Decentralized Autonomous Organizations: targeting the potential beyond the hype

The law, economics and technology of blockchain-organized business activities

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Abstract

Decentralized Autonomous Organisations (DAOs) aim at innovating the possible organization forms for business activities. DAO are complex blockchain-based smart contracts, which allow token holders to participate directly in decision-making processes and decentralize entrepreneurial activities as much as possible. The advocates of this new kind of digital organization argue that DAOs enjoy significant operational efficiencies and can effectively work outside of any legal recognition.

This paper analyses DAOs through the lenses of the economic and legal theories on the firm and on business organization. The analysis makes three contributions: first, it contributes to the literature on the theory of the firm, looking at the role of digital technology in innovating the organization of business activities. Second, it contributes to the literature on the legally recognized forms of business organization, analyzing the tension between the essential role of the law and the limitations of tamper-resistant technologies, such as the blockchain. Third, it contributes to the largely ideological and dichotomic debate on the promises of DAOs, providing analytical guidelines as to why current forms of sector-specific regulation fail to leverage the potential of DAOs.

Keywords. DAOs, decentralization, business organization, corporate governance, tokens.

JEL Classification. K22; L22; G34

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1. Introduction.

Distributed ledger technology and blockchain are not simply about payments and investments. Blockchain applications to decentralised finance (DeFi) are increasingly posing tricky questions going beyond the recurring issues of the first applications, such as the need to avoid fraudulent behaviours and protect investors.[1] This article investigates one of the most fascinating examples of this sort, Decentralised Autonomous Organisations (DAOs). DAOs aim to decentralise entrepreneurial activities through digitally automated protocols, promising to offer a new paradigm of business organisation. In its very essence, a DAO is a blockchain-enabled organization that allows large numbers of individuals across different jurisdictions to carry out business activities in a decentralized fashion.[2]

DAOs originally made it to the headlines for the hack that happened in 2016 to "The DAO project", a smart contract running on Ethereum that was designed to work as a venture capitalist.[3] This enterprise was meant to allow any token holder to propose a project for financing through decentralised digital voting. Anyone with DAO tokens could vote on plans and would then receive rewards if the projects turned profitable. Soon after collecting $150 million USD worth of ether (ETH) by means of a token sale, a member exploited a vulnerability in the code to reap away $60 million of ether. This led the founders to roll back the Ethereum network's history and "un-do" the leakage of funds, ultimately contradicting the much-vaunted immutable and censorship-resistant characteristics of the blockchain, not to mention the overarching principle under which "code is law".[4]

However, as crypto developers went through a learning-by-doing process over recent years, the technology experienced a sizable evolution, and several running projects already gained

[1] For an in-depth overview on DeFi, see Dirk A Zetzsche, Douglas W Arner and Ross P Buckley, 'Decentralized Finance (Defi)' (2020) 6 Journal of Financial Regulation 172; Patrick Schueffel, 'DeFi: Decentralized Finance-An Introduction and Overview' (2021) 9 Journal of Innovation Management I; Claudia Biancotti, 'What's next for Crypto?' [2022] Bank of Italy Occasional Paper Forthcoming; Sabina Marchetti, 'Web3, Blocksplained' [2022] Bank of Italy Occasional Paper. For a critical analysis of the risks and the promises of DeFi, see Sirio Aramonte, Wenqian Huang and Andreas Schrimpf, 'DeFi Risks and the Decentralisation Illusion' [2021] BIS Quarterly Review 21.

[2] For a discussion over the definition of DAOs, see Samer Hassan and Primavera De Filippi, 'Decentralized Autonomous Organization' (2021) 10 Internet Policy Review 1.

[3] Samuel Falkon, 'The Story of the DAO — Its History and Consequences' (*Medium*, 24 December 2017) <https://medium.com/swlh/the-story-of-the-dao-its-history-and-consequences-71e6a8a551ee> accessed 30 September 2023.

[4] Quinn DuPont, 'Experiments in Algorithmic Governance: A History and Ethnography of "The DAO," a Failed Decentralized Autonomous Organization', *Bitcoin and beyond* (Routledge 2017).

worldwide attention. Some examples include DAOs gathering digital artwork[5], raising funds for the Ukrainian army[6], attempting to buy a first-edition copy of the U.S. Constitution[7], and even trying to distribute grants to nurture biotech research.[8] Most of them are projects which engage in venture-style type investments or other forms of funding activity within the crypto world.

Notably, on 6 November 2021, a limited liability company bought 40 acres of land close to the Yellowstone National Park in Wyoming. While this type of transactions happens all the time, the nature of the buyer was somewhat unique: CityDAO is a decentralized autonomous organization running on the Ethereum blockchain, with no official leader.[9] This is only one of the hundreds of DAO LLCs which have been incorporated since the Wyoming's Decentralized Autonomous Organization law became effective on 1 July 2021.[10] The decision to buy the land involved a group of approximately 6000 members debating and taking common decisions online through the chat app Discord. According to their long-term plan, this is just the first step to build a city on the Ethereum blockchain ("an experiment in decentralized ownership of real-world assets" in their own words).[11] Anyone holding one of the 10,000 "citizenship" tokens issued for 0.25 ether each (almost $1000) can vote on what land to acquire and how to use it.

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[5] Jamie Powell, 'SpiceDAO Paid $3m for a Copy of Jodorowsky's Dune' (*Financial Times*, 17 January 2022) <https://www.ft.com/content/e83fe16f-fb28-4795-919e-4f1d314e6794> accessed 30 September 2022.

[6] Cristina Criddle, 'Ukraine Plans to Issue NFT Collection to Fund Armed Forces' (*Financial Times*, 3 March 2022) <https://www.ft.com/content/b4e13435-a818-4d80-94a4-4149a702a094> accessed 30 September 2023; Owen Thomas, 'How War in Ukraine Became War on the Blockchain' (*Protocol*, 3 April 2022) <https://www.protocol.com/newsletters/sourcecode/war-crypto-russia-ukraine> accessed 30 September 2022.

[7] Eric Platt and Madison Darbyshire, "Ken Griffin buys copy of US constitution after bidding war with crypto traders", Financial Times (London, 19 November 2021).

[8] Eric Lipton and Ephrat Livni, "Reality Intrudes on a Utopian Crypto Vision" New York Times (Washington, 8 March 2022).

[9] Miles Kruppa and Hannah Murphy, 'Ken Griffin Buys Copy of US Constitution after Bidding War with Crypto Traders Miles Kruppa and Hannah Murphy' (21 2021) <https://www.ft.com/content/c38b7579-bbba-4a79-b8df-e6dd13c5aa2a> accessed 30 September 2023.

[10] Wy. Stat. § 17-31-101 through 17-31-115.

[11] See Edward Ongweso, 'Crypto Investors Buy 40 Acres of Land in Wyoming to Build Blockchain City' (*Vice*, 11 March 2021) <https://www.vice.com/en/contributor/edward-ongweso-jr> accessed 30 September 2023. On the issues in developing CityDAO, see Jamie Crawley, '"Blockchain City" CityDAO Falls Victim to $95K Hack via Discord' (*CoinDesk*, 14 January 2022) <https://www.coindesk.com/business/2022/01/14/blockchain-city-citydao-falls-victim-to-95k-hack-via-discord/> accessed 30 September 2023.

To date, DAO projects are mainly kicked off by a relatively small community of blockchain proponents claiming that DAOs bring about significant efficiency gain in structuring and governing business activities. However, DAOs have not yet been widely accepted as a form of business organization and some authors even accused DAOs of simply being a bunch of utopian promises that cannot have real-life, scalable applications beyond the small community of blockchain proponents.[12] This article delves deeper into this matter, trying to understand the role of DAOs in the future of business organization beyond contrasted ideological takes on the desirability and the social value of blockchain technology. The key contentious point is the role of the law in disciplining the status of DAOs protocol and the necessity of legal provisions to make DAOs a scalable form of business organization.[13]

In doing so, this contribution builds an analytical framework to understand if and – especially – when DAOs can bring about efficiency gains compared to other forms of business organization. The framework is composed of three main steps: first, why DAOs exists; second, can dominant theories of the firm explain the features of DAOs; third, can DAOs replicate the features of legal forms of business organization through technology.

This article contributes to two separate streams of literature. First, it contributes to the specific literature on DAOs and more generally to the literature on DeFi applications of the blockchain by anchoring the debate to solid theoretical grounds. This allows to formulate hypotheses and propositions about the adoption of DAOs and their desirable legal regime. Second, it contributes to the literature on the development of the business organization forms, positioning DAO and its peculiar technological design within the historical development of the ways in which business activities are organized.

The article is structured as follows. Section 2 sets forth a working definition of DAOs as well as an overview of their functioning. Section 3 sets out the analytical framework considering economic, legal and technological aspects of the business organization of economic activities. Section 4 investigates the main legal problems which could affect DAOs, namely the lack of limited liability, the governance issues and the representation of interests. Section 5 looks at some of the most interesting legislative tools and proposals

[12] See, for instance, Jean-Philippe Vergne, 'Decentralized vs. Distributed Organization: Blockchain, Machine Learning and the Future of the Digital Platform' (2020) 1 Organization Theory 2631787720977052; Jathan Sadowski and Kaitlin Beegle, 'Expansive and Extractive Networks of Web3' (2023) 10 Big Data & Society 20539517231159629.

[13] JG Allen, 'Bodies without Organs: Law, Economics, and Decentralised Governance' (2020) 4 Stan. J. Blockchain L. & Pol'y 53.

which apply to DAOs. Section 6 discusses the role of DAOs as a form of business organization beyond ideological takes about blockchain technology. Section 7 concludes.

2. DAOs Promises: Self-Driven Organizations as an Ideology

DAOs, in their current form, can be understood as collective organizations that run through the automatic functioning of smart contracts. A smart contract is a piece of software run on a distributed ledger enabling the automatic execution of activities based on pre-set contingent rules.

Where DAOs are concerned, these rules typically embed an agreement reached between two or more parties, regardless of their lawful character.[14] In this way, each step of the execution, such as asset transfer, acquisition of information from an external source, and so forth, is timestamped and publicly recorded on the ledger. This means that the activities performed through a smart contract, once recorded on the blockchain, are particularly resistant to being reversed or deleted.[15]

Allegedly, the chief advantage of smart contracts is represented by the substantial reduction of the costs related to the exercise as well as the verification of rights in the context of business relationships. A complex nexus of smart contracts is the backbone of hard-to-change rules under which DAOs are governed. As a consequence, individuals taking part in a DAO do not need to rely on costly intermediaries to control and manage the organization's assets either directly or indirectly.

Thus, according to DAO proponents, there is no actual need to rely on legal formalities among their founders and participants. Rather, with different degrees, members abide by and trust the software and the smart contracts underpinning each DAO – in other words, "rule of code".[16] This is because DAOs run on a blockchain infrastructure, namely a

[14] Riccardo de Caria and others, 'A Digital Revolution in International Trade? The International Legal Framework for Blockchain Technologies, Virtual Currencies and Smart Contracts: Challenges and Opportunities', *Modernizing International Trade Law to Support Innovation and Sustainable Development. Proceedings of the Congress of the United Nations Commission on International Trade Law. Vienna, 4-6 July 2017. Volume 4: Papers presented at the Congress* (United Nations 2017). For a wider analysis of smart contracts, see Max Raskin, 'The Law and Legality of Smart Contracts' (2016) 1 Geo. L. Tech. Rev. 305; Roberto Pardolesi, Antonio Davola, and others, 'What Is Wrong in the Debate about Smart Contracts', *Smart Statistics for Smart Application: book of short papers SIS 2019* (Pearson 2019).

[15] Oscar Borgogno, 'Smart Contracts as the (New) Power of the Powerless? The Stakes for Consumers' (2018) 26 European Review of Private Law.

[16] Usha R Rodrigues, 'Law and the Blockchain' (2018) 104 Iowa L. Rev. 679; Aaron Wright and Primavera De Filippi, 'Decentralized Blockchain Technology and the Rise of Lex Cryptographia' [2015] Available at SSRN 2580664.

decentralized, peer-validated crypto-ledger consisting of a network of nodes that provides a permanent chronological record of all prior changes.[17] Figure 1 illustrates the main steps required to launch a DAO.

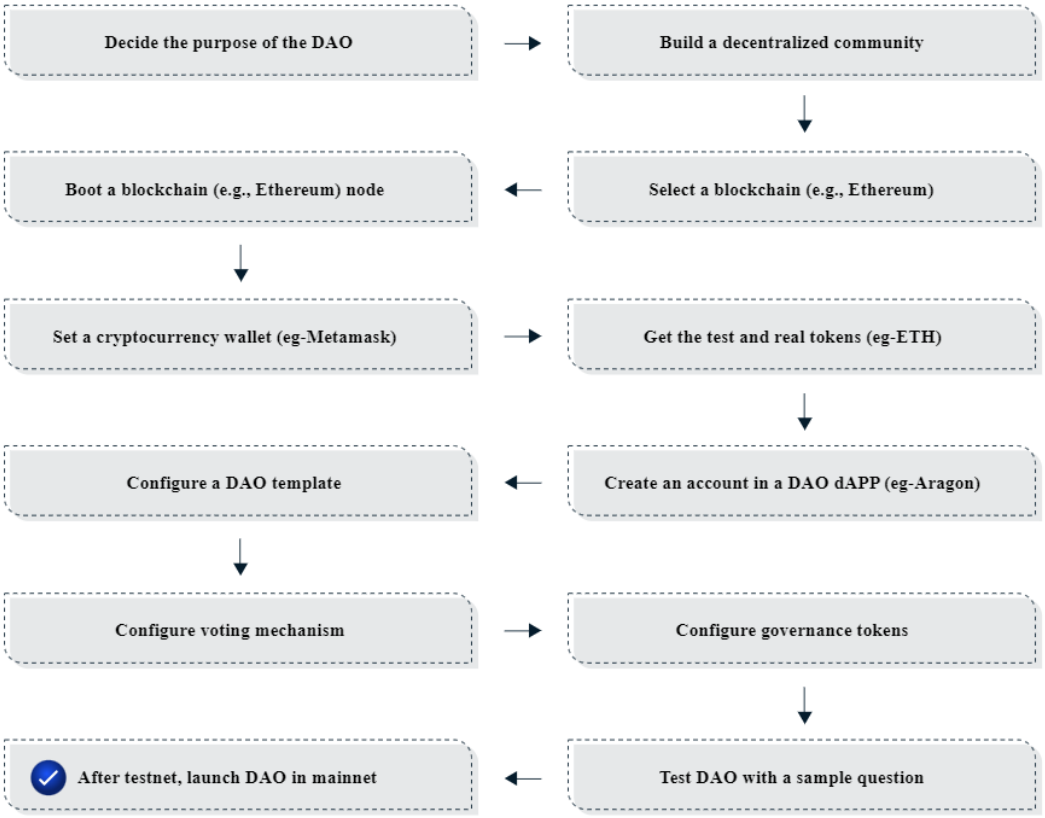

Figure 1: Leeway Hertz (2022).

DAO membership often comes in the form of a blockchain-based token. It can be purchased in exchange for capital or allocated for free by the protocol, can be exchanged in the secondary market and provides specific rights.[18] Some DAOs give members the right to a

[17] For the purposes of the present article, it is worth highlighting the two main distinctions in the realm of DLT: permissioned/permissionless and public/private ledgers. Unrestricted (or permission less) ledgers allow all those with the necessary technical capacity to take part in updating and validating new transactions. Restricted or permissioned ledgers are open only to predefined subjects. In sum, public and private ledgers differ in terms of access rights and visibility to third parties. Anyone can have access to the transactions in a public ledger, whereas a private ones can be read only by predetermined subjects (actual participants, third parties or supervisory authorities). On a related note, it is worth pointing out that validation algorithms on the most long-standing blockchains have proven to be extremely hard to hack. See Rui Zhang, Rui Xue and Ling Liu, 'Security and Privacy on Blockchain' (2019) 52 ACM Computing Surveys (CSUR) 1.

[18] Jonathan Rohr and Aaron Wright, 'Blockchain-Based Token Sales, Initial Coin Offerings, and the Democratization of Public Capital Markets' (2018) 70 Hastings LJ 463, 479.

portion of an organization's profits and losses; others provide their members with the right to access or manage the resources or services that an organization controls.

Governance in DAOs often takes forms that are less hierarchical than traditional corporate organizations.[19] Voting shares are measured through tokens which are distributed to users of the smart contract, as well as the smart contract's initial developers and sometimes the investors who supported the launch. Decisions usually depend on group consensus or majority voting rather than boards of directors or chief executive officers.

In "participatory DAOs", the software is used to aggregate the votes or preferences expressed by members on a continuous basis and translate such information into decisions according to the rules set by the protocol. This type of crypto-organization is commonly used to engage in traditional entrepreneurial endeavours - like venture capital financing - or to manage open-source technology involving a smart contract running on different blockchains (e.g. Ethereum).

A extreme alternative is offered by "algorithmic DAOs" where the management choices are entirely algorithmic in nature. They rely on software to structure and coordinate social interactions, in the same vein as Bitcoin and other decentralized blockchain-based protocols. In its essence, the taxonomy of DAOs can be conceptualized as a spectrum encompassing a diverse range of configurations. This spectrum extends from highly algorithmic entities, in which a multitude of functions (including decision-making and interactions with token-holders) are predominantly automated, to comparatively simpler structures characterised by the use of code primarily for the purpose of record-keeping, as exemplified by Bitcoin.

Less algorithmic DAOs help soften some of the organizational rigidity that accompanies smart contracts which automatize governance activities. By relying on a DAO, the founders, who usually are the initial developers of the smart contract-based protocol, can transfer ongoing decision-making to the software's users and supporters. Developers of these DAOs generally retain the control powers allowing them to update the smart contract itself.

The advocates of this new kind of digital organization argue that DAOs enjoy significant operational efficiencies compared to other organizational forms and are already used to

[19] For an overview of the literature, see Anne Lafarre and Christoph Van der Elst, 'The Viability of Blockchain in Corporate Governance' [2023] European Corporate Governance Institute-Law Working Paper.

manage hundreds of millions in assets.[20] Allegedly, DAOs can rapidly pool and deploy capital, implement low-cost and fast digital voting schemes, harness transparent monitoring procedures that protect assets and reduce the need for ongoing control to target fraud or other insider abuses. That being said, such advantages come with an extremely rigid organizational architecture that makes it next to impossible to change the business model or the inner functioning of a DAO to meet new market dynamics once the token base is highly dispersed. This can be a serious setback, especially for start-ups at an early stage of development when continuous adjustments to the business model and the organization framework are often needed.

As long as DAOs work on a publicly accessible blockchain, transparency and business accountability are expected to be significantly higher than in traditional corporations.[21] By making use of a blockchain-based voting system, members should be able to cryptographically verify the results of member votes (e.g. who voted and how in the absence of secret vote) and whether token holders' identities are correlated with the addresses used for voting. DAO members' decisions are open for public audit by all members of the organization (and potentially even the public), helping to ensure compliance with procedural rules for decision-making and avoid risks of vote miscounting.

A more consistent and streamlined reliance on the voting process, so the crypto-narrative goes, should allow DAO members to take care of the management of organizations. Thus, this new blockchain-based kind of organization is set to make obsolete the old-fashioned primacy of allocating managerial authority in the hands of the board of directors.

Lastly, DAOs are often described as useful tools to cope with misappropriation or the misuse of common funds. As opposed to traditional organizations, DAOs are governed according to rigid rules defined in the code of smart contracts. This should make it possible to structure the business dynamics in a more deterministic manner, with code detailing the

[20] Aaron Wright, 'The Rise of Decentralized Autonomous Organizations: Opportunities and Challenges' (2020) 4 Stan. J. Blockchain L. & Pol'y 1.

[21] For the purpose of this article, it is worth highlighting the two main distinctions in the realm of DLT: unrestricted/restricted and public/private ledgers. Permissionless (or unrestricted) ledgers allow all those with the necessary technical capacity to take part in updating and validating new transactions. Conversely, permissioned (or restricted) ledgers are open only to predefined subjects. Further, public and private ledgers differ in terms of access rights and visibility to third parties. Anyone can have access to the transactions in a public ledger, whereas a private ones can be read only by predetermined subjects (actual participants, third parties or supervisory authorities).

rules under which members and insiders can interact.[22] Other DAOs give members control over any assets deposited into the organization. An increasing number of recently launched DAOs provides members with smart contract-enforced mechanisms to withdraw their investment at any time. This process, emphatically named "rage quitting" provides members with a back-up option and a degree of control over any funds deposited into a DAO. In sum, members can vote to deploy assets for a particular purpose or can withdraw their capital if they disagree with the activities of the organization.

3. The organization of economic activities: law, economics and technology

How to organize economic activities is an everlasting problem of mankind. The most intuitive way to carry out economic activities is via contracts, whereby a party promises to provide a good or service to the other in exchange for some sort of consideration. In this setting, the price determined in the market drives the organization of economic activities. However, contracting is not always possible because of excessive transaction costs, contract incompleteness or other forms of market failures; hence, economic activities can be carried out via a variety of different organizational forms with different levels of centralization.[23]

Descriptively, the organization of economic activities can range from pure spot markets based on contract to full central planning, with several intermediate organizational forms in between these two extremes. Organizations are dynamic and ever-evolving, new organizational forms have emerged and new organizations have arisen as a consequence of technological and cultural changes.[24]

In this broader perspective, the rise of blockchain technology and blockchain-based organizations can be seen as a natural evolution of the menu of possible organizational

[22] For instance, DAOs often allocate organizational duties among members and rely on smart contracts to prevent any DAO-related transaction from taking place absent the express approval of different parties.
[23] Oliver E Williamson, 'Transaction-Cost Economics: The Governance of Contractual Relations' (1979) 22 The journal of Law and Economics 233.
[24] See, for instance, Ron Harris, *Going the Distance: Eurasian Trade and the Rise of the Business Corporation, 1400-1700* (Princeton University Press 2020). For a historical analysis of the role of the law in business organization, see Henry Hansmann, Reinier Kraakman and Richard Squire, 'Law and the Rise of the Firm' (2005) 119 Harv. L. Rev. 1335.

forms, rather than as an unprecedented disruption in the organization of economic activities.[25]

In this context, the first relevant question concerning DAOs is where are they positioned in this spectrum between contracts and planning. In other words, are DAOs organizations? And if so, why the rise of such an organizational form was necessary? Which specific problems of decentralised contracting it aims at addressing?

Positioning DAOs within this broader context is a key step to understanding their role in organizing economic activities in the 21st century. However, this aspect has been completely overlooked by the existing literature, which predominantly took an enthusiastic or sceptical take on DAOs compared to the *status quo*. Section 3.1 positions DAOs in the spectrum or organizational forms; Section 3.2 discusses DAOs vis-à-vis the dominant theories of the firm; Section 3.3 discusses the role of legal organizations for DAOs. Section 3.4 takes a broader look and discusses the role of technological advances in the development of business organizations.

3.1 Are DAOs Organizations?

The debate over the promises of blockchain technology has mainly revolved around the benefits of decentralization.[26] On the other hand, the off-chain economy has often been described as a cluttered group of greedy intermediaries extracting rents and generating inefficiencies.[27] However, the market mechanism underpinning such an off-chain economy is, in principle, the truly decentralized institution where the non-coordinated interactions of self-interested individuals lead to the maximization of social welfare.[28] Therefore, the off-chain pure market economy is the real and most genuine decentralized platform. This is in sharp contrast with the narrative of blockchain proponents where the off-chain firms

[25] On the economic relevance of the choice of enterprise form, see Timothy W Guinnane and Jakob Schneebacher, 'Enterprise Form: Theory and History' (2020) 76 Explorations in Economic History 101331.

[26] Among many, see Sinclair Davidson, Primavera De Filippi and Jason Potts, 'Economics of Blockchain' [2016] Available at SSRN 2744751.

[27] Alex Tapscott and Don Tapscott, 'How Blockchain Is Changing Finance' (2017) 1 Harvard Business Review 2. For a broader analysis on the role of financial intermediaries in the face of technological disruption, see Fatjon Kaja, Edoardo D Martino and Alessio M Pacces, 'FinTech and the Law and Economics of Disintermediation', *Routledge Handbook of Financial Technology and Law* (Routledge 2021).

[28] In the words of Adam Smith: "He intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was not part of his intention guided by the 'invisible hand'". Adam Smith, *The Wealth of Nations* (W Strahan and T Cadell 1776) 454.

are heavily centralized and blockchain technology promises to break such an inefficient centralization.

The market economy in its purest form is – to a large extent – a theoretical construct and does not actually exist. In the real world, we witness many forms of conscious and hierarchical coordination for the production and exchange of goods and services. These arise as a response to market imperfections and, more specifically, to address various limitations of private contracting.

In this context, what are DAOs? A complex set of automated (smart) contracts coping with most of the limitations of off-chain contracting? Or an organizational form that levers on the new possibilities provided by blockchain technology?

DAO stands for 'Decentralised autonomous organization'; however, qualifying a DAO as an organization should not be taken for granted. Rather, we should investigate if and to what extent DAOs help parties to cure the limitation of private contracting or simply expand the possibilities of private contracting. The answer to this preliminary question drives not only our analysis but more radically the whole regulatory approach to this phenomenon.

First, the blockchain technology itself can be understood as a market infrastructure, allowing decentralized exchanges. From this perspective, the difference between the blockchain, a marketplace where fish is sold, and a modern stock exchange is not ontological but is cultural and technological. Crucially, as with any other marketplace, using the blockchain is costly.[29] In other terms, blockchains mimic off-chain markets, promising to reduce the transaction costs of other marketplaces.

If blockchain technology efficiently mimics a pure market economy in allowing peer-to-peer exchange, why should we observe organizations? If the blockchain solves all issues related to private contracting, there are no compelling reasons to have organizational forms to govern the coordination and exchange of crypto assets as it could be efficiently done via individual 'spot' smart contracts.

This would imply that the code deploying the smart contract can discipline all present and future contingencies, devising fully on-chain algorithmic solutions for any possible state of

[29] Edoardo D Martino and Georg W Ringe, 'The Social Cost of Blockchain. Externalities, Allocation of Property Rights, and the Role of the Law' Forthcoming.

the world.[30] At this stage of technology, the blockchain and its applications are not apt to this challenge. However, it is useful to keep this construction as a benchmark. In this context, there would not be any organization since everything would be 'contracted' ex-ante.[31]

On the other side of the spectrum, we observe blockchain applications that provide no room to solve any problem related to private contracting but simply provide a way to record and store transaction data. This other benchmark closely tracks the Bitcoin blockchain. This does not represent an organizational form either as all other governance decisions must be taken through off-chain contracting ex-post.

In between these two extremes, there exist infinite possible variations of blockchain applications that try to address the shortcomings of private contracting with different levels of algorithmic autonomy and encoded rules of decentralized decision-making.

In this legal and economic context, merging the concepts of decentralization, autonomy and organization results in confusion and misunderstandings. The label 'DAO' can be useful in the computer science community or for marketing purposes but says little to nothing for the economic analysis of blockchain-based organizations as well as for the legal debate over their status and regulation.

We should therefore restate the problem and apply the discussion over the desirable legal status and regulation of the blockchain applications that address organizational problems. Such applications will arise when two conditions are met.

First, such applications will arise whenever it whenever it is preferable – ie: cost saving - compared to the coordination and exchange of the crypto activity in the wider blockchain protocol through several, bilateral smart contracts among different nodes. Second, a truly organizational DAO will arise that if that is preferable – ie: cost saving – compared to performing the same activity off-chain, whether through off-chain contracts or off-chain organizations.

Uniswap is a perfect example to understand why both conditions are crucial to understand the rise of a DAO. Uniswap is a DAO that organizes the most successful decentralized

[30] For an overview of the matter, see Rowan van Pelt and others, 'Defining Blockchain Governance: A Framework for Analysis and Comparison' (2021) 38 Information Systems Management 21. See also, Steven A Wright, 'Measuring DAO Autonomy: Lessons From Other Autonomous Systems' (2021) 2 IEEE Transactions on Technology and Society 43.

[31] Eric Maskin, 'On Indescribable Contingencies and Incomplete Contracts' (2002) 46 European Economic Review 725.

exchange of cryptocurrency. Uniswap is governed by the UNI token holders.[32] Uniswap is an intermediate solution between the peer-to-peer exchange of cryptocurrencies and the off-chain, centralized, exchange of cryptocurrencies. On the one hand, Uniswap entails some positive on-chain organizational costs but aims at economizing on on-chain transaction costs, acting as an automated market maker. On the other hand, Uniswap aims at reducing the organizational costs of off-chain centralized exchanges such as Coinbase or FTX.[33]

This conceptualization represents the first step for a simple, non-formal, analytical approach to DAOs beyond ideologic considerations on the desirability of blockchain technology, providing guiding principles on why DAOs exist.

However, the two conditions discussed above are relevant mainly from a conceptual and descriptive perspective. From a more analytical perspective, it is crucial to clearly define what are the problems of private contracting that are usually addressed through organizations and then investigate if such problems can be addressed by blockchain applications. The economic and legal literatures have widely discussed a variety of limitations of private contracting which are solved through organizations.

In economics, organizations primarily solve problems of control. Private contracting can fail in efficiently allocating control in different settings. For instance, when it is necessary to pool capital from several different sources, private contracting cannot handle the agency problems stemming from the separation of ownership and control.[34] Another typical case where organizations help to efficiently allocate control is the impossibility to contractually commit to make an efficient asset-specific investment.[35] These issues are analysed by the theories of firm. Section 3.2 discusses the two dominant theories of the the firm – the agency and the property theories – and applies these to DAOs.

[32] On the governance model of Uniswap, see https://uniswap.org/governance, accessed 30 September 2023.
[33] On the issues related to centralised exchange, see Ilya Kokorin, Tycho De Graaf and Matthias Haentjens, 'The Failed Hopes of Disintermediation: Crypto-Custodian Insolvency, Legal Risks and How to Avoid Them' [2020] Singapore Journal of Legal Studies 526. Centralised exchanges have been on top of the media debate due to several scandals, among which the most well-known is the collapse of FTX. See Douglas W Arner and others, 'The Financialization of Crypto: Lessons from FTX and the Crypto Winter of 2022-2023' [2023] Available at SSRN 4372516.
[34] Hayne E Leland, 'Agency Costs, Risk Management, and Capital Structure' (1998) 53 The Journal of Finance 1213.
[35] Michael H Riordan and Oliver E Williamson, 'Asset Specificity and Economic Organization' (1985) 3 International Journal of Industrial Organization 365.

In the legal sphere, the key problem is to go beyond the *inter partes* effects of contractual arrangements and device solutions that can also bind third parties. For instance, how can the contract concluded between the CEO of a company and a customer be binding and have effects also on other shareholders? Section 3.3 discusses the features of legal organizations of business activities in relation to DAOs.

Finally, Section 3.4 delves into the role of technology in the development of new forms of business organization, showing how technological innovation can both create new ways to organize activities and solicit legal innovations in the field.

3.2 DAOs and the theory of the firm: capital and control

A firm can be defined as an economic unit that organizes its activities according to pre-specified governance rules and not directly according to the price determined by the market. Such governance rules imply some level of centralization and hierarchy in decision-making.[36]

Having a clear understanding of what are the determinants for the existence of a firm is crucial to set an analytical framework for Decentralized Autonomous Organizations. This section refers to two dominant theories of the firm, the agency theory and the property theory, and applies the basic insights of these theories to DAOs.[37] These two theories are largely complementary and non-mutually exclusive, even if they hardly talk to each other and, consequently, gave rise to rather distinct and autonomous streams of literature.[38]

If the basic and utopian promises of DAOs hold true, none of these aspects would be relevant. In its simplest configuration, a DAO does not have a separation between ownership and control and the holders of governance tokens are equally owners and decision-makers. Moreover, hold-up problems should not arise as contractual relationships

[36] The economic literature has treated the existence of the firm as a given for a long time. However, if the economic system is 'automatically' and efficiently governed by the price mechanism, it is difficult to understand the existence of big organizations that are organized differently. In 1937, Ronald Coase proposed a simple and elegant explanation for the existence of the firm which proved extremely influential in economic theory for the decades to come. Using the market, i.e. the price mechanism, entails positive costs – the transaction costs. If the transaction costs of using the market outweigh the organizational cost, then the firm arises. See Ronald H Coase, 'The Nature of the Firm' (1937) 4 economica 386.

[37] See, respectively, Michael C Jensen and William H Meckling, 'Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure' (1976) 3 Journal of financial economics 305; Sanford J Grossman and Oliver D Hart, 'The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration' (1986) 94 Journal of political economy 691.

[38] See, Giuseppe Dari-Mattiacci, 'The Theory of Business Organizations' [2018] Forthcoming in Encyclopedia of Law & Economics, Corporate Law and Economics Adam Badawi, ed., Amsterdam Law School Research Paper 23.

between parties can be ex-ante coded to ensure ex-post automatic enforcement and – accordingly – the allocation of control rights should not be relevant for the efficient investment in DAO activities. This is a specification of the contradiction highlighted above: DAOs' basic promises would make it a contractual arrangement deployed through a complex smart contract and would not display any organizational feature. However, it is sufficient to scratch the surface to see that this does not hold true and that the key organizational features and problems of DAOs arise when the ideological promises surrounding them are disregarded.

3.2.1 Agency costs of DAOs

The basic tenet of the agency theory of the firm is that entrepreneurs are budget-constrained and need external funds to finance their projects. This leads to a separation between ownership and control, generating agency costs – for instance between managers and shareholders or among controlling and dispersed shareholders. The agency costs are ultimately borne by the agent in terms of increased cost of capital. These costs can be reduced by both the agent and the principals through bonding and monitoring activities, which are also costly. In the basic setting, all parties will have incentives to reduce agency costs and maximize the value of the firm, irrespective of any legal obligation. In this setting, the organization acts as a legal fiction serving as a nexus of a set of contractual relationships between the agents and the principals.[39] The firm is therefore necessary because all these contracts could not take place in the spot market but need the existence of a firm with specific governance roles. Therefore, the firm is a device that solves the budget constraints of individuals and facilitates the pool of large sums or resources and, as a by-product, generates agency costs. In turn, these can be conceptualized as a specific type of organizational costs generated by pooling together external capital for joint projects.

From an agency theory perspective, preliminary empirical evidence shows that governance tokens are disproportionately allocated to founders and core developers.[40] This, to the very least, generates an agency conflict between the token holders of majority stakes and the

[39] Jensen and Meckling (n 39) 310.

[40] Johannes Rude Jensen, Victor von Wachter and Omri Ross, 'How Decentralized Is the Governance of Blockchain-Based Finance: Empirical Evidence from Four Governance Token Distributions' [2021] arXiv preprint arXiv:2102.10096. For some corporate law insights from this *de facto* centralizations, see Edoardo D Martino and Simone Spijkerman, 'How Decentralised Are "Decentralised Autonomous Organisations" (DAOs)?' (*Oxford Busines Law Blog*, 11 May 2021) <https://blogs.law.ox.ac.uk/business-law-blog/blog/2021/11/how-decentralised-are-decentralised-autonomous-organisations-daos> accessed 30 September 2023.

dispersed investors, who often show rational apathy in voting as well.[41] The corporate governance literature stemming from the agency theory have long discussed the conflict between majority and minority (share)holders that parallels the DAO case.[42] Such literature developed two approaches to handle this conflict.

The first approach focuses on the protection of minority holders and – more generally – dispersed investors.[43] In line with the basic configuration of the agency theory, limiting the possibility for majority holders to tunnel private benefit out of the firm decrease the cost of external capital and, ultimately, increase the total value of the firm. This approach is particularly valuable when the ownership instruments, shares or tokens, are somehow listed and tradable, as the protection of dispersed investors increases the liquidity of such instruments.

The second approach – the so-called 'idiosyncratic view'– focuses on the importance of the entrepreneurial vision of the founder(s).[44] Such vision is valuable for the firm, but it is difficult to observe ex-ante for outside investors. Therefore, the power of minority investors to influence the founder's decision should be limited and the founder should even be allowed to extract some level of private benefit of control, to incentivize her to fully implement such vision which, ultimately, may create value for the whole firm, including minority investors. This approach is particularly valuable for start-up firms when the upside possibilities are uncertain but sizeable and it is difficult to generate reliable information about the probability of success of the firm.[45]

Interestingly, most DAOs, at least at this technological iteration, are both start-ups where the founders' idiosyncratic vision is crucial and firms that are 'listed' in a public market, since the blockchain is an inherently transactional technology where tokens are freely transferable. In the absence of a clear legal discipline of the matter, the private arrangements – i.e. the DAO code – hold and the anecdotal evidence shows that majority

[41] Tom Josua Barbereau and others, 'DeFi, Not So Decentralized: The Measured Distribution of Voting Rights', *Proceedings of the Hawaii International Conference on System Sciences 2022* (2022). On some possible ways to solve the issues from a theoretical perspective, see Nicola Dimitri, 'Voting in DAOs' [2023] Distributed Ledger Technologies: Research and Practice.
[42] See Fabrizio Barca and Marco Becht, *The Control of Corporate Europe* (Oxford University Press 2001).
[43] John Armour, Luca Enriques and Others, *The Anatomy of Corporate Law: A Comparative and Functional Approach* (Oxford University Press 2017) 79.
[44] Alessio M Pacces, 'Control Matters: Law and Economics of Private Benefits of Control' [2009] ECGI-Law Working Paper; Zohar Goshen and Richard Squire, 'Principal Costs: A New Theory for Corporate Law and Governance' (2017) 117 Colum. L. Rev. 767.
[45] Alvaro Pereira, 'Designing Startup Corporate Law: A Minimum Viable Product' (2022) 40 Review of Banking and Financial Law.

block holders are significantly shielded by the pressure of dispersed investors in DAOs' tokens. To the best of our knowledge, there is no empirical study that attempts to measure this agency cost in terms of the increased cost of capital for DAOs and, conversely, in terms of decreased volume of investment in the industry.

3.2.2 Allocation of Residual Control in DAOs

The 'property theory' of the firm is the second dominant theory of the firm, developed by Grossman and Hart and then further formalized by Hart and Moore.[46] It is important to emphasize that the term "property" is not understood in its legal connotation of *erga omnes* right, but rather in its economic meaning of granting residual control rights. In this setting, the firm is defined as a bundle of assets. The defining feature of the firm is the property of such a bundle of assets. That is what provides the owner with the possibility to decide upon all the non-contracted contingencies.[47] The theory is based on contract incompleteness and the holdup problems that this can create when specific investments are needed.[48] In these cases, the integration of two or more contractual relationships within the firm would incentivize the efficient level of ex-ante investment as long as the ownership is allocated to the potentially held-up party. The hold-up costs can be conceptualized as transaction costs limiting the ability of the price mechanism to efficiently allocate resources.

The core question answered by the property theory of the firm is how to – *rectius*: to whom – allocate the control of the bundle of assets that constitute the firm to make sure that efficient investments are made ex-ante. This theory, in its basic configuration, is not directly applicable to DAOs, as the firm is conceptualized as a bundle of physical assets.[49] However, it is easy to transpose the core idea of control allocation and hold-up for a firm that is made of only digital assets: codes and tokens. All these digital assets are bundled together in the DAO protocol. As discussed above, there is no compelling reason not to have a myriad of bilateral smart contracts allocating digital entitlements, but for the fact that doing so is costly. Centralized controls of the bulk of smart contracts and tokens limit the cost of using the blockchain.

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[46] Oliver Hart and John Moore, 'Property Rights and the Nature of the Firm' (1990) 98 Journal of political economy 1119.
[47] Phillipe Aghion, Nicholas Bloom and John Van Reenen, 'Incomplete Contracts and the Internal Organization of Firms' (2014) 30 The Journal of Law, Economics, & Organization i37.
[48] Riordan and Williamson (n 37).
[49] The Grossman, Hart and Moore theory of the firm that revolves around the ownership had had several extensions beyond physical assets. For a review of that literature, see Robert Gibbons, 'Four Formal (Izable) Theories of the Firm?' (2005) 58 Journal of Economic Behavior & Organization 200.

This goes against the common wisdom of decentralized control by all token holders but matches the empirical evidence of considerable centralization in DAOs, where the initial allocation and the design of the tokens are crucial to determine how the control over the DAO's operation is actually allocated.

However, it is irrefutable that the construct of DAOs makes control allocation more difficult than in off-chain firms. This has an impact on what DAOs can achieve. Unsurprisingly, most of the successful DAOs currently deployed aim at facilitating transactions whereas the aggregation multi-stage processes are still particularly complex. The example of Uniswap is, once again, enlightening from this perspective. This implies that the complexity of contingently allocating control in the blockchain brings about some level of under-investment. To the best of our knowledge, no fully-fledged theoretical or empirical studies have been carried out to investigate hold-up problems in the blockchain. While hold-up and asset-specific, sequential, investment can be seen as less relevant in current DAOs, this is a crucial element for the scalability of DAOs beyond a homogeneous community of blockchain technology enthusiasts. Even more so if the next iterations of the technology will allow for a simpler way to tokenize assets. At that point, the ability to allocate control efficiently over the bundle of digital assets, codes and tokenized assets will be crucial for the adoptability of DAOs as an organizational form.[50] In fact, theory show that if residual control cannot be efficiently allocated, through legal ownership or other means, there will be a structural underinvestment and potentially beneficial projects will be foregone.[51]

Notably, none of these economic theories postulate an actual essential role of the law beyond enforcing contractual arrangements that, in the context of blockchain and DAOs, equals the code. If this was all the story, the promises advanced by the blockchain and DAO enthusiasts would be confirmed even with some level of 'algorithmic incompleteness' as the DAO code could easily achieve second-best solutions. The private development of new coding structures would be beneficial as the blockchain automatically enforces contracts and allows for encoding incentive-compatible devices in the DAO's protocols. In this respect, the traditional legal system should simply avoid interfering and enforce the allocation of decision-making rights performed by the code. However, this approach does

[50] Giuseppe Ferrara and others, 'Physical Assets Tokenization for Blockchain Market', *International Symposium on Intelligent and Distributed Computing* (Springer 2021).
[51] Hart and Moore (n 48).

not take into account that DAOs, in and of themselves, do not exist in the real world. There is, indeed, a difference between the concept of the firm and the concept of (legal) organization. If the firm is a concept indicating the economic unit that organizes the production and exchange of goods and services according to some pre-specified governance rules, the organization is the material entity through which such an economic unit enters into contact with the outside world.

Therefore, the relationships of the DAOs with the outside world, both on-chain and off-chain, cannot be regulated by the DAO protocol itself. Therefore, the next step of our framework consists of bridging the DAO as a firm with the legal status of DAOs.

3.3 The legal organization of business activities and DAOs

Firms and (legal) organizations are different concepts but are often – and mistakenly – used interchangeably by legal and economic scholars. This misconception is relevant also for DAOs, as their acronym denotes them as organizations even if they are closer to the concept of firms as economic units of production and exchange. Delving into the legal organization of DAOs means investigating what are, if any, the third-party effects of DAOs' transactions. This is a crucial and overlooked step in the understanding of what DAOs are and, more importantly, what they can achieve in terms of innovating the organizational forms of business activities. In other words, the discussion over the theories of the firms as applied to DAOs looks at the problem of how to efficiently organize transactions. Whereas the theory of business organization looks at how firms can be legally organized and interact with the outside world. Indeed, the organization – and not the firm – can enter into contracts, sue, be sued, get bankrupt, etc.

In terms of third-party effects, the literature enucleated five key elements to define and classify all the legal organizational forms of business ventures: limited liability; entity shielding; (legal) agency; transferability of shares and capital lock-in.[52]

Limited liability refers to the (in)ability of the company's creditors to seize the assets of the organization's members. Entity shielding, conversely, refers to the (in)ability of the members' personal creditors to have recourse on the company's assets. Legal agency refers to the ability of a manager of an organization to act in the name and on behalf of the entity. Share transferability refers to the (im)possibility to freely transfer tokens representing the

[52] Armour, Enriques and Others (n 45) 1. On capital lock-in, see Margaret M Blair, 'Locking in Capital: What Corporate Law Achieved for Business Organizers in the Nineteenth Century' (2003) 51 UClA l. reV. 387; Margaret M Blair and Lynn A Stout, 'Specific Investment: Explaining Anomalies in Corporate Law' (2005) 31 J. Corp. L. 719.

organization's capital to third parties having the transferee bound by the existing arrangement of the organization. Capital lock-in refers to the (im)possibility of the member of the organization to withdraw the conferred capital at will.

To better grasp these concepts and their relevance for DAOs, it is useful to briefly introduce a paradigmatic example in the business organization landscape, discussing the difference between the corporation and the partnership. Both are forms of business organization. A partnership is a contract between the parties – the partners. In its simplest form, the partnership does not enjoy any of the five characteristics discussed above: partners are unlimitedly liable for the obligations of the venture; partner's personal creditors can attach the partnership assets; there is no legal agency for external managers or active partners; the participation of the partners are personal and cannot be transferred without the agreement of all other partners; finally, the capital provided by partners is not locked in the venture, so that any partner can force the liquidation of the venture.[53] On the other hand, corporations are a form of business organization with legal personality and display all the five characteristics discussed above: shareholders are limitedly liable; their creditors can only attach their shares and not the assets of the corporations; the managers have legal agency so that they act in the name and on behalf of the entity itself; the shares are, in principle, freely transferable; finally, the capital provided by shareholders is locked in the corporation and cannot be attached by shareholders themselves.

This distinction is crucial for DAOs as their early proponents simply assumed that all the five characteristics of the modern corporation would automatically apply to DAOs as well, whereas several court decisions held otherwise.[54] The analysis of the specific legal regime for DAOs is discussed in Sections 4 and 5. However, to introduce the discussion, it is important to notice that the key underlying difference between a corporate entity and a partnership is ultimately the role of the law.[55] To enjoy all the five characteristics discussed above, the organization must be provided with legal personality status. This allows the organization to go beyond *inter partes* contractual arrangements and be able – to the extent

[53] Richard Squire, 'Why the Corporation Locks in Financial Capital but the Partnership Does Not' (2021) 74 Vand. L. Rev. 1787.
[54] For an overview of the cases, see Alan Rosenberg, 'Getting down with DAOs: Decentralized Autonomous Organizations in Bankruptcy' (2022) 41 American Bankruptcy Institute Journal 12.
[55] Henry Hansmann and Reinier Kraakman, 'The Essential Role of Organizational Law' (2000) 110 Yale LJ 387.

and within the limits allowed by the law – to have arrangements that are valid *erga omnes*, therefore that also bind third parties – such as the personal creditors of each shareholder.[56]

Over the centuries, entrepreneurs devised several contractual arrangements that, to an extent, were able to mimic some of the characteristics of the corporate entity. However, only the law can provide them all. The natural follow-up question is to understand if and to what extent technology can also mimic (some of) these characteristics or if the law still has an essential role in the blockchain-based organization of business activities.[57] In DAOs there are two layers of 'third parties': the on-chain and the off-chain actors who interact with the DAO. Especially for the latter, the position of the DAO cannot be a direct function of the technological specifications of the DAOs, rather it is a combination of such technological specifications and the applicable legal regime.

Legal arrangements may be necessary for the scalability of DAOs as a form of business organization even if these are not strictly essential, but only enabling and supporting. Along this line, the ways in which the internal relationships among members are governed also generate several legal issues. All the literature on corporate law and corporate governance has developed from such tension in an attempt to design an efficient legal framework to allow an entity to operate. In DAOs, this discussion should be refurbished, by looking at the code of the DAO protocol that regulates the relationship between members. Indeed, even if (smart) contracts can in principle handle potential agency costs, default legal arrangements can decrease the costs of doing so and allow a wider participation of investors.

3.4 Business organization and technological advancements

The last piece of our analytical framework is the role of technology in the development of new forms of business organization. Providing a complete historical account of such a complex phenomenon is clearly beyond the scope of this contribution.[58] This section limits itself to the discussion of a few examples of technological advancement that brought about a development in the available forms of business organization.

[56] John Armour and Michael J Whincop, 'The Proprietary Foundations of Corporate Law' (2007) 27 Oxford Journal of Legal Studies 429.
[57] Hansmann and Kraakman (n 57) 437.
[58] For a theoretical account, see Louis Galambos, 'Technology, Political Economy, and Professionalization: Central Themes of the Organizational Synthesis' (1983) 57 Business History Review 471.

It is possible to identify two types of technological advancements impacting business organizations. First, technological innovations that trigger organizational developments and technological innovation that enables organizational developments.

In the first category, one can mention the new technology for building vessels that made possible to development of long-distance maritime trade between the 16th and the 17th centuries. To seize these new business opportunities, ventures required a larger amount of capital and better risk-bearing structures.[59] This brought to the emergence of modern corporate forms, first in the Dutch Republic and then in England. For the first time, the law allowed a private entity the privilege to have legal personality, locking in the capital of shareholders and preventing personal creditors from liquidating the venture.[60] Similarly, two centuries later, the rapid development of the railroad technology required the liberalization of the corporate form. For instance, in the US, more and more States liberalized the incorporation of business ventures, and such a liberalization was driven by the growing need to pool capital to build railroad infrastructure.[61] This liberalization allowed any private entity to seek legal personality as long as it abides by the law, without the need to seek for a privilege from the lawmaker.

In the second category, one can mention the invention of the double-entry book-keeping accounting technique appeared in the 14th century and was crucial for the organizational developments in the middle-age, especially for Italian merchants who developed several organizational forms that contractually mimicked many of the corporations' organizational features, such as the limited liability for passive owners and a weak form of entity shieling.[62]

Blockchain protocols and distributed ledger technology are both an enabling and a triggering technology for the development of DAOs as a new form of business organization. Enabling in the sense that the possibility to record and store transaction data, the possibility to device software allowing for partially algorithmic governance decisions, and so forth, generate the possibility to have blockchain-enabled systems to organize business activities – the Decentralised Autonomous Organization. Triggering in the sense that the existence and development of blockchain technology also required the

[59] Giuseppe Dari-Mattiacci and others, 'The Emergence of the Corporate Form' (2017) 33 The Journal of Law, Economics, and Organization 193, 195.
[60] ibid 200.
[61] Henry N Butler, 'Nineteenth-Century Jurisdictional Competition in the Granting of Corporate Privileges' (1985) 14 The Journal of Legal Studies 129.
[62] Hansmann, Kraakman and Squire (n 26) 1367.

development of new organizational forms.[63] Not only the rise of blockchain technology triggered organizational innovation, but the ongoing development of such technology could trigger even a bigger and deeper innovation. In this landscape, there seem to be two crucial aspects. First, the integration of artificial intelligence in blockchain applications could give an important competitive advantage to DAOs compared to off-chain organizations.[64] Second, the growing ability to tokenize off-chain assets in a cost-effective way will expand the possibilities to organize business activities as DAOs as it enlarges the type and volume of operations that can be operated on blockchain. This would provide DAOs with a competitive advantage vis-à-vis the 'simple' peer-to-peer transactions on the blockchain because of the superior governance possibility and adaptability as well as vis-à-vis off-chain organizational forms because of increased transactional efficiency.

4. Reconciling technological promises and legal realities.

4.1 DAO in context

Before delving into the key aspects that shape the legal status of DAOs, we need to refine their 'ideological' promises. Building on the economic, legal and technological framework proposed in Section 3, there are five key analytical points to keep in mind: (1) DAOs are an innovative way to organize the production and exchange of (crypto)assets; (2) as any organizational form, DAOs address a specific set of limitations of private contracting, on- and off-chain; (3) DAO protocols are a way to allocate residual control rights as contracting remains incomplete; (4) DAOs brings about 'agency cost' of decentralised governance; (5) DAOs are not per se legal entities, hence they cannot bind third parties in spite of their technological design.

These points highlight the relevance of the relationship between DAOs as shaped by their technological design and the legal framework for business organization. For any entrepreneur, the choice of the legal form to give to their business project is crucial. In contrast, DAO developer shared a widespread about the autonomy from national jurisdictions and their legal order. However, a broad array of legal issues needs to be sorted out for DAOs to be a scalable organizational form and achieve a widespread application. Relevant legal issues range from the lack of limitation of liability to governance concerns and the definition of token-holders' rights within DAOs. This section abstracts from

[63] See supra, text to note 3030.
[64] Wessel Reijers and others, 'Now the Code Runs Itself: On-Chain and off-Chain Governance of Blockchain Technologies' (2021) 40 Topoi 821.

possible off-chain organizational choices of entrepreneurs, the so-called legal wrappers,[65] and investigates if and to what extent these legal issues can be solved through technological design.

By looking at these problems, it becomes clear that the traditional issues addressed by corporate and organizational law for centuries are not set to disappear once we enter the DAO environment. On the contrary, their theoretical underpinnings are solid and the legal and economic debate should focus on the necessary adjustment of current practices to the new technology. The remainder of this section analyses how the various characteristics of the corporate form apply to DAOs, focusing on the interaction between their technological design and their legal status.

4.2 (Un)limited liability.

According to the mantra "code is law", DAOs are promised to be totally self-sufficient from a legal perspective. No intermediary is required to enable their smooth functioning, including a legal system. After all, smart contracts are praised for functioning as a sort of self-enforcing software mechanism which ensures the performance of an agreement without the need for judicial enforcement.[66] Such an unshakable confidence in the potential of blockchain led a large share of crypto evangelists to believe that there is no need to create an underpinning legal entity.

Unfortunately, this approach would prevent DAOs from enjoying the benefits that usually come with the recognition as a legal entity, namely the ability to shield the personal assets of an organization's directors and owners from creditors. Even though DAOs mimic to a certain extent the functioning and structure of corporations (such as governance rights conferred to token holders along the lines of equity stakes), they do not automatically qualify as legal entities subjected to a limited liability regime. On a broader level, when two or more individuals engage in even a tenuous economic or business relationship, they are deemed a "general partnership" (a sort of *de facto* company). That is to say that the partners of an organization which lacks any corporate form are fully exposed to unlimited liability towards the creditors of the organization itself.

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[65] For an up-to-date overview of the legal wrappers that DAO developers could rely on, see Chris Brummer and Rodrigo Seira, 'Legal Wrappers and DAOs' [2022] Available at SSRN.

[66] Raskin (n 12) 196; Pierluigi Cuccuru, 'Beyond Bitcoin: An Early Overview on Smart Contracts' (2017) 25 International Journal of Law and Information Technology 179, 185.

One could argue that the actual exposure to unlimited liability is quite low as well-designed DAOs would provide for specific compensation schemes and resources to automatically cope with every possible on-chain transaction scenario. Having said that, there is a wide range of potential risks triggering legal liabilities from which DAOs are not exempted. For instance, if a court ordered the members of an unregistered DAO the duty to provide compensation in favour of a specific subject, the relevant financial resources could be released only subject to the rule of the blockchain-based organization. If DAO members were unwilling to abide by the judgment, liability could jointly fall on all individual participants.

This risk has materialized in several judicial rulings as extant DAOs gather a community of members who share a common optimism towards the potential of blockchain applications and are generally aware of the risk of losing their initial investment. Further, a portion of a DAO's treasury could be specifically allocated to work as a self-insurance fund to weather unforeseen circumstances generating liability.[67] However, if DAOs scaled up outside the limited circles of crypto-enthusiasts, they would be unlikely to have sufficient funds to cover potential liabilities.

Under an unlimited liability regime, creditors can request the payment from DAO members that they would be able to reach.[68] Unsurprisingly, the ones with the deepest pockets (or perceived as such) would naturally be the preferred target of creditors. The risk that membership could put the members' assets at an unlimited risk would naturally discourage individuals and legal entities with significant assets on hand (institutional investors and financial institutions) from joining or otherwise supporting unregistered DAOs.

4.3 The Problem of Legal Agency

Legal agency is the status in which a principal – the entity – can authorize an agent to bind the principal with third parties.[69] In other terms, the (legal) agent acts in the name and on behalf of the legal entity. This concept is tightly related to the concept of personality and to the issue of liability.

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[67] See, for instance, United States District Court in Sarcuni v bZx DAO, No 22-cv-0618 (S.D. Cal. March 27, 2023)

[68] There are also important unresolved questions about this theory, including whether each DAO member would be deemed to be a general partner just by virtue of being a token holder, or whether more formal involvement by DAO token holders is required to be liable as a general partner (for example, participating in governance). However, in a worst-case scenario, a DAO member could be responsible for all of the liabilities facing a DAO.

[69] Hansmann and Kraakman (n 45) 406.

In off-chain organizations the law of agency substantiates in the delegated management of corporate entities.[70] In partnerships, the management can be either delegated or remaining within the owners. Understanding who has agency of the organization is crucial as the agent brings the organization to life, entering into contracts, buying property, suing, being sued, and so forth.

This great power entails great responsibilities. Indeed, in partnerships, the manager is jointly, severally and unlimitedly liable for the obligations she enters into. However, the corporate status shields not only shareholders but also the management from the downsides of corporate activities. Moreover, the management is further shielded from the liability deriving from their decision by the business judgement rule.[71]

For DAOs, two key questions arise: who is the agent? What liability regime applies to the agent? This represents one of the instances where the ideological promises of DAO proponents and the legal reality of business organizations differ.[72]

In principle, DAOs can have no formal management. However, the law requires actions to be imputable to some natural or juridical person. This imputability problem is radically different for fully on-chain and automated transactions or for instances where the DAO's activities have some off-chain relevance. In the first instance, the problem of legal agency is residual and largely coincides with the problem of unlimited liability of the members in case of bankruptcy. In the second case, the problem is crucial also in going-concern. Notably, this is the most interesting case for the scalability of DAOs.

In terms of liability regime, without explicit legal provisions, we doubt that limited liability nor something functionally similar to the business judgment rule can be applied to the 'DAO agent', so that their liability would be unlimited. Interestingly, this would apply both in the case of pure DAOs, where the whole business is organized in the smart contract protocol, and in DAOs with a legal wrapper. Those who act in the name of the DAOs would be liable for the obligations of the DAO and for their business decisions.

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[70] Armour, Enriques and Others (n 38) 50.

[71] Adam B Badawi, 'The Business Judgment Rule' [2023] Available at SSRN 4465571.

[72] Mark Fenwick and Erik PM Vermeulen, 'Technology and Corporate Governance: Blockchain, Crypto, and Artificial Intelligence' (2019) 48 Tex. J. Bus. L. 1, 13. For a more balanced view on the matter, see Iris HY Chiu and Ernest WK Lim, 'Technology vs Ideology: How Far Will Artificial Intelligence and Distributed Ledger Technology Transform Corporate Governance and Business?' (2021) 18 Berkeley Bus. LJ 1, 3.

Understanding who can be characterised as an agent for DAOs is complex and the discussion largely mirrors the one on the unlimited liability of the members. Most likely, controlling members can be conceived as agents. Some argue that also the developers of the protocol should be considered as agent and owe fiduciary duties to stakeholders, even if such designation remains vague.[73]

4.4 The virtues of temper-resistant technology for business organization

Organizing activities through tamper-resistant technologies, such as the blockchain, has some interesting by-products in terms of business organizations. One of the core ideas underpinning blockchain technology is that transactions recorded on the blockchain are particularly resistant to outside manipulation.[74] This resistance from the outside world includes the interventions of creditors and judges. As discussed in the previous section, this implies that the liability of token holders is not per se limited, at least towards non-contractual third parties. Conversely, this also implies that the capital and the digital assets within the DAO are particularly difficult to attach by both on-chain and off-chain stakeholders.

This technological design is able to mimic to a large degree some of the core features of the corporate form, namely entity shielding and capital lock-in.

The basic idea behind both entity shielding and capital lock-in is to protect the organization from outside threats that do not directly relate to its business activities. Such protection works towards the personal creditors of the members of the organization, in the case of entity shielding, and towards the members themselves, in the case of capital lock-in. Interestingly, these two features of corporate entities could not be reproduced contractually and the legal intervention of the State.[75] In particular, the technological design of blockchain-enabled smart contracts protects DAOs from inefficient liquidation.

Imagine that the personal creditor of a token holder is unable to realize its claim and wants to attach the creditors' assets. Or, similarly, the token holder herself has liquidity needs and wants to divest from the DAOs. In off-chain organizations, these two instances represent

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[73] Angela Walch, 'In Code (Rs) We Trust: Software Developers as Fiduciaries in Public Blockchains'; Raina S Haque and others, 'Blockchain Development and Fiduciary Duty' (2019) 2 Stan. J. Blockchain L. & Pol'y 1.

[74] While the original promise of absolute tamper-resistance cannot be taken at arm's length, the tamper-resistance of blockchain transactions can be considered one of the promises that better performed in the first decade of blockchain experimentations. See, for instance, David Yermack, 'Corporate Governance and Blockchains' (2017) 21 Review of finance 7, 14.

[75] Hansmann, Kraakman and Squire (n 20); Dari-Mattiacci and others (n 48).

an existential threat to the survival of the entity and only the law can effectively safeguard the organization from such threat bestowing upon them legal personality. In DAOs, the possibility for token holders or personal creditors to force the liquidation of the DAOs, even if it has no legal personality, appears legally dubious, technologically challenging and uneconomical.

The implications of these technological features are rebalanced by the free and easy-to-enforce transferability of tokens. This allows token holders to easily mobilize their capital and to their personal creditors to easily realize the value of the DAOs' tokens.

The free transferability of tokens is the natural and necessary complement to the technology-enabled entity shielding and capital lock-in. The blockchain is an inherently transactional technology so that the transferability of tokens is perhaps the most quintessential feature of DAOs in terms of business organization and corporate governance. Free transferability implies a certain degree of liquidity of the tokens, which makes it more efficient for the token holders and their personal creditors to dispose of or attach the tokens by selling those, rather than forcing the liquidation of the whole DAO.[76]

The relevance of technologically enabled entity shielding and capital lock-in has been completely overlooked by the existing literature and this is not straightforward to explain. One possible explanation is that this requires to look at the theory underpinning business organization, which is an original contribution of this manuscript. More profoundly, one could argue that after the liberalization of the corporate form during the XIX century, these features are relatively easy to achieve; hence their technological replicability is less relevant.[77] However, this would disregard centuries of organizational and legal evolution on how to partition and allocate the ownership of assets, creating specific patterns for creditors or – more generally – third party rights.[78]

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[76] For a parallel argument on corporate entities, see Kenneth Ayotte and Henry Hansmann, 'Legal Entities as Transferable Bundles of Contracts' [2013] Michigan Law Review 715.

[77] There are competing explanations of the liberalization of the corporate form. First, there is a demand-side explanation whereby some capital intensive, long-term projects are better handled by legal persons and hence entrepreneurs required such legal innovation. See Dari-Mattiacci and others (n 48). Second, there is a supply-side explanation whereby the liberalization of the corporate form spread to outperform other jurisdiction and hence attract corporate investment. See Butler (n 50). Third, there is a novel explanation linking the liberalization of the corporate form to the willingness of investors to have a new, liquid, asset class to invest on. See Guillaume Vuillemey, 'The Origins of Limited Liability: Catering to Safety Demand with Investors' Irresponsibility' [2023] Available at SSRN 4351433. It is reasonable to think that a combination of these and potentially other factors contributed to the liberalization of the corporate form.

[78] Hansmann and Kraakman (n 45) 1401.

Contrary to what may appear at first sight, these aspects are not mere relics of the past. The process of asset tokenization aims to increase de-materialization so that property can be easily exchanged through the transfer of tokens in the blockchain.[79] Asset tokenization implies that high transaction costs for exchanging property off-chain are reduced effectively moving such exchanges on-chain. It is reasonable to think that such a shift would bolster the emergence of DAOs to organize and manage this inflow of complex on-chain assets. This would also imply that off-chain assets would be owned by DAOs and their counterparties and that partitioning these assets would be, at least to an extent, a technological feature.

4.5 The challenges of internal governance

By leveraging blockchain-based smart contracts, DAOs promise to streamline voting schemes and engage a larger number of participants in governance and decision-making. Ultimately, in line with the mantra of the crypto community, this would enable the decentralization of entrepreneurial governance. As a greater number of business decisions could be taken by token-holders, DAOs are expected to avoid any reliance on central managers and directors to manage the organization. Having said that, we are still in the early days of DAOs and an optimal governance structure is far from being settled.[80]

Despite all the enthusiasm that comes with decentralized governance and straightforward decision-making, such factors fall short of overcoming the need for corporate governance. In fact, it is not even clear whether complete transparency and decentralization within a business organization are desirable from an incentive-framework perspective.[81] As long as participatory DAOs are concerned, it seems unlikely that a large array of token-holders would have the time and skills to meaningfully engage with the management choices of the

[79] On asset tokenization and the related legal challenges, see Juliet M Moringiello and Christopher K Odinet, 'The Property Law of Tokens' (2022) 74 Fla. L. Rev. 607; Rosa M Garcia-Teruel and Héctor Simón-Moreno, 'The Digital Tokenization of Property Rights. A Comparative Perspective' (2021) 41 Computer Law & Security Review 105543.

[80] See Martino and Spijkerman (n 35) arguing that "DAOs' governance structure largely depends on the initial distribution and the protocol-specific voting mechanisms".

[81] Edmund Schuster, 'Cloud Crypto Land' (2021) 84 The Modern Law Review 974, noting that "It is hardly surprising that the challenges posed by blockchain technology can be avoided by adopting a design which removes the very feature of blockchain technology which distinguishes it from other, existing and widely available systems, ie the reliable establishment of consensus between parties who do not necessarily know or trust each other". See also Martin Walker, '"Unnecessary Complexity": The Crypto Industry's Continuing Efforts to Avoid Regulation' (*LSE Business Review*, 13 October 2021) <https://blogs.lse.ac.uk/businessreview/2021/10/13/unnecessary-complexity-the-crypto-industrys-continuing-efforts-to-avoid-regulation/> accessed 30 September 2023.

organization. Indeed, direct voting involves a constant alignment between token holders and the DAO itself. Potential frictions among members could even lead to higher inefficiencies compared to traditional hierarchical organizations. Indeed, the concepts of "direct democracy" and active member participation applied to DAOs showed all their limits when faced with the old-fashioned issue of voter apathy.[82]

To solve these problems, new attempts have been put forward to facilitate participation in governance-related decisions and alleviate voter apathy. For instance, there are DAOs in which votes are weighted according to how long a token-holder support a specific proposal in order to take into account individuals' conviction.[83] An alternative solution is the so-called "quadratic voting" which is based on the willingness of each member to pay for achieving a given outcome.[84] Finally, developers tried to tackle the problem by replicating traditional corporate law mechanisms, such as proxy and quorum voting. This is an arguably disappointing result if tested against the promises of disruptive decentralization extolled by crypto enthusiasts.

A more drastic way to circumnavigate frictions related to individuals' limited rationality and information asymmetries is to rely on algorithmic DAOs. Such an option implies that token holders should fully trust the functioning of the underlying code. The only governance tool in their hand would be the choice to acquire – or not acquire – the related tokens.[85] Needless to say, algorithmic DAOs build on the (bold) assumption that the underlying code is actually fit for purpose and capable of automatically drive the organization throughout its life. In particular, such a concept implies the ability to rely on artificial intelligence systems to automatically manage a complex organization, ultimately making self-driven companies possible.[86]

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[82] Darcy WE Allen and others, 'Cryptodemocracy and Its Institutional Possibilities' (2020) 33 The Review of Austrian Economics 363; Qinxu Ding and others, 'Voting Schemes in DAO Governance' [2023] Forthcoming in Annual Review of Fintech.

[83] Jeff Emmett, 'Conviction Voting: A Novel Continuous Decision Making Alternative to Governance' (*Medium*, 7 March 2019) <https://blog.giveth.io/conviction-voting-a-novel-continuous-decision-making-alternative-to-governance-aa746cfb9475> accessed 30 September 2023.

[84] Nicola Dimitri, 'Quadratic Voting in Blockchain Governance' (2022) 13 Information 305; Alon Benhaim, Brett Hemenway Falk and Gerry Tsoukalas, 'Balancing Power in Decentralized Governance: Quadratic Voting under Imperfect Information' [2023] Available at SSRN.

[85] Carla L Reyes, '(Un) Corporate Crypto-Governance' [2021] Russ. J. Econ. & L. 135.

[86] This essay does cover the fascinating relationship between AI and business organization. For a complete overview of the matter see John Armour and Horst Eidenmuller, 'Self-Driving Corporations?' (2020) 10 Harv. Bus. L. Rev. 87.

In case of software bugs or problems due to unforeseen circumstances which cause the DAO to experience technical disruptions, members can either abandon it or modify the underlying software thereby giving rise to a "fork" of the DAO with updated rules and hoping that the other token-holders move their assets to the new entity.

4.6 All around DAOs

There are blurred lines between governance tokens and traditional securities. Economic rights, participation rights, governance rights, and utility rights can all be associated with tokens which are then sold to the public in ways that are similar to a traditional initial public offering.

Jurisdictions around the world are still grappling with the question of whether tokens should be treated as financial securities from a regulatory perspective. If they are, it follows that the issuer must comply with disclosure requirements and disclosure obligations.[87] Since most DAOs work with tokens providing non-traditional interests (e.g., a digital token that solely provides governance earned through use), it is highly disputed if they should be deemed as equity securities (or even securities at all). Under modern corporate laws of most countries, DAO developers will struggle with finding a structure that does not either (i) risk the potential unlimited liability of general partnerships, or (ii) risk that the DAO interests are deemed securities by market supervisors, tax authorities, and courts.

Further, such issues are set to influence the ability of markets to rightly price governance tokens. As things stand, information costs are expected to be significant as market players would need to understand what the code embedded within a specific DAO means and how it works. Even though an in-depth analysis of taken-related financial regulation goes beyond the scope of the present work, it is worth highlighting that private ordering alone could fall short of ensuring the informational efficiency of crypto markets. Thus, since governance tokens are a major factor in the functioning of DAOs, new legislative initiatives should aim to clarify the boundaries and the nature of such new assets.

Last but not least, DAOs raise serious issues when it comes to tax enforcement over token-holders. The emergence of blockchain-based anonymization techniques and decentralized exchanges compromise the enforcement of a regulatory framework for taxation akin to that

[87] In the US, Section 12(g) of the Securities Act of 1934 provides that a company is required to register with the SEC and comply with ongoing disclosure requirements if it has more than $10 million in assets and a class of *equity* securities that are "held of record" by either 2,000 persons or 500 persons who are not accredited investors.

of cloud-based agents.[88] Since DAO processes and procedures are carried out by code existing in cyberspace, they cannot be conventionally connected to an agent or a specific jurisdiction. This means that token holders, rather than being above (or outside of) the law, are exposed to a high degree of legal uncertainty and fiscal liabilities.

5. Navigating the Legal Crypto-Landscape.

5.1 DAO Structure and Governance with Current Law

When it comes to the legal status of blockchain-enabled organizations, it is worth drawing a main distinction between registered and unregistered DAOs. The former are those registered within a corporate registry and managed in compliance with the laws of the jurisdiction where they operate. The latter rely exclusively on informal cooperation based on software. From a practical viewpoint, the absence of a formal legal identity can generate any number of troubles for DAOs when interacting with the off-chain environment. Opening bank accounts, hiring employees, paying taxes, contracting with services providers, and so on, become significantly more difficult or even impossible, without a formal identity.

Notably, an increasing number of DAO initiatives have managed to obtain a legal entity status by offshoring in jurisdictions other than that of operation with favourable tax frameworks (e.g. the Cayman Islands, Singapore, Panama, Switzerland and Ireland). Those jurisdictions offer the opportunity to set up foundation entities with a very flexible governance structure. In its very essence, the foundation regime ensures that proposals which were validly executed on the blockchain are closely replicated off-chain so that the DAO can legally operate in the outside world. However, the choice to rely on a foreign jurisdiction comes with substantial barriers to entry and legal uncertainties (from a tax law and employment law perspective).

Further, one should not forget that under existing legal systems, it is a tricky task to identify with certainty the jurisdiction which applies to a specific DAO.[89] This does not mean that

[88] See David Shakow, "The Tao of The DAO: Taxing an Entity That Lives on a Blockchain" (2018) 160 Tax Notes 929, 937, arguing that "the pure blockchain form does not work well for an entity under the IRC [United States Internal Revenue Code]"

[89] According to international private law principles, the jurisdiction which applies to entities is largely based on the place of incorporation of such organisation (incorporation theory) or the place where key managerial decisions of such organisation are taken (real seat theory). Since DAO are based on digital and decentralized ledgers, traditional principles are not very helpful in delivering legal certainty and predictability.

DAOs and token holders can easily avoid law enforcement. In fact, national laws statutes allow courts to stretch their jurisdiction to non-resident entities whenever they have 'sufficient minimum contacts' within the state (so-called "long arm statutes"). What falls within the umbrella of such minimum contacts is a matter of case-by-case evaluation by the government, agencies and courts. Factors that are usually considered by lawyers are the presence of transactions within the jurisdictions, or the execution of a tort in the state or the residency of the consumers who allegedly incurred damages. In order for DAOs to avoid legal uncertainty, it is thus preferable to choose a specific jurisdiction by means of legal incorporation. For some crypto enthusiasts, legal formalities defeat the point of DAOs, which usually aim to employ "direct democracy" and non-hierarchical governance systems with fluid membership bases under which participants are also decision-makers.

However, the reasons which usually lead traditional businesses to form legal entities are appealing also to DAO developers, regardless of the most extreme narratives under which blockchain-related implementations are set to overcome legal systems and a clear path to limited liability is key to put DAOs to good use for society. In particular, a legal entity officially recognized within a specific jurisdiction allows to partition assets, to secure limited liability, and benefit from an autonomous corporate legal personhood for the DAO itself (in this way the DAO's representatives would be able to sue and negotiate agreements in the entity's name).[90] It is widely acknowledged that business players need certainty with regard to the contractual counterparties they are negotiating with and which assets are available to meet potential future liabilities.

Having said that, the main issue policymakers are facing is the degree to which the substitution of blockchain-based governance for traditional structures should be legally accommodated. This challenge stems from the inherent features of this new kind of digital organization. While traditional corporate governance deals with the impossibility of complete contracting by means of a wide array of "gap fillers" (e.g. fiduciary duties), most DAO advocates purport to avoid any such legal tools through code-based mechanisms. Notably, the rules behind the DAO's architecture have to be comprehensive before the underlying smart contracts are launched. If the smart contract code is exposed to a particular vulnerability, that (hidden) flaw has the potential to be exploited, ultimately disrupting the DAO. The necessity to take into account any potential future scenario that could arise is set to be a major weakness of DAOs, especially in light of the difficulties of

[90] Hansmann and Kraakman (n 45).

enforcing legal rules and relying on judicial intervention within blockchain environments.[91] Having said that, it is not entirely clear whether or not fiduciary duties in the field of corporate governance can be satisfied by software and, even more fundamentally, what smart contracts automation means in the context of fiduciary duty.

Further, one should consider that forcing DAO developers to rely on legal agreements and formalities on top of their digital activity would hinder blockchain-related innovation. Arguably, the obligation to enlist lawyers and other professional consultants to follow the creation and the development of a DAO could run against the original crypto objective not to rely on intermediaries and move quickly in the web3 environment.[92]

5.2 DAO Structure and Governance with DAO-specific laws

For starters, it is worth highlighting that only two of the problems identified in Section 3 are targeted by new legislative initiatives, namely the legal status of DAOs and tokens. Conversely, the issue of decentralized governance is not addressed. This can be explained by the fact that from a legal perspective, it is already possible under specific circumstances to delegate most managing powers to token-holders.[93] Of course, the question remains of whether such decentralization is actually feasible to facilitate the DAO functioning.

While the EU still lacks a fully-fledged legislative strategy targeting DAOs, in September 2020 the European Commission put forward the Proposal for a Regulation on Markets in Crypto-assets (MiCA) to set a legal standard governing the crypto-economy.[94] This piece of legislation is intended to lay down uniform rules on transparency and disclosure requirements for the issuance, offer to the public and admission to trading of crypto-assets. In addition, there are rules on the authorisation and supervision of crypto-asset service providers and their issuers.

As the MiCA proposal recently exited trilogue negotiations, the European Parliament and the Council are now expected to officially approve the provisional political agreement

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[91] Nathan Tse, "Decentralised Autonomous Organisations and the Corporate Form", Victoria University of Wellington Law Review (2020).

[92] Marchetti (n 3).

[93] Edmund Schuster, "DAOs are better than corporations?", The Blockchain Debate Podcast, available at <https://podcasts.apple.com/us/podcast/motion-daos-are-better-than-corporations-kain-warwick/id1493609456?i=1000538460790>

[94] Regulation (EU) 2023/1114 of the European Parliament and of the Council of 31 May 2023 on markets in crypto-asset [2023] OJ L 150/40.

reached on 30 June 2022.[95] It is interesting to note that the negotiating position adopted by the Economic and Monetary Affairs Committee of the European Parliament on 14 March 2022 amended the original draft with new provisions targeting DAOs.[96]

According to the European Parliament, a new recital should recognize that "some types of crypto-assets are not issued by legal entities, but are instead managed by decentralised autonomous organisations".[97] Notably, the draft sets forth a legal definition of a DAO, meant as "a rule-based organisational system that is not controlled by any central authority and whose rules are entirely routed in its algorithm".[98] DAOs should thus be admitted to offer crypto-assets to the public or seek admission of such crypto-assets to trading on a trading platform for crypto-assets. Having said that, the European Parliament proposed to entrust competent authorities with the task of ensuring that DAOs comply with all the requirements laid down in the regulation for other crypto-assets (such as the notification and publication of an appropriate white paper as well as the authorization regime).[99]

After the political accord in October 2022, MiCA no longer mentions DAOs specifically. This means that fully decentralized DAOs are not currently under MiCA's jurisdiction. However, the actions of individual members within these DAOs may still have legal consequences. It could be argued that if a DAO, even if not fully decentralized, issues tokens classified as crypto-assets and provides services falling within MiCA's scope, it must comply with MiCA's requirements. As MiCA becomes applicable at the end of 2024, DAOs will need to establish legal personality or a legal status that ensures a level of protection for third-party interests equivalent to that of legal persons. They should also be subject to prudential supervision appropriate to their legal form. For instance, DAOs might issue crypto-assets, but these can only be offered to European citizens by a registered CASP. Notably, MiCA does not specify the particular form of legal personality that DAOs should adopt, which may lead to potential regulatory fragmentation.[100]

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[95] European Council, "Digital finance: agreement reached on European crypto-assets regulation (MiCA)" (30 June 2022).

[96] European Parliament (2022), "Report on the proposal for a regulation of the European Parliament and of the Council on markets in crypto-assets and amending Directive (EU) 2019/1937", COM(2020)0593 – C9-0306/2020 – 2020/0265 (COD).

[97] European Parliament (2022), Recital 13(a).

[98] European Parliament (2022), Article 3(1)(1a)

[99] European Parliament (2022), Article 3(b).

[100] Ellen Naudts (2023), 'The future of DAOs in finance: In need of legal status' ECB Occasional Paper Series, https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op331~a03e416045.en.pdf.

On the other side of the Atlantic, neither Congress nor any federal agency has yet passed specific regulations on DAOs. However, on 7 June 2022, Senator Kirsten Gillibrand (D-NY) and Senator Cynthia Lummis (R-WY) introduced the Responsible Financial Innovation Act (RFIA) with the goal of establishing a comprehensive regulatory framework for digital assets in the United States.[101] On 12 July 2023 the proposal was reintroduced to incorporate substantial feedback from stakeholders, including regulatory agencies such as the SEC and CFTC, experts in illicit finance, technologists and financial institutions.[102] As the Securities and Exchange Commission (SEC) and the Commodities Futures Trading Commission (CFTC) lack explicit authority on the issue, they implemented a "regulation-by-enforcement"[103] approach with the goal of shaping the legal framework for cryptoassets. Having said that, federal agencies are clearly struggling to apply existing laws to innovative crypto-products.

To the contrary, several US jurisdictions tried to fill the regulatory gap with crypto-tailored legislative initiatives. Delaware and Vermont made some steps over the last years, but Wyoming has taken a leading position with the goal of establishing a friendly reputation towards the blockchain community by means of a favourable legal framework. On 1 July 2021 the state passed a law granting DAOs the status of limited liability companies.[104] However, this initiative was harshly criticized for classifying all DAOs as being member-managed unless they opt to be "algorithmically managed".[105] This means that a start-up DAO cannot be nurtured and grown by an initial group of founders when it is at its most vulnerable stages of development. In fact, DAOs are often launched in a centralised

[101] This proposal defines DAOs as organizations (i) which utilize smart contracts to effectuate collective action for a business, commercial, charitable, or similar entity, (ii) the governance of which is achieved primarily on a distributed basis, and (iii) which are properly incorporated or organized under the laws of a State or foreign jurisdiction as a decentralized autonomous organization, cooperative, foundation, or any similar entity. See: <https://www.gillibrand.senate.gov/news/press/release/-lummis-gillibrand-introduce-landmark-legislation-to-create-regulatory-framework-for-digital-assets> accessed 22 June 2022.

[102] Kirsten Gillibrand, Press Release, 12 July 2023, https://www.gillibrand.senate.gov/news/press/release/lummis-gillibrand-reintroduce-comprehensive-legislation-to-create-regulatory-framework-for-crypto-assets/.

[103] By the concept "regulation-by-enforcement" is usually meant the willingness of Government agencies to extend the boundaries of existing laws into new areas (such as the crypto industry), even in the absence of perfectly fitting regulation providing market players with legal certainty and predictability, see Chris Brummer, Yesha Yadav and David T Zaring, 'Regulation by Enforcement' [2023] University of Southern California Law Review, forthcoming.

[104] Pursuant to § 17-31-104(a), a decentralized autonomous organization is precisely a limited liability company whose articles of organization contain a statement that the company is a decentralized autonomous organization.

[105] Unfortunately, the bill does not clearly define what "algorithmically managed" means. See 17-31-104(e).

fashion, granting a sufficient amount of governance tokens to the founders so to ensure the core functionality and carry out the necessary code overhauling. After this starting phase, the governance tokens are allocated among the other (non-developing) supporters as provided for in the protocol. It is likely that such a process requires different legal entities according to the development phase of the DAO at stake.

Arguably, this kind of legislative efforts can be considered a form of legal branding rather than a true innovation for corporate governance. The reason for this is that they try to fit intrinsic features of DAOs into existing legal business structures.[106] However, traditional legal entities were designed with traditional corporations in mind, and based on the 20th century assumptions about individuals' ability to collectively associate themselves. It is hardly the case that the alleged innovative potential of DAOs can be fully harnessed by relying on traditional legal structures which do not account for the inherent features of blockchain-based entities.

The most interesting alternative to the creation of new types of registered DAO forms is the proposal to rely on "regulatory equivalence".[107] This concept requires identifying the policy objective of a regulation in order to figure out whether a particular technology can achieve that same purpose, being then subject to the same rules already provided for traditional businesses.

A notable example of regulatory equivalence is the relationship between registration requirements for corporate entities and the use of a DAO on a blockchain. Registration requirements are justified by the objective of publicity and reliability, which is underwritten by the trust that market players have in public supervisors. Similarly, the implementation of a smart contract on a blockchain with relevant data about a DAO can achieve the policy objectives of publicity and certainty without the need to rely on third-party ledgers.

This approach represents a valuable alternative to the current fragmentation trend witnessed by several corporate governance systems. Further, as it embeds new technologies into the existing legal framework, it does not necessitate large-scale legal reforms. On the downside, such a proposal may not be easy to turn into legal reality as it implies that the current state of the art of blockchain technologies offers workable solutions to achieve the

[106] Schuster (n 68); Brummer and Seira (n 52).

[107] Regulatory equivalence in its most common use refers to the equivalence of the regulatory regime of two different jurisdictions, often in the context of trade or financial regulations. The proposal was put forward in November 2021 by Choi, C., De Filippi, P., Dudley, R., Elrifai, S., Fannizadeh, F., Guillaume, F., Leiter, A., Mannan, M., McMullen, G., Riva, S., Shimony O.

same levels of transparency, accessibility, and openness available with traditional registries. To be sure, experiments and sandboxes should be initiated to test current solutions and assess their ability to perform better than traditional legal procedures.

6. DAO Beyond ideology: what's left?

After the discussion on the theory of the firm and of business organization, their application to DAOs and the possible applicable legal regimes; it is time to answer the fundamental question of this article: beyond the ideological takes in favor of DAOs, is there something left?

One could legitimately wonder whether DAOs are a truly genuine breakthrough able to change business or even social dynamics or an empty attempt by a small but vocal crypto community to achieve the "promised land" of decentralization and transparency by means of blockchain technology.[108] The analysis highlights that, to an extent, both the options are true. DAO proponents clearly overshoot the promises of DAOs as an organizational form especially in relation to decentralization and autonomy from the legal framework. On the other hand, the technological design of DAOs can achieve results that are not replicable with other organizational forms, especially in terms of ownership structure, asset bundling and control allocation. Interestingly, this narrative seems to diverge from the mainstream premises of contemporary corporate law, which disproportionately focuses on the effects of the separation of ownership and control of the firm.[109] The analysis showed that, beyond ideology, there are instances in which organizing business through DAOs is preferable compared to using the on-chain or off-chain alternatives.[110] However though these

[108] On the tension between innovation and the 'Nirvana' fallacy in the corporate context, see Luca Enriques and Dirk A Zetzsche, 'Corporate Technologies and the Tech Nirvana Fallacy' (2020) 72 Hastings LJ 55. On the actual decentralisation and democratization brough by DAOs and by DLT technology in general, see Sarah Azouvi, Mary Maller and Sarah Meiklejohn, 'Egalitarian Society or Benevolent Dictatorship: The State of Cryptocurrency Governance', *Financial Cryptography and Data Security: FC 2018 International Workshops, BITCOIN, VOTING, and WTSC, Nieuwpoort, Curaçao, March 2, 2018, Revised Selected Papers 22* (Springer 2019).

[109] See, for instance, Frank H Easterbrook and Daniel R Fischel, *The Economic Structure of Corporate Law* (Harvard University Press 1996). The focus on the separation between ownership and control is part of the intellectual and cultural impact of the research by Jensen and Mechkling on agency theory. However, there are many relevant aspects of corporate law which are even more relevant in DAOs, that cannot be explained only referring to the contractarian literature. On this strand of literature, see Armour and Whincop (n 46); Dari-Mattiacci (n 31).

[110] Reaching results that sharply differ from those of Kelvin FK Low, Edmund Schuster and Wai Yee Wan, 'The Company and Blockchain Technology'.

instances may well be different in magnitude and nature from those purported by DAOs proponents.

At this stage, there are no clear-cut answers as to what and how much is left. However, we can derive some basic guidelines as to when a DAO organization is likely to arise. In so doing, we distinguish between economic, technological and legal features related to DAOs. This distinction is somehow artificial as these aspects often overlap and interact with one another; however, it remains useful for explanatory and analytical purposes.

Starting with the economic aspects, the key features are the agency and hold-up costs. The question is whether DAOs decrease agency costs compared to off-chain organizations and if DAOs decrease hold-up costs compared to the blockchain infrastructure or the off-chain market. These dimensions are heavily affected by the level of automation of the smart contract underpinning the DAO, ie the extent to which it is possible to ex-ante 'complete' the (smart) contract.[111]

In terms of agency, DAOs clearly entail positive agency costs. The level of autonomy algorithmically encoded in the smart contract is crucial The initial allocation of tokens shapes the control of the DAO and block holders can easily control the key deliberations, especially considering that dispersed token holders appear to be rationally apathetic, as in off-chain listed companies.[112]

In principle, the more algorithmically automated a DAO is, the more likely is to reduce agency costs, as the algorithm is likely to act as a near-to-efficient bonding device.[113] Agency costs can come back and be particularly severe if someone, such as the founder or a small group of core developers, can update the initial protocol, especially if tokens are disproportionally allocated initially. On the other hand, as the founder and core developer have control over the DAO set-up, the algorithm can be used to extract private benefit from such control. From this perspective, less automated and more participatory DAOs can decrease this type of agency cost.

In terms of hold-up costs, the possibility to allocate control over non-contracted contingencies is crucial. In this regard, near-to-fully automated DAOs can entail significant hold-up costs as the allocation of residual control rights is difficult to achieve because of

[111] Text to note 31.

[112] For the centralization of initial allocation, see Jensen, von Wachter and Ross (n 35). For rational apathy in voting behaviour, see Barbereau and others (n 36).

[113] All these arguments go under the assumptions that all parties can understand the underlying algorithm and the algorithm is written benevolently.

the rigidity and 'immutability' of the construction. Founders and core developers often have the power to upgrade the algorithm. However, in all instances where the party that is held up is not the founder, this does not cure the problem, rather it increases it.[114] DAOs that are more open to participatory adjustments and updates seem a better fit to address hold-up problems and correctly allocate residual control rights, as long as the voting system works genuinely.

Therefore, in agency cost and control allocation terms, DAOs can marginally decrease organizational costs compared to odd-chain alternatives, especially in settings that are fully on-chain, repetitive and non-strategic, such as the activity of market-making discussed in the Uniswap example.[115] However, there will also be several instances in which such costs can considerably increase, especially when the need for the efficient allocation of residual control rights is particularly relevant and the initial allocation of tokens consolidates control upon the founder or core developers. In the former case, we expect a structural underinvestment in DAOs. In the latter case, we expect the cost of capital to increase. Both these instances decrease the likelihood of DAOs to arise.

The second key dimension to understand the likelihood of organizing business through DAOs is possible technological advancements. Intuitively, the more the blockchain technology allows business players to operate on-chain, the more likely is a DAO to arise compared to off-chain alternatives. These aspects are not directly related to the design of DAOs, to their agency and hold-up cost or to their legal configuration, rather these can be understood as exogeneous innovations that enlarge the DAOs' production frontier and – all else being equal – make DAOs more likely to be used to organize business activities.

In this regard, the key advancement that is currently ongoing is asset tokenization. The easier, cheaper and legally sound is to pass the property of physical assets through tokens, the more likely is for business activities to be organized as DAOs.

Another crucial technological aspect is the development of Artificial Intelligence applications and their integration into business activities. Artificial intelligence has the potential to decrease both off-chain and on-chain costs of organizing business activities as

[114] On the high cost of hold-up and ex-post adjustment in the general setting of smart contracts, see Massimiliano Vatiero, 'Smart Contracts vs Incomplete Contracts: A Transaction Cost Economics Viewpoint' (2022) 46 Computer Law & Security Review 105710.
[115] Text to note 32.

well as the costs of off-chain market transactions.[116] Therefore, the net result of artificial intelligence development in terms of the likelihood of DAOs emergence remains unclear.

Finally, the legal configuration of DAOs affects their likelihood to arise. In this realm, we should distinguish between the regulatory compliance costs stemming from crypto assets regulation and the impact of the legal status of DAOs as business organizations.

Regulatory compliance with crypto regulation does not have a direct impact on the analysis of the organizational virtues of DAOs. Rather, it can be conceptualized as a fee that DAO projects need to pay for the use of blockchain technology sanctioned by law. In exchange for such a 'fee', compliance can decrease DAOs' cost of capital thanks to the increased investor confidence generated by a trustworthy legal regime that decreases the risk of adverse selection in crypto investing. On the other hand, also off-chain organizations incur compliance costs, and these are likely to be larger.

As per the legal status of DAOs as business organizations, we clearly need to distinguish between their status under default legal arrangements and under DAO-specific legislation.

Looking at default legal arrangements, a DAO can either be an informal, unincorporated, partnership or adopt some specific legal status through its legal wrapper. In the first case, DAOs are clearly less likely to arise as the liability status of token holders and legal representation of the entity is unclear. Accordingly, more mature DAO projects employ wrappers such as offshore corporations or foundations. This marginally increases compliance costs, but sharply decreases the cost of capital, as token holders are sure that their liability is limited. However, the use of legal wrappers can amplify agency and hold-up costs. In fact, the organization will be subject to the specific costs entailed by the organizational form in which the DAO is wrapped. Moreover, the existence of a legal wrapper potentially duplicates the control allocation and agency problem, as the DAO can be understood as an entity controlled by the wrapper itself, giving rise to dynamics similar to those of the corporate groups.[117]

DAO-specific legislation is a more promising avenue to unleash the potential of DAO as an organizational form or at least to test if such potential is there. The advantage of DAO-specific law, compared to the use of legal wrappers, is that the can actively shape the

[116] Christopher M Bruner, 'Distributed Ledgers, Artificial Intelligence and the Purpose of the Corporation' (2020) 79 The Cambridge Law Journal 431; Armour and Eidenmuller (n 73).

[117] For an overview of the issues related to the corporate groups, see Mariana Pargendler, 'The New Corporate Law of Corporate Groups' [2023] European Corporate Governance Institute-Law Working Paper 6–15.

property foundation of the organization and the agency relationship in its internal governance. This increases the organizational costs of DAOs, at least from the perspective of the founders, but can sharply decrease agency and hold up costs, favouring the adoption of DAOs anytime that the technological specification of the business would make it desirable while controlling for potential adverse consequences of DAOs activities. At the same time, it is important to keep in mind that the kind of legislation we are arguing for should not be confused with the legal branding initiatives implemented so far in the United States. Rather than forcing the inherent characteristics of DAOs into existing legal business structures, it is key to rely on "regulatory equivalence". This means that legislators should identify and allow what DAO and the underpinning block chain infrastructure can carry out better than traditional tools (e.g. transparency regime and public disclosure obligations).

As such, the solution of DAO-specific law is also in line with the growing literature on the beneficial effects of an 'organizational menu', whereby there are social gains from offering entrepreneurs with more organizational options.[118]

7. Conclusion

The article provides the first in-depth analysis of Decentralised Autonomous Organization vis-à-vis the foundational economic and legal theories of the firm and business organization. The article aims to enrich the largely dichotomic debate between DAO proponents and DAO sceptics, identifying possible scalable uses of DAOs for the organization of business activities.

The analysis highlights that, in different ways and to different extents, both proponents and sceptics fail to ground their arguments on solid theoretical grounds. On the one hand, the promises of the proponents about decentralization, elimination of governance issues and autonomy from the legal system are unwarranted and limit the possible applications of DAOs. On the other hand, the claim that DAOs are in the end useless and should only be used by small communities of crypto enthusiasts

[118] See, for instance, Timothy W Guinnane, 'Creating a New Legal Form: The GmbH' (2021) 95 Business History Review 3; Timothy W Guinnane and Susana Martínez-Rodríguez, 'Choice of Enterprise Form: Spain, 1886–1936' (2018) 34 The Journal of Law, Economics, and Organization 1.

also fails to account for the promises of the technological design of DAOs vis-à-vis the theory of the firm and business organization.

The article formulates a number of guidelines – which could also be interpreted as testable hypotheses – on the likelihood of DAOs being adopted as business organizations. These guidelines a threefold and consider the economic, the technology and the legal features.

With regard to the economic theory, the level of algorithmic solutions to problems in the economics of the firm, namely on agency and hold-up costs. It reveals that there is not a one-size-fits-all answer, but different protocols can either increase or decrease agency costs as well as hold-up costs, depending on the specific business activity at hand. This is in line with the literature on off-chain organization, whereby different activities and different settings are better handled by different organizational features.

Moreover, the article provides guidelines in terms of technological advancement, identifying in asset tokenization the key technologically enabled activity that would sharply increase the likelihood of business activities to be carried out by DAOs. On the other hand, the net impact of artificial intelligence is unclear, as it facilitates not only DAO development but also other types of off-chain organizations.

In terms of legal organization, the analysis favours the adoption of DAO-specific legislation as it represents the most effective way to unleash DAOs' potential while curbing their risks. However, this guideline comes with the caveat that the current legal experimentation does not seem to be tailored to the technological specificities of DAOs, both in terms of risks and benefits.

Finally, the analysis highlights a peculiar aspect of an organizational form in its infancy such as DAOs. They appear to be very efficient and effective in all the dimensions requiring high depersonalization of business activities, such as entity shielding and token transferability. On the other hand, for all the more personalized aspects of business activities, such as members' liability and (legal) agency, DAOs lag considerably behind compared to virtually any other form of off-chain organization. This is counterintuitive only from the perspective of the theory of organizational developments, whereby depersonalization is the result of long-

lasting experimentation.[119] However, it makes perfect sense from the technological perspective, whose design is particularly apt to the depersonalization of transactions. This final notation highlights once more the relevance of this analysis and, at the same time, opens the door to further research on the relationship between technological innovation, the organization of business activities and the role of the law.

[119] See Henry Hansmann, Reiner Kraakman and Richard Squire, 'The New Business Entities in Evolutionary Perspective' (2007) 8 European Business Organization Law Review (EBOR) 59; Timothy Guinnane and others, 'Putting the Corporation in Its Place' (2007) 8 Enterprise & Society 687.