specifically, a large percentage of the governance tokens are held by the addresses attributed to the DeFi protocols themselves except for Ampleforth.³⁰ The percentages range from 1.4 percent for Ampleforth to 43 percent for Uniswap in October 2022. These holdings could belong to the protocol founders and developers or the protocol treasury. However, with the available data, it is not possible to further pin down these holdings. It is important to note that holdings by developers or the protocol's treasury may have different implications for governance and regulatory considerations. The distribution seems to be rather sticky, with only slight changes between October 2022 and May 2023 and no clear trend. While for MakerDAO the

³⁰ Centralised exchanges hold a substantial share of FORTH tokens, as further detailed below.

protocol-held tokens have increased, the share remains unchanged for Ampleforth and Uniswap and has decreased for Aave.

Chart 4

Governance token holdings by DeFi protocols and centralised and decentralised trading platforms



Sources: Etherscan, own calculations.
 Notes: addresses associated with the specific DeFi protocol. CEX stands for centralised exchanges and DEX for decentralised exchanges.

As indicated, another large share of the holdings can be attributed to centralised and decentralised exchanges, ranging from 3 percent for Uniswap to 22 percent for Aave in October 2022, where centralised exchanges dominate. For the four protocols, centralised exchange holdings are much larger compared to those of decentralised exchanges, excluding the protocols’ own token holdings.³¹ The centralised exchange holdings are in particular high for Ampleforth (19 percent) and Aave (16 percent). Instead, for MakerDAO the holdings amount to 8 percent and for Uniswap

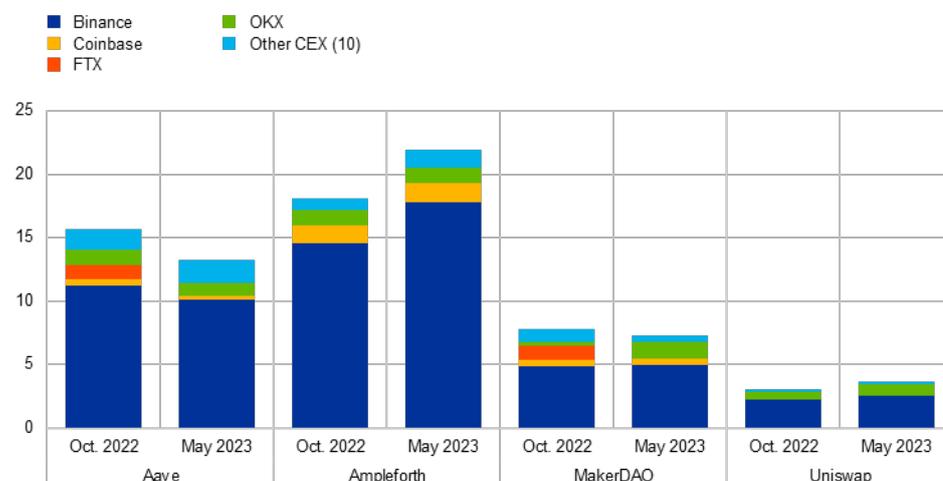
³¹ Centralised exchanges include 14 exchanges: Binance, Bitfinex, Bitkub, Bitstamp, Bittrex, Coinbase, Crypto, FTX, Gate, Gemini, Huobi, Mexc, OKX and Paribu. Decentralised exchanges include 4 exchanges: Balancer, Curve, SushiSwap, and Uniswap.

to 3 percent. As of May 2023, holdings of centralised and decentralised exchanges have generally slightly increased. In some cases, this growth is driven primarily by centralised exchanges, while in others it stems from decentralised – with the exception of Aave. For Aave the total exchange holdings remained unchanged, though the composition shifted, with holdings of centralised exchanges decreasing and holdings of decentralised exchanges increasing.

Zooming in on the holdings of centralised trading platforms (Chart 5), we see that the holdings vary between the protocols. However, for all four protocols the largest share of governance tokens held by centralised trading platforms can be attributed to Binance ranging from 2 to 15 percent. Two protocols had a noticeable share held by FTX in October 2022 (around 1 percent for both Aave and MakerDAO). Other larger holdings of centralised exchanges come from Coinbase (1.4 percent of Ampleforth governance tokens) and OKX (1.2 percent of both Aave and Ampleforth). These findings should be interpreted with caution as the data used does not allow us to distinguish between the amount of tokens held directly by the centralised exchanges and those held on behalf of their customers.

Chart 5

Governance token holdings by centralised trading platforms (as a percentage of total supply)



Sources: Etherscan, ECB own calculations.
 Notes: Based on public tags from Etherscan; data includes both Ethereum wallets and smart contracts. Other centralised exchanges include: Bitfinex, Bitkub, Bitstamp, Bittrex, Crypto, Gate, Gemini, Huobi, Mexc, Paribu. CEX stands for centralised exchanges.

4.2 Governance proposals

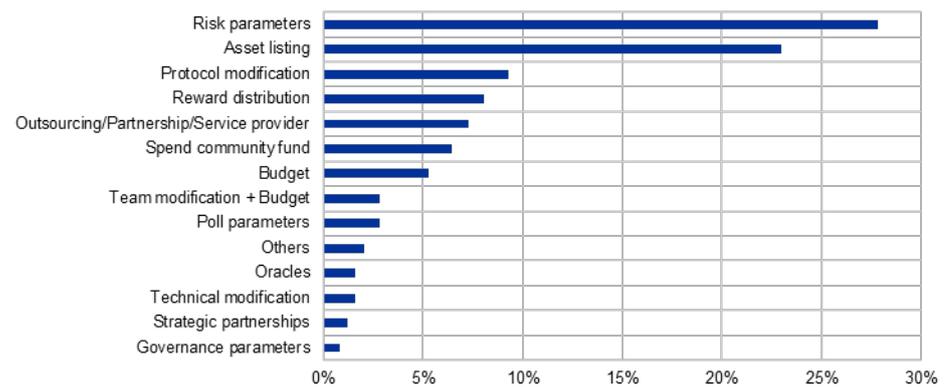
The systematic categorisation we apply to our sample of governance proposals shows that the two most relevant categories in terms of number of proposals are the category “risk parameter” with 28 percent and the category “asset listing” with 23 percent (see Chart 6).³² The risk parameter category covers a range of topics

³² For more details on the categorisation of proposals, see Table A.1 in the Annex.

relevant for shaping the risk profile of the protocol, including, for example, the (1) loan to value ratio, (2) liquidation parameters, (3) freezing/re-enabling assets, (4) borrowing rate, (5) debt ceiling, (6) disable borrowing, (7) stability fee, (8) reserve factor, and (9) emergency shutdown. The category “asset listing” mainly includes proposals on whitelisting crypto-assets or so-called real-world assets and collateral onboarding.

There are a number of categories that cover between 5 and 10 percent of the proposals, with the category “Protocol modification” being the largest one. It covers issues such as protocol version upgrade, governance/smart contract upgrade, chain deployment, contract deployment, and minting tokens. Interesting to note is that the category “governance parameters”, which reflects crucial matters for the governance of a DeFi protocol such as cross-chain governance, multisignature, and board members, contains the smallest share of proposals, i.e., only about 1 percent.³³

Chart 6
Distribution of proposal categories



Sources: MakerDAO governance dashboard, sybil.org, tally.xyz, ECB staff calculations.
Notes: Number of proposals include: 115 proposals for MakerDAO (from their governance dashboard), 126 proposals for Aave (from Sybil.org), 9 proposals for Ampleforth (from tally.xyz) and 24 proposals for Uniswap (from sybil.org) for the period from November 2020 to December 2022. This sample represents all proposals except for MakerDAO, for which only 100 proposals from July 2022 to December 2022 are included. 10 cancelled proposals are excluded.

4.3 Top voters on governance proposals

Governance tokens grant holders voting rights, enabling them to actively participate in shaping the future of the protocol. Nonetheless, they may not always exercise their voting right. They may choose to abstain from voting or delegate their voting power to a third party. The option to delegate votes raises the possibility that the top token holders and top voters may or may not be the same. Specifically, top token holders could delegate their votes to a third party implying that they would not appear as top voters even though their delegated party would be representing their interest. Vote delegation is a facet of the voting mechanism that adds layers of

³³ This means that only 2 proposals across the 4 protocols were suggested on such matters during our sample period.

opaqueness to the DeFi governance system and therefore complicates the task of linking the top token holders with the top voters.

To shed light on who influences the governance decisions in our sample of DeFi protocols, we investigate who mostly votes on the governance proposals of these protocols. We identify the 68 top voters across the four protocols and look at the aggregate voting for all proposals. We find that interestingly these top voters are mostly delegates (see Table 4). We explore several sources to trace their identities and associations, but it has proven very difficult to discover the identities of these delegates as some remain fully anonymous or pseudonymous without any hint concerning their identity.

In particular, Table 4 shows the top voter for each protocol, which is a delegate in all three cases. It also reports the number of token holders delegating their votes to this respective delegate. We observe that the top voter for each protocol remains largely unchanged between December 2022 and May 2023. In the case of Aave, the title of the top voter in May 2023 is different than in December 2022 but both top voters are associated with Aave. The top voter of Ampleforth is the 9th top holder of FORTH tokens, consistently maintaining this position across both data snapshots. For Uniswap, the top voter in both data snapshots is a16z, an abbreviation for Andreessen Horowitz, a venture capital firm. The number of delegators to a16z increased from 100 in December 2022 to 125 in May 2023, potentially increasing the voting power of the firm.³⁴

Table 4
Top voters per protocol

Protocols	Top voter	# of delegators	Top voter	# of delegators
	December 2022		May 2023	
Aave	Aave Ecosystem Reserve contract	4	Aave smart contract	0
Ampleforth	9th top holder of FORTH, individual	2	9th top holder of FORTH, individual	3
Uniswap	A16z, venture capital firm	100	A16z, venture capital firm	125

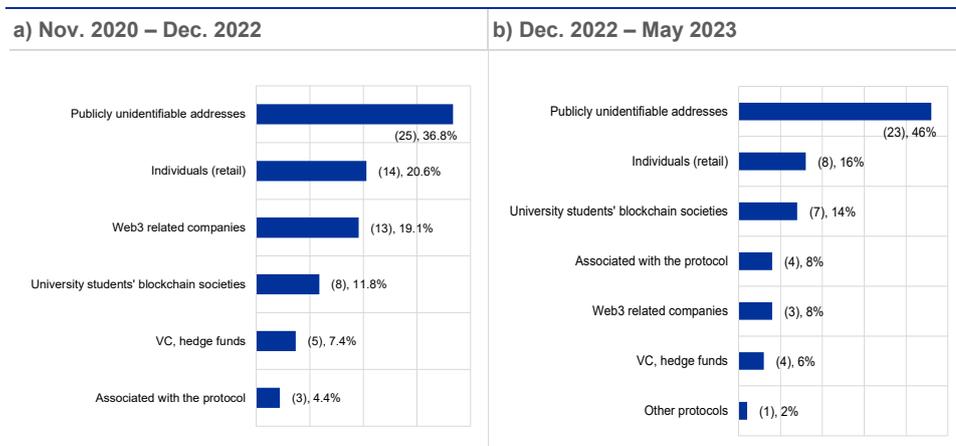
Sources: Sybil.org, tally.xyz, own calculations. MakerDAO is not displayed because the identities of the voters could not be identified in view of incomplete addresses.

Chart 7 clusters the top voters across the different categories for December 2022 and May 2023. Among the addresses we were able to identify, “individuals” represent the most dominant group of those, accounting for 20.6 percent of the top voters, followed by Web3 companies with a share of 19.1 percent. Other prominent categories include university students’ blockchain societies and venture capital firms. However, up to almost 50 percent of the top voters in our sample remains unidentifiable in both data snapshots. Ideally, we would have liked to explore in more detail and examine how voting behaviour differed across these groups for various types of proposals. Due to the significant manual effort this would have required, such an analysis was not feasible.

³⁴ Ceteris paribus, an increase in the number of delegators would increase the overall voting power of a delegate.

Chart 7

Share of top voters category



Sources: MakerDAO governance dashboard, sybil.org, tally.xyz, own calculations.

Next to shedding light on the distribution of voting power in these DeFi protocols, we examine the proportion of governance tokens that have been delegated and how this delegation concentrates influence among top voters. More specifically, Table 5 provides statistics on the number of governance tokens in circulation and the share of tokens that are delegated for Ampleforth, MakerDAO, and Uniswap. We observe notable differences in the delegation rates across protocols: Ampleforth has only 5% of its governance tokens delegated, MakerDAO has 14.8%, and Uniswap exhibits a higher delegation rate of 27.3%. For Aave this information was not available, we could only identify the delegators for the top voter.

Table 5

Voting statistics

Protocols (governance token)	Circulating tokens	Tokens delegated	share of token supply delegated	# of Top voters	Voting power (as % of supply)	Voting power (as % of tokens delegated)
Aave (AAVE)	14,090,000	-	-	20		
Ampleforth (FORTH)	14,982,364	749,457	5.00%	20	4.80%	96.04%
MakerDAO (MKR)	977,631	144,718	14.80%	10	9.80%	66.17%
Uniswap (UNI)	762,209,327	207,932,920	27.28%	18	14.31%	52.44%

Sources: MakerDAO governance dashboard, sybil.org, tally.xyz, ECB staff calculations. To note that for Aave the number of delegated tokens is not available.

These variations in delegation rates have significant implications for the concentration of voting power. For Ampleforth, despite the low delegation rate, the top 20 voters control 96% of the voting power of the delegated tokens, which corresponds to 4.8% of the total circulating supply. This indicates a highly concentrated voting influence among a small group of delegates. Similarly, in MakerDAO, the top 10 voters hold 66% of the delegated voting power, representing 9.8% of the circulating supply. Uniswap shows a slightly more dispersed concentration, with the top 18 voters possessing 52% of the delegated voting power, amounting to 14.3% of the circulating supply.

These findings highlight the impact of vote delegation on the centralisation of governance power within DeFi protocols. Even with a modest proportion of tokens being delegated, as seen with Ampleforth, the aggregation of voting rights among top delegates can lead to significant influence over governance decisions by a few individuals or entities. This concentration raises important considerations about the transparency and fairness of the governance processes in DeFi platforms. It underscores the need for mechanisms that promote broader participation and prevent potential governance capture by dominant delegates.

Moreover, these results provide evidence on the importance of delegates in DAO governance due to generally low participation rates among token holders. Our analysis complements existing work (see, for example, Barberau, 2023 and 2022 or Fritsch et al., 2024) on the voting right tokens by linking voting tokens and their delegates for additional protocols confirming that the control of major DeFi projects is highly centralized. Voter turnout in DAO proposals is often significantly lower than ideal, with some studies indicating participation rates as low as 5% to 10% of eligible voters (see for instance Pandian et al., 2023). This low engagement amplifies the influence of delegates, who actively participate and mobilize their delegated voting power. As a result, delegates can have a disproportionate impact on governance outcomes, steering decisions in ways that may not reflect the broader token holder community's preferences. This exacerbates the centralisation of power and highlights the need for initiatives that encourage greater participation from individual token holders to ensure a more representative governance process. Understanding the pivotal role of delegates is therefore crucial in assessing the actual dynamics and health of DAO governance structures.

5 Discussion of the results

Our findings have implications for ongoing discussions on how to regulate DeFi. The results show that based on current publicly available data, governance token holders, developers, and centralized exchanges cannot be used as regulatory entry points at the moment. This is because there is ambiguity surrounding who holds decision-making power within these protocols and hence, which parties can ultimately be held accountable. Improving the traceability of token holdings and clarifying the roles and obligations of various stakeholders – including for example of delegates - could facilitate more effective governance and regulatory oversight.

From a policy perspective, these findings could inform ongoing discussion on whether and how decentralised finance could be captured in regulation. Our results confirm that decentralisation exists on a spectrum indicating that *full* decentralisation is not achieved.³⁵ This is in particular relevant as it further complicates application of existing regulation. For instance, crypto-asset services provided in a *fully* decentralised manner are currently excluded from the scope of the Markets in Crypto-Assets Regulation (MiCAR) while crypto-asset services are within scope if not fully decentralised. Given that there is no threshold for "full decentralisation", the results highlight the conceptual challenges with this definition.

According to a framework brought forward by the Danish FSA (2024), a pragmatic approach for regulators to assess the applicability of technical decentralisation could involve evaluating whether autonomous, immutable smart contracts operate without human intervention or embedded control mechanisms. This aligns with the broader principle that decentralized governance requires the absence of managerial control by any single, identifiable legal entity, ensuring that authority and decision-making are distributed rather than concentrated in one organization. However, our analysis reveals a significant gap between the theoretical ideal of decentralisation and its practical implementation. The identified concentration of governance tokens among protocols' treasuries, founders, and centralized exchanges reveals substantial managerial control, indicating that most DeFi platforms would not meet the criteria for full decentralisation. In addition, the widespread practice of vote delegation further complicates the evaluation of genuine decentralisation. While delegation can enhance participation, it often obscures the concentration of voting power in the hands of a few influential delegates. This dynamic introduces hidden centralisation, undermining transparency and challenging accountability.

For governance token holders or voters to suit as a possible regulatory entry point to DeFi, regulators would need to consider mechanisms to improve transparency around token ownership structures and about delegating voting activities, perhaps by requiring disclosure of affiliations and voters. It needs to be clear whether the holders can be held accountable, as it seems the link between the largest token holders and top voters is not possible to easily ascertain. In addition, the lack of identifiable legal entities in DAOs, in particular unclear distinction between protocol-controlled

³⁵ Previously also acknowledged by ESMA (2023).

treasuries and developers holding control, complicates the assignment of responsibility. A potential regulatory approach could involve creating tailored legal structures specifically for DAOs, clarifying responsibilities, liabilities, and governance obligations explicitly.

Addressing these regulatory ambiguities may require refining existing frameworks or developing new, DAO-specific legal entities. Hybrid models, as emphasized by the Law Commission (2024), which integrate traditional legal frameworks with blockchain-based governance, present innovative and promising pathways forward. These hybrid models can provide clarity on liabilities, governance, and regulatory compliance while preserving some benefits of decentralized decision-making. Enhancing traceability of token holdings, clarifying governance responsibilities, and considering hybrid legal frameworks are essential steps toward fostering a genuinely decentralized, transparent, and accountable DeFi ecosystem.

Based on the empirical evidence of this paper, we show that DeFi governance, though commonly portrayed as decentralized and community-driven, exhibits concentrated governance rights among a restricted set of actors. Dominant entities include centralized exchanges, protocol developers, affiliated foundations, and early-stage venture capitalists. However, unlike traditional finance, DeFi lacks robust disclosure frameworks and fiduciary accountability mechanisms, exacerbated by the pseudonymous nature of blockchain governance which hinders transparency regarding stakeholder identities and their incentives. Our findings are consistent with the functional framework proposed by Aquilina, Frost, and Schrimpf (2024) which provides for a structured approach to understanding the unique characteristics, risks, and economic implications of decentralized finance. In particular, this framework highlights how DeFi replicates traditional financial functions despite technological differences, leading to governance concentration similar to traditional finance. Their analysis supports the view that similar intermediation roles result in analogous concentration of power, thereby warranting comparable regulatory considerations.

Concentration of power in DeFi represents the main imperfection hindering that these markets operate in a fully decentralised manner as often claimed. The impact of concentration of voting power in DeFi is amplified compared to traditional listed companies because of the asymmetry in investors' rights. While in traditional finance ownership rights, dividend and voting scopes are clearly defined from a legal perspective, in DeFi governance token holdings do not imply any legal ownership of the protocol but rather utility-like rights as described by Adhami et al. (2018).

Comparing voting behaviour within DAOs and corporate shareholder governance, both systems face low voter turnout, leading to governance outcomes being largely shaped by a small influential subset of recurrent voters. In traditional finance these dynamics are mitigated through institutional safeguards such as proxy voting rules, stewardship codes, and clearly defined legal duties for boards and executives. While DeFi governance faces a similar concentration of voting power, it lacks the protections, formal mandates, disclosure requirements, and effective recourse mechanisms found in traditional systems, thereby exacerbating the risk of agency conflicts from a principal-agent model perspective. Governance tokens holders enjoy full voting power on all proposals contrasting with exclusive mandates of the board

(routine and minor policy changes) and preferred shareholders in traditional finance. This extensive voting power further exacerbates the risk of agency conflicts. Proposals in DAOs governance are submitted all along the year and are not bundled, making voting involvement more time consuming compared to publicly listed companies where proposals are submitted to shareholders typically once a year during the annual general meeting. This annual frequency of decision making in traditional finance allows shareholders to receive background documentation ahead of the meeting to assess the soundness of proposals while information on DAOs proposals require active involvement of the governance token holders in governance forums and several channels including private channels and groups in encrypted apps such as Signal or Telegram.

Increased agency costs in DeFi compared to traditional finance may stem from moral hazard. For example, Initial Public Offerings (IPOs) in traditional equity markets require companies to meet strict listing standards, such as demonstrating stable revenue over several years and securing underwriter approval. In contrast, Initial Coin Offerings (ICOs) in DAOs lack disclosure or financial performance requirements, allowing protocols to raise capital without adhering to compliance, size, or profitability standards. This opacity can lead to higher agency costs for governance token holders.

Overall, the evidence suggests that DeFi governance reflects principal-agent dilemmas and ownership concentration risks similar to those in corporate governance, but it is further constrained by a lack of effective mitigation tools and oversight mechanisms. The difficulty in identifying entities that can be held accountable also has repercussions on effective enforcement. If DeFi increasingly integrates with traditional financial markets and real economic activities, clarifying governance responsibilities and assessing the adequacy of existing regulatory frameworks becomes imperative for managing emergent risks effectively.

6 Conclusion

In this paper, we have explored the implications and suitability of DeFi governance arrangements for regulating and supervising DeFi. In particular, we looked at the concentration of governance token holders of four DeFi protocols (Aave, MakerDAO, Ampleforth, Uniswap) and find that these are highly concentrated. Assessing in more detail who is behind the concentrated holdings, we find that for most protocols around half or more of all holdings can be attributed to addresses associated with either the protocols themselves or with centralised and decentralised exchanges. Looking at top voters across the different protocols, we find that top voters mostly comprise delegated agents. For most cases, these delegated agents could not be identified, however, nor linked with the token holders.

Overall, our study offers valuable insights for policymakers to implement policy measures aiming at bringing relevant entities under the regulatory umbrella. The results have implications for the discussion on regulatory anchor points, as governance token holders, developers or centralised exchanges have often been proposed as entry points in the debate. However, as our results show it is not always clear who in the end is responsible or can be held accountable based on public data available so far.

Annex

Table A
Proposal categories

Risk parameters	Asset listing	Protocol modification	Reward distribution	Outsourcing / service provider / Partnership	Spend community fund	Budget
LTV, Liquidation, bonus, Liquidation threshold	Whitelist asset	Protocol version upgrade	Liquidity provider fee	Whitelister (institutional adoption)	Protocol development	Budget approval
Liquidation/Auction	Whitelist real world asset	Governance contract upgrade	Liquidity mining reward	Risk management, risk specialists	Marketing, education, research	Budget implementation
Freeze asset, pause asset, re-enable asset	Collateral onboarding	Smart contract update	Safety incentives	Bridge	Events	Target spend level
Disable borrowing	Delist an asset	Chain deployment	Stacking reward	Bug fixing	Community rewards	Special purpose fund (SPF)
Debt Ceiling		Contract deployment	Bounty	Security	Seed funding	Compensation
Stability fee		Mint tokens	Trading reward	Treasury management		Cost of capital
Reserve factor		Liquidity pools	Delegate compensation			Onboard/offboard units
Borrowing rate						Oracle gas costs
Emergency shutdown						
Poll parameters						
Proposal thresholds/proposition power						
Voting delay period						
Quorum						
Differential						

Poll parameters	Team modification (+ Budget)	Technical modification	Oracles	Strategic partnerships	Governance parameters	Others
Proposal thresholds/proposition power	Add a role	Fix error	Add price source for an asset	Token swap	Cross-chain governance	Investment
Voting delay period	Onboard/Offboard	Contract update	Protocols' oracle fees	Token acquisition	Guardian powers	Treasury management
Quorum			Create oracle, whitelist protocols		Multisig	Assist a user in fund recovery
Differential			Oracle whitelist		Board members	Canceled

Sources: Authors' classification

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