Governance Adaptation in Distributed Autonomous Organizations (DAOs)

Fred Riggins
College of Business
North Dakota State University
fred.riggins@ndsu.edu

Samuel Fosso Wamba
Département Management de l'Information
TBS Education
s.fosso-wamba@tbs-education.fr

Abstract

Distributed autonomous organizations (DAOs) are a new organization form that resides entirely on a blockchain. In a DAO, organizational governance rules are hardcoded in an immutable smart contract. This paper examines whether DAOs are able to adapt their governance structures when shocks in the external environment occur. If the DAO is truly decentralized and governance is hardcoded in a smart contract, then effective adaptation may be a challenge. Using case examples, we illustrate approaches to governance adaptation including orderly voting by DAO members, contentious voting with exit by some participants as the DAO evolve, hard forks in the event of negotiation failure, off-chain resolution mechanisms, and the role of a "benevolent dictator". We provide justification for why DAOs may not be as decentralized as conceptualized if they are to be effective. Our research contributes to the theoretical development of DAO management strategies as this new organizational form evolves.

Keywords: Blockchain, decentralized autonomous organization, DAO, smart contract, governance.

1. Introduction

In 2009, Bitcoin was launched as the first fully decentralized public blockchain by Satoshi Nakamoto (2008). Satoshi's objective was to provide a system where two parties, who had no reason to otherwise trust one another, could exchange the digital currency Bitcoin without the need of an intermediary. Satoshi solved the digital currency double spend problem using a combination of cryptography, network consensus, and minting new currency over time, all within a pseudonymous peer-to-peer network using the internet. New transactions are vetted by peers in the network and then added to the blockchain in a new block by a miner who receives a reward. Once added, the transaction is fully transparent and immutable.

Within a few years, Vitalik Buterin proposed an enhanced blockchain where permanent and immutable decentralized applications (DApps) could be programmed on a blockchain using smart contracts (Buterin, 2014). Szabo (1994) coined the term "smart contract" as "a computerized transaction protocol that executes the terms of a contract." Ethereum was launched in July 2015, which acts as a Turing-complete global computer running on the peer-to-peer Ethereum blockchain whereby any application that could be developed on a client-server system can be run on Ethereum as a DApp or smart contract. Once added to the blockchain, these smart contracts are permanent and immutable and cannot be changed.

Furthermore, a smart contract can theoretically encode the rules by which an organization can function. In this way, distributed autonomous organizations (DAOs) have been proposed as a new type of organizational form where the organization exists solely on a blockchain (see Hassan & Di Filippi, 2021 for a review of terms, definitions and issues). In a DAO, the rules of governance are hardcoded in a fully-transparent immutable smart contract that executes on the blockchain according to code. While we will discuss different manifestations of DAOs, theoretically they do not have a traditional hierarchical management structure. Instead, the organization exists as a group of participants who have a common goal and have invested in the DAO by contributing to a treasury. In return, participants receive tokens that may change in value and provide voting rights in the operations of the DAO. These voting rights are important since new initiatives within the DAO may take the form of proposals made, and voted on, by token-holders. In this way, DAOs exhibit an interesting new form of decentralized governance.

Noting that corporate governance can be defined many ways depending upon the context, Turnbull (1997) proposes a broad definition as "all the influences affecting the institutional processes, including those for appointing the controllers and/or regulators, involved in organizing the production and sale of goods and services." According to ISO 26000, organizational governance is "a system by which an organization makes and implements decisions in

URI: https://hdl.handle.net/10125/106514
978-0-9981331-7-1

pursuit of its objectives" (Bernhart & Maher, 2011). Williamson (2005) speaks of the economics of governance as "an effort to implement the study of good order and workable arrangements" to manage transaction costs. He pays close attention to how alternative modes of governance allow for adaptation to external factors and stresses that adjusting to changing conditions is a key purpose of management. Weill (2004) defines IT governance as "specifying the decision rights and accountability to encourage desirable behavior in the use of IT." Beck, et al. (2018) analyze DAO governance by looking at the structure of decision rights, accountability, and incentives within these new organizations.

While some preliminary research exists as to the efficacy of DAOs as a new organization form, we believe governance in DAOs is a promising area of research. In particular, if rules of a DAO are hardcoded in an immutable smart contract on a blockchain and if the DAO is truly decentralized, then it is not clear whether a DAO can be flexible and nimble enough to adjust to changing external conditions. While a traditional top-down organization may use managerial dictates to navigate tumultuous changing conditions, it is not clear that a DAO could respond in a similar fashion. We examine how DAOs respond to external shocks and what governance mechanisms allow for effective and timely governance adaptation?

We begin with an overview of relevant literature on governance and DAOs. Then we examine several case examples of DAOs and how they respond to challenging circumstances. While we will take the events of the 2022 crypto winter as a frame of reference, we will examine other DAO crises moments as well. Next, we analyze our findings using a framework from Klein, et al. (2019) to understand different pathways for DAO governance adaptation considering the maturity of the DAO and the extent to which a DAO is truly decentralized. We conclude with a discussion of additional research questions.

2. Background Literature

Several definitions of governance have been noted in our introduction. The common theme is that organizations must decide how to arrange their operational and decision-making rules to move towards a goal. Furthermore, these internal rules may need to change as conditions evolve. DiRose and Mansouri (2018) define governance as "the process by which new features are proposed, designed, agreed upon and implemented." They define a DAO as a virtual entity "comprised of a large number of individual actors that respond according to a well-defined set of rules. These rules are often organized by a broad social structure that constitutes 'governance'." In their analysis, they treat the Bitcoin and Dash blockchain communities as distributed autonomous organizations that needed to consider changes to enhance scalability—specifically, changes to block size. For these authors, Bitcoin represents the extreme case of a DAO, where any changes need to be generated from the users. In 2014, four years after the "benevolent dictator" Satoshi Nakamoto was last heard from, Bitcoin enthusiasts implemented the Bitcoin Improvement Proposals (BIPs) process where improvements—BIPs—may be proposed and debated. BIPs that are accepted by miners (95% must signal acceptance) have their status set to "Final" and are voluntarily adopted at a specific block. The BIP process states, "The BIP process does not aim to be a kind of forceful 'governance' of Bitcoin, merely to provide a collaborative repository for proposing and providing information on standards, which people may voluntarily adopt or not." DiRose and Mansouri (2018) note that Dash also has a mechanism to consider change proposals, but this process is heavily dominated by Dash's equivalence of a "benevolent dictator", Evan Duffield, who submits a large number of the change proposals. These authors conclude that Dash is more effective at making changes than Bitcoin due to the continued presence and involvement of the blockchain's benevolent dictator.

This notion of the role of a benevolent dictator is found elsewhere. Beck, et al. (2018) discuss the creation of the DAO Swarm City and note that the presence of "a necessary benevolent dictatorship" may be needed in the early stages of DAO development. Comparing Bitcoin to Ethereum, Azouvi, et al. (2019) found that for both blockchains the number of people making comments in relevant GitHub discussions was rather limited indicating a high level of centralization. However, in terms of creating and commenting on proposals, Ethereum was more centralized than Bitcoin. The existence of the Ethereum Foundation which oversees the operation of the blockchain may account for that, whereas Bitcoin has no such oversite structure. They note that both blockchains have experienced hard forks with Bitcoin splitting from Bitcoin Cash and Ethereum splitting from Ethereum Classic. By comparing the communities behind the two pairs, they found that in both cases the forking process resulted in bringing in new people rather than splitting the initial communities.

DeFilippi and Loveluck (2016) examine governance in the Bitcoin system and note that Satoshi and core developers sought to make Bitcoin self-governing and self-sustaining through what they call governance *by* infrastructure. However, tensions among key participants in the BIPs process and other

discussion boards indicate considerable disagreement on a number of issues, including the role of mining pools, block size, and excessive power usage of the network. This results in the need to have a process for governance *of* infrastructure. The authors point out that the actual number of decision-makers in the BIPs process is relatively small. However, they note that if core developers were to strongly suggest changes to the Bitcoin code that the community (miners) disagrees with, the miners might simply refuse to run the new code. In this way, the decentralized group of miners has veto power that ensures the legitimacy of the code rests in the hands of users.

Klein, et al. (2019) define an organization's governance structure as the established "rules about who will be in charge, how leadership turnover will occur, who will be involved in critical decisions, how gains will be distributed, and who will bear the risk of failure." These authors focus on how governance structure adaptation occurs since external conditions are constantly changing. Indeed, one of the main purposes of management is to alter governance mechanisms as needed. They note that organizational adaptation requires some degree of centralized control and coordination (Williamson, 1996). Furthermore, the problem of adaptation becomes more difficult when the required governance adaptation challenges the authority of the organization's core stakeholder groups. For our purposes, we can theorize that DAOs which are by definition highly decentralized with their governance structure hardcoded in an immutable smart contract on a blockchain could have difficulty adapting to changing conditions, unless it has some level of centralized coordination and control. Klein, et al. (2019) identify four broad pathways of governance adaptation: continuity, architectural change, enfranchisement change, and redistribution.

Beck, et al. (2018) make use of Weill's (2004) governance framework to discuss DAO governance in terms of allocation of decision rights, accountability, and incentives. They note that Fama and Jensen (1983) describe two different types of decision rights: decision management rights and decision control rights. Contrary to the examples noted above which treat entire blockchain communities as DAOs, Beck, et al. (2018) focus on DAOs as a new type of organization structure within the blockchain economy. Here, DAOs represent a new organizational form which would have governance radically different from organizations common in the off-chain world. They then discuss governance in the specific DAO case of Swarm City. We will return to their case discussion and an update of Swarm City in the next section.

Our focus is akin to this notion of DAOs as a new organizational form rather than exploring whether the Bitcoin or Ethereum communities constitutes a DAO. Hassan and DiFilippi (2021) provide some clarity by defining a DAO as "a blockchain-based system that enables people to coordinate and govern themselves mediated by a set of self-executing rules deployed on a public blockchain, and whose governance is decentralised." They note that some argue that Bitcoin was the first DAO, however, they clarify that "the term is today understood as referring not to a blockchain network in and of itself, but rather to organisations deployed as smart contracts on top of an existing blockchain network." With this narrower definition of DAOs, we now turn to several case examples of DAOs to examine how they responded to crisis situations.

3. DAO Case Examples

3.1. The DAO

The first distributed autonomous organization was appropriately called The DAO and was an attempt to generate venture capital funding for Ethereum-based start-ups. The DAO was launched on April 30, 2016 allowing investors to pay ETH into The DAO treasury and receive tokens to vote on start-up projects that might be funded from the treasury. After several days of funding The DAO had attracted about 14% of all ETH in existence. Much has been written about the failure of The DAO project which will not discussed here (see Dhillon, et al., 2017 and Mehar, et al., 2019). In short, a paper published in May 2016 outlined several possible flaws in The DAO smart contract (Popper, 2016). After discussion board postings in June, a software fix was proposed by June 14th and was awaiting voting approval from The DAO members. On June 17th hackers were able to steal $50 million USD out of the $168 million USD DAO treasury. Once discovered, the remaining funds were moved to an account subject to a 28-day holding period.

Since the hack was discovered rather quickly there were immediate discussions about what to do next. There was no governance mechanism within The DAO that could stop the attack. Members of The DAO and the Ethereum community debated whether the attack should be allowed as an unethical, but technically feasible use of the smart contract, or should the entire Ethereum blockchain be rolled back to before the attack. Purist viewed such a centralized rollback move by the Ethereum Foundation as counter to the spirit of Satoshi. Ethereum founder Vitalik Buterin proposed a soft fork solution to blacklist the hacker address so no additional funds could be taken. The hackers responded that they had done nothing illegal and had used the smart contract as written. The hackers even threatened legal action. Eventually, on

July 20th the Ethereum network was hard forked to move the funds to a recovery address where they could be recovered by their owners. Those in disagreement with this centralized move continued using the original blockchain which is now known as Ethereum Classic.

For the purposes of our discussion it is worth noting that The DAO had no governance mechanism that could effectively adjust to the software flaw in the original smart contract. Token-holders had some warning that their funds might be at risk, but most didn't have time to move their funds to another account. The DAO voting process was activated, but was not able to conclude an appropriate course of action within the needed time frame. Ultimately, The DAO suffered a catastrophic failure it could not adjust to through its governance system. Instead, the Ethereum infrastructure on which The DAO was build needed to come to the rescue through a centralized decision. While 89% of miners agreed to the hard fork decision it was certainly not without controversy and threatened the trustworthiness of the blockchain system itself since the solution went against the notion of an immutable blockchain. The DAO hack lives as an important reminder to carefully verify the security of smart contract programs.

3.2. Swarm City

First, we will highlight several important findings from the Swarm City case example discussed in Beck, et al. (2018) that are pertinent to our analysis. Those authors provided details of interviews with Swarm City founders that indicated a need during early development to maintain "a necessary 'benevolent dictatorship'". As a Swarm City system architect who was interviewed in that study stated, "You might say that the initial governance structure is something like a dictatorship … We do it this way because we believe that to build [Swarm City] as a tool, you [need] to do it in a military style … Of course, we are trying to build a totally decentralized open platform that is open source and that anyone can use and add value to. But in order to make the tools, we initially need a really hierarchical governance." The goal was to eventually make Swarm City decentralized where decision rights would be in the hands of token-holders. However, the developers expressed some concerns about whether decentralized decision making could be effective in some situations. It was believed that even with decentralized voting there would still need to be a board of directors doing day-to-day management of the organization. Beck, et al. (2018) note this as a separation of decision management rights (held by token-holders with voting rights) from decision control rights (in the hands of the board of directors). They point out that "some iterations of the blockchain economy might include some centralization" (in the early stages), however, the governance would become decentralized at a later point.

Managing major governance differences in the blockchain economy might be facilitated by extreme alternatives such as forking. Beck, et al. (2018) state, "when the individuals who became Swarm City disagreed with decisions made by the managing individuals of their predecessor, Arcade City, they 'forked off,' or split, from Arcade City by copying the code and setting up an alternative, competing project. In the words of one of the Swarm City cofounders: 'Arcade City's still running, but we forked off into a separate organization, 'cause we had a certain way of wanting to do things.'"

At this point we would like to revisit the example of Swarm City to provide a case update. On July 19, 2017 investors in Swarm City suffered a catastrophic hack (Vitaris, 2017). The hacker was able to take advantage of a bug in a multi-sig wallet created by Parity Wallet. 153,000 ETH (approximately $32 million at the time) was stolen from three Ethereum wallets. On July 19th, Parity Technologies published a critical security alert stating there was a vulnerability associated with Parity Wallets and that users should move their assets to a different secure address. Again, there was not enough time to act. That same day, a post in the Swarm City blog stated, "At approximately 12:30 PM ET Bernd Lapp, Business Hive leader noticed that the entire contents of the Swarm City ETH multisig wallet had been drained. Bernd checked the receiving address and noticed a few very large transactions had hit the same wallet. We alerted the Ethereum Foundation and multiple developer groups immediately. Together, we were able to determine that malicious actors had exploited a flaw in the Parity Multisig code, which allowed a known party to steal over 153,000 ETH from several projects including Edgeless Casino, Aeternity, and Swarm City." (Swarm City, 2017).

A swift response from an Ethereum whitehat group used the same exploit to drain many other project's parity multisig wallets, in order to protect them from theft (Vitaris, 2017). This group was able to save over 377,000 ETH. Unfortunately, the 44,055 ETH that was in Swarm City's wallet was gone.

The news of this hack quickly spread to mainstream media and resulted in the price of ETH dropping from $235 to $196. It should be noted that the loss of ETH from the Swarm City wallets was not due to a flaw in the Ethereum blockchain or smart contracts in general. Nor was it due to an error by Swarm City developers, but rather an error in the Parity multi-sig wallet smart contract (Vitaris, 2017).

While development of Swarm City continued for several months, there were minimal financial resources available for the developers (Swarm City, 2020). Well into 2021, whitehats were still attempting to trace the hackers and noted that hackers were not able to liquidate their wallet address without potentially disclosing their identity. At the time of this writing, efforts are still underway to recover the funds in order to return the stolen ETH to the original Swarm City investors.

In terms of governance, there is little that could be done due to the nature of the error in the parity smart contract. It is incumbent upon DAO smart contract developers to be sure there are no bugs in the smart contract that could result in such a loss. Furthermore, DAO developers are dependent upon the security of the blockchain they utilize and the related wallet tools being used. Once hackers were able to identify the flaw, executing the hack was rather straightforward and done quickly. Swarm City token-holders had very little time to move their funds from the wallet once the parity flaw was announced. In this case, the overall community of whitehats external to Swarm City have attempted to provide restitution to the fleeced token-holders. This effort continues to this day. So, as a last resort, the crypto community as a whole through the efforts of volunteer whitehats may attempt to function as last-ditch governance mechanism to right any wrongs that may be committed.

The last post on the Swarm City blog site was made on January 1, 2020 by Bernd Lapp (CoachB), who announced the formation of the Swarm City Association and was soliciting applications for members. CoachB claimed to the only remaining Board Member from Swarm City and was proposing a membership fee of $500 USD per year with voting tokens distributed based on amount contributed (Swarm City, 2020).

3.3. Terraform Labs

In January 2018, Do Kwon and Daniel Shin co-founded Terraform Labs which released the cryptocurrency Luna on the Terra blockchain later that year. In 2020, Terraform launched the stablecoin TerraUSD (UST) on Terra. While many crypto-currencies are volatile in value, stablecoins have their value pegged to a referent asset such as the US dollar. There are three main approaches by which stablecoins are designed to maintain their peg. First, the stablecoin may be backed by a fiat currency where the fiat currency is held by a third-party financial entity. The role of the third-party makes these stablecoins centralized. USD Tether (USDT) and USD Coin (USDC) are examples. Second, the stablecoin may be backed by a paired cryptocurrency that is allowed to fluctuate so that minting or destruction of the paired coin is used to drive the stablecoin to its peg. To account for volatility in the crypto market, the rules in the smart contracts typically require these stablecoins to be heavily overcollateralized. If the value of the collateral decreases to threaten the over-collateralization, the loan may be liquidated by a liquidator. This type of stablecoin is decentralized. DAI is an example that is paired with MKR coin and is administered by MakerDAO. Finally, the stablecoin may be algorithmic whereby the value of a paired cryptocurrency is automatically adjusted to maintain the peg. This type of stablecoin is designed to be decentralized and administered by a DAO and/or a foundation. TerraUSD (UST) was designed in this manner and was paired with the Luna coin.

The Luna Foundation Guard (LFG) was established in Singapore to provide oversite of the Luna/UST algorithm. (Luna, 2022). “LFG is advised and overseen by its founding members and a council of experts committed to advancing its mission by facilitating the growth and support of various community-driven activities through targeted grants and funding. They ensure the activities of the Foundation are aligned with promoting transparency, governance, advancing research and development in open and decentralized networks.” The LFG website lists five members including Do Kwon.

While the LFG was to be advisory, the TerraDocs web page indicates that the Terra protocol is a decentralized public blockchain governed by a community of Luna token-holders. Token-holders can propose and vote on change proposals through a democratic process (TerraDocs, no date). Proposals require a refundable Luna deposit to be made within a seven-day deposit waiting period to avoid unnecessary proposals and prevent spam. The deposit is refunded if a quorum of 30% of staked Luna is achieved and if less than 33.4% of the votes are NoWithVeto. If this is achieved, a one-week voting period occurs. In this process, one Luna equals one vote and token-holders can delegate their vote to delegates.

In March 2022 the U.S. Federal Reserve began raising interest rates raising concerns about a potential recession. Prior to this in November 2021, Bitcoin had been trading at an all-time high near $65,000 USD, but inflation concerns and uncertainty about the Fed’s future actions resulted in Bitcoin dropping to around $40,000 by March 2022. With the Fed’s actions in March, the price of Bitcoin dropped under $30,000 by early May 2022 losing more than half of its all-time high value. The value of Ethereum followed a similar pattern. In short, the value of various cryptocurrencies

were in steep decline in May 2022 compared to just six months earlier.

With concerns about the U.S. economy, many investors abandoned the crypto market. The Terra blockchain was particularly hard hit when several prominent investors sold over $285 million USD worth of UST on May 7, 2022. On May 8th, the value of UST hit a low of $0.985, but sales of Luna were insufficient to return the UST stablecoin to its $1 peg. UST's sister currency Luna dropped from $85 USD on May 5th to $59 on May 9th. On May 8th, the LFG, created to be a reserve for Luna, sold much of its Bitcoin holdings to loan $1.5 billion USD to defend the peg and curb the volatility of UST. However, Luna went into freefall to under $2 by May 11th. With both coins precipitously losing value, Luna dropped from a high of $120 USD to essentially zero in a matter days whereby $50 billion USD was lost from the crypto market setting off panic across the speculative sector. This eventually resulted in nearly half a trillion USD being wiped out from various cryptocurrency markets in the late spring of 2022. The aftermath has been called the "crypto winter" as investors sat on the sidelines to await a possible U.S. recession.

Based on the previously outlined voting process, it is clear the decentralized token-holders were not in a position to adapt to these changing market conditions. Furthermore, the centralized LFG took action that may have exacerbated the situation by sending a signal to the market that the panic was justified. In the aftermath, Do Kwon made a proposal on May 14th to abandon the UST stablecoin and redistributing Luna tokens amongst the community members. When this did not receive community support, Kwon made a second proposal on May 16th noting that the LFG had used up its reserves in the previous week's loan. The new proposal, to be voted on May 18th would be to hard fork Terra to create a different blockchain Terra 2 (Cointelegraph, 2022). In the midst of the chaos there were concerns voiced about the voting process (Cryptoslate, 2022). Finally, it was announced on May 25th that the hard fork proposal had passed and the new version of Terra 2 with Luna would go live on May 27th. The stablecoin UST would not be part of the new blockchain (Markets, 2022).

The crash of the algorithmic stablecoin UST and the resulting crypto winter sent chills through the crypto markets for many months. The governance mechanism for Terra was not able to adjust to the fast-changing market conditions. Eventually, a contentious voting process resulted in a hard fork solution with a large turnover of membership in the Terra community.

While smart contracts are designed to enforce on-chain activities, occasionally the off-chain legal system may intervene. In February 2023, Kwon was charged by the SEC with fraud in how Terraform Labs marketed their system by "orchestrating a multi-billion dollar crypto asset securities fraud." On March, 23 2023, Kwon was arrested in Montenegro while attempting to travel to Dubai using falsified Costa Rican documents. He was also found to be carrying falsified Belgian travel documents. Following his arrest, he was charged by a U.S. federal grand jury in New York of eight counts, including securities fraud, commodities fraud and wire fraud and conspiracy.

3.4. MakerDAO

MakerDAO was created by Rune Christensen in 2014 to administrate the stablecoin DAI. DAI, its sister coin MKR, and its related smart contracts were launched in December 2017 with DAI designed to be an overcollateralized stablecoin pegged to the U.S. dollar. In September 2018, the venture capital firm Andreessen Horowitz invested $15 million USD in MakerDAO to secure 6% of the MKR tokens. That same year MakerDAO formed the Maker Foundation which was tasked with providing technical support for the MakerDAO protocol in terms of code creation during the early days of growth until it would transition to a fully functioning decentralized organization. The Maker Foundation employed people to manage the organization and perform tasks necessary to bootstrap the protocol to maturity. Christensen has served as CEO of MakerDAO since its inception. In July 2021, Christensen announced that the Maker Foundation would turn over operations to the MakerDAO community and that the Foundation would be dissolved in late 2021.

MakerDAO is a DAO running on the Ethereum blockchain to facilitate DeFi applications such as borrowing and savings using the cryptocurrency-collateralized stablecoin DAI (for a good overview of MakerDAO, see Harvey, et al., 2021, p.69-78). All DAI are created through loans with an overcollateralization of other cryptocurrencies such as ETH or other tokens. Owners of ETH can loan themselves money in DAI without the use of a centralized third party or credit checks. The borrower is held to accounts by a MakerDAO smart contract running on Ethereum. When conditions are such that the loan is not sufficiently overcollateralized according to the terms of the smart contract, the loan is quickly liquidated through the use of keepers who are incentivized to monitor contracts that move to default. MakerDAO also allows depositors who keep DAI locked in the MakerDAO bank to receive interest in a DSR (DAI Savings Rate) smart contract.

Members of the MakerDAO organization contribute cryptocurrency into the DAO treasury and receive the MKR token in proportion to their contribution/investment. While DAI is stable, MKR can fluctuate in value offering an investment opportunity for MKR token-holders. MKR has two purposes. First, it is used to stabilize the DAI stablecoin. If the value of DAI fluctuates from its peg, MKR tokens can be liquidated to fund the peg. If DAI is stable, MKR tokens can be burned decreasing the MKR supply and increasing the value of MKR. Second, MKR token-holders receive voting rights for the governance of MakerDAO and vote on issues such as the setting of fees in the system and the amount of collateral needed to take out loans. MKR token-holders have an incentive to see the value of the MKR token increase in value, so they should vote on proposals that stabilized the value of DAI and keep the MakerDAO ecosystem solvent and stable.

While collapse of the algorithmic stablecoin TerraUSD precipitated the onset of the crypto winter in May 2022, the overcollateralized stablecoin DAI faired fairly well during this period as DAI was able to maintain its peg. While the value of MKR declined like other cryptocurrencies during that time, it has continued to hold value. Until late 2022, MakerDAO was the largest DeFi protocol in terms of total value locked when it was surpassed by Lido Finance.

However, in 2022 Christensen raised concerns about the ability of MakerDAO with its existing governance structure to compete with off-chain financial institutions. On May 31, 2022, Christensen posted a proposal, entitled The Endgame, to radically restructure the MakerDAO governance mechanism (TheDefiant, 2022a). "The governance processes and political dynamics… fundamentally aren't compatible with the reality of effectively processing complicated real-world financial deals," Christensen wrote. Trying to "manage" a number of projects within MakerDAO was too cumbersome and difficult to move quickly.

At the time of the proposal, MakerDAO had about 115 employees at various levels with Christensen as CEO. His proposal would replace MakerDAO with many smaller MetaDAOs each with a distinct token and a more specific purpose. Some MetaDAOs would fail, while others would succeed. But overall, by being smaller, a MetaDAO could be nimbler and more responsive to the real-world competitive environment. Related to this, Christensen was also concerned about MKR voter apathy. The proposal would create voting committees to align governance objectives across the MakerDAO ecosystem and facilitate new projects. It would also establish rewards to increase voter participation. With voter apathy and governance complexity, MakerDAO had grown to the point that it could no longer be entrepreneurial and innovative. Christensen also noted that MakerDAO was losing $9.4 million annually. "We have reached a point where it is basically impossible to try to make any kind of change or even discuss ideas without upsetting people that are entangled in this uncontrolled web of relationships and often have conflicting incentives." Using the MetaDAO approach would allow more focus without the "single-threaded governance process" currently in place.

On October 10, 2022 it was announced that The Endgame proposal had passed with 80% approval of the votes cast. However, the results were not without controversy (TheDefiant, 2022b). In particular, only 15% of circulating MKR tokens voted, this despite one of the concerns with the original proposal was voter apathy. Furthermore, three quarters of the votes cast were backed by Christensen. While MakerDAO was designed to be decentralized in reality it was not able to maneuver in a dynamic, complex financial environment when voters were apathetic about voting on new proposals. In the aftermath, MakerDAO has deepened its ties to the traditional financial world by making alliances with several traditional financial organizations. In general, leadership at MakerDAO is using the new governance structure to position itself for potential new U.S. government regulations in the DeFi sector by aligning closer to off-chain financial institutions.

4. Synthesis of Findings

To summarize, a DAO is an organization native to a blockchain where governance rules are encoded in a transparent smart contract. With no centralized authority and no hierarchical management structure, a DAO operates autonomously without third-party intervention. Members pay to receive native tokens indicating voting rights, where membership is pseudonymous and members rarely interact off-chain. The group pools resources to fund a common goal that may change via consensus. Decisions are made from the ground up as members make and vote on proposals, but members may assign voting rights to delegates who solicit representation pseudonymously or with full disclosure. Certain day-to-day activities may be delegated to a Foundation or other group.

We have discussed a number of different approaches to governance adaptation that we summarize here. First, orderly voting by members can result in changes to governance rules if the external shock allows time for such voting to occur. However, in some cases, orderly voting may be superseded by contentious voting with proposals passing but with disgruntled voters leaving as the purpose and

objectives of the DAO evolves. In some cases, if the external shock is substantial a hard fork may be necessary in the event of failed negotiation. In some extreme cases off-chain groups such as whitehats and legal processes seeking to resolve unresolvable on-chain logjams may be necessary to avoid catastrophic failure of the organization. Several observations can be made at this point.

One implication of the forking approach used by Swarm City to depart from Arcade City that needs to be considered is that by forking and creating a separate DApp with similar, but different governance objectives, the smaller size of the two DApps might not benefit from the externalities associated with a larger single DApp. So, while forking may be a legitimate governance mechanism, certain associated externality costs must be taken into account.

Furthermore, the Swarm City developers found the transaction costs of staying within the Arcade City ecosystem too high and chose to break away. Here we see an interesting tradeoff of the transaction costs associated with staying within a larger ecosystem such as negotiating, proposing, voting for new directions, verses breaking away (forking) and developing a separate, smaller, more flexible DApp. Note that while forking seems a radical solution to an impasse, when the smart contract code is freely available and copiable the costs of forking may not be as high in the blockchain economy compared to similar approaches in the off-chain world. This may encourage smaller more flexible DApps to emerge, but they would not benefit from the externalities available to participants who choose to participate within a larger DApp ecosystem and face the transaction costs of negotiating through internal governance mechanisms.

In terms of accountability noted in Beck, et al. (2018), a Swarm City software engineer indicated that they need not hold users accountable for potential illegal activities stating, "we are not intermediaries, we just offer a platform and in the end [we are just enabling] a transaction on the blockchain, a peer-to-peer transaction, and we are not involved in that". This disassociation of accountability on the part of platform users may not be in compliance with emerging legal regulatory frameworks which are evolving.

Klein et al. (2019) state that to reduce risk from changes in the environment, governance structures should identify stakeholders as legitimate holders of decision rights, which they call "enfranchisement" and specify how created value will be distributed, which they call 'claimancy." In a DAO, members contribute to a treasury and get voting rights based on their tokens. On a public blockchain, anyone is free to join or leave at any time. Furthermore, how the structure of the DAO voting process is defined will determine the efficacy of enfranchisement and claimancy. Also, the degree to which the DAO is decentralized will impact the efficacy of enfranchisement and claimancy.

By distinguishing among claimancy rights as being perceived as either equitable or inequitable, and the divergence in stakeholder interest as either low or high, Klein et al.'s four pathways for governance adaptation are shown in Figure 1 within our context of DAO governance adaptation.

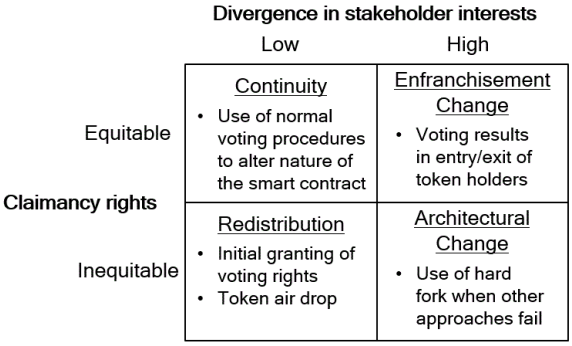

Figure 1. Pathways of Governance Adaptation in DAOs. (adapted from Klein, et al, 2017

Continuity occurs when the internal governance process is able to cope with changes in the environment in ways designed by the DAO founders. Here, divergence in stakeholder interests is low, claimancy rights are considered equitable, and there is no major shock to the environment. In DAOs, this occurs when a voting proposal is made, discussed, and voted upon. MakerDAO may vote to alter the DAI savings rate (DSR), changes are made to governance rules that are generally acceptable, or a project is funded to increase security. However, continuity may be insufficient if participants (token-holders) are not able to respond quickly enough as in The DAO hack, the Swarm City hack, or the Terra debacle.

The opposite extreme pathway of architectural change occurs when divergence of stakeholder interests is high and claimancy rights are perceived as inequitable. Here, a major adaptation is needed such that the organization must be completely reconstituted. If successful, new organizational rules emerge to preserve the organization's assets and capabilities. If unsuccessful, the organization may face failure and dissolution. The DAO hack, Swarm City forking from Arcade City, the Swarm City hack, and the Terra are all examples of this approach.

Enfranchisement change occurs when divergence in stakeholder interests is high, yet claimancy rights are seen as equitable. Here, adaptation occurs by changing the governance structure which causes some stakeholders to exit or others to join the DAO. This could be the case where rules are changed altering the

level of decentralization—likely through the normal voting process, but the changes result in an exodus of some token-holders who cash out their investments. Other investors may see the new environment as attractive and enter. For example, altering the make-up of the oversite foundation, approving changes to the DAO voting process, or authorizing projects that result in power shifting to smart contract programmers. In these cases, governance structures may change resulting in more or less power to token-holders, but claimancy rights do not change.

Redistribution occurs when claimancy rights are viewed as inequitable for the organization's goals and changes are made giving some stakeholders greater claim to created value. Correcting the perceived inequity may result in another stakeholder group losing some claimancy rights. When the development group moves to launch the DAO and institutes voting rights to future contributors, this represents a dilution of the power of the original developers. DAOs may view this move to decentralization as necessary to incentivize investors to contribute to the group.

How do these pathways interact with DAO maturity? While we do not prescribe a preferred pathway, it seems that in early stages DAOs are very centralized but move towards decentralization through redistribution. As the DAO matures, confidence that the DAO can function well in a decentralized manner may allow changes so the DAO may become more decentralized through enfranchisement change with the goal of encouraging additional investors. With the DAO in a steady state of operation, continuity would likely occur due to changing market conditions if the DAO is able to successfully navigate the changes. In the case of an extreme environmental shock where continuity is insufficient for governance adaptation, enfranchisement change may prove effective, but if not, architectural change may be necessary with a hard fork. This evolutionary process may be altered due to the leverage of a benevolent dictator indicating the DAO is not as decentralized as original planned.

5. Conclusions and Further Research

We summarize a number of observations about the evolution of DAOs as follows:

- There is often an entrepreneurial effort by a small number (perhaps one) people to put together a software artifact for a specific purpose. While initially centralized, the goal is to make the organization decentralized at a later date
- A smart contract is written with governance rules that requires careful testing to ensure no software bugs.
- Once launched on the blockchain a governance token is offered to those wishing to help fund the effort. At this point, decentralization is advantageous to encourage token ownership.
- A group (foundation) is often set up with funding which includes employees who have specific roles and do the work needed for the operations of the software artifact. However, most of the day-to-day operations of the DAO are automated in the software artifact.
- As the software artifact is in operation there are a few decisions that need to be made relating to parameters in operation that impact the functioning of the artifact that can be voted on by the members. However, strategic decision making of the DAO can be difficult if it gets too large in terms of number of token holders and the types of decisions are largely non-routine and unstructured.
- Voting on decisions may suffer from low participation levels as participation requires too much effort and bounded rationality on the part of most of the members. A smaller number of delegates can be more effective in voting on proposals as they take time to learn the issues and be more informed about the decisions, however this results in less decentralization.
- Delegates may need incentives to make such efforts. If leadership in the foundation group desires to have the purpose of the DAO branch out into other areas (for example due to changing market conditions, growth and new opportunities, or new technological developments) there may be a need to set up separate DAOs for each new opportunity.
- Larger decentralized DAOs seem to lack flexibility and agility to take advantage of new opportunities.

In conclusion, to be functional in a dynamic environment, it may be the DAOs are not able to be as decentralized as originally proposed if they are to be nimble and capable of adjusting to shocks in the external environment.

This analysis has highlighted a number of important research questions that could be explored.

What accounts for DAO token-holder voter apathy? Do non-participants view themselves as not having good claimancy rights? Does bounded rationality limit the extent to which they participate? Does an increase in token value encourage participation? Does voting participation decline if the value of the token has declined? If token-holders do not see prospects of good increases (due to external market conditions) they may become complacent, lose interest and not participate.

Does forking as an alternative depend on the role of the benevolent dictator? In the case of MakerDAO, the leader was able to convince the limited participating token-holders to go along with his vision and make changes via the voting process. If that had not occurred, would forking have been appropriate? Is

this a reasonable approach in the event of a negative vote on a proposal from the benevolent dictator?

When discussing architectural change as a radical solution, Klein, et al. (2017) state "this form of change is difficult to accomplish because it requires re-designing many elements of a system simultaneously." However, is that the case in a DAO? Copying the fully available code and starting over seems like a drastic step, but the transaction costs of copying and pasting could be rather low. Therefore, are radical changes more likely in DAOs than traditional organizations? Are DAOs by their nature more volatile to radical change than traditional organizations due to lower transaction costs of engaging in radical adaptation?

Klein, et al. (2017) further note that in some cases "architectural change is so daunting that the result is organizational collapse, despite attempts by external authorities to mitigate conflicts." But is this the case with DAOs? Due to the low transaction costs of forking we might expect to see forking followed by a decline in one of the two forks, as a normal part of the DAO evolutionary process. What is viewed as extreme off-chain may be just part of the DAO evolutionary process. How does this impact investors?

Finally, Klein, et al. (2017) list regulation/ deregulation as part of the changes that might cause architectural change. As we move into a volatile crypto regulatory environment we might expect to see more forking occur as DAOs seek to adjust to extreme changes in the external environment.

6. References

Azouvi, S., Maller, M., & Meiklejohn, S. (2019). Egalitarian society or benevolent dictatorship: The state of cryptocurrency governance. In *Financial Cryptography and Data Security*. Springer Berlin Heidelberg.

Beck, R., Müller-Bloch, C., & King, J.L. (2018). Governance in the blockchain economy: A framework and research agenda. Journal of the Association for Information Systems, 19(10), 1020-1034.

Bernhart, M.S. & Maher, F.J. (2011). ISO 26000 in practice – A user guide. Quality Press.

Buterin, V. (2014). Ethereum: A next-generation smart contract and decentralized application platform. Whitepaper at https://ethereum.org/en/whitepaper/.

Cointelegraph. (2022). https://cointelegraph.com/news/do-kwon-proposes-terra-hard-fork-to-save-ecosystem

Cryptoslate. (2022). https://cryptoslate.com/terra-luna-fork-voting-in-chaos-amid-massive-inflation/

De Filippi, P. & Loveluck, B. The invisible politics of bitcoin: governance crisis of a decentralised infrastructure. Internet Policy Rev. 5, 1–28 (2016).

Dhillon, V., Metcalf, D., Hooper, M. (2017). The DAO Hacked. In *Blockchain Enabled Applications*. Apress, Berkeley, CA.

DiRose, S. & Mansouri, M. (2018). Comparison and analysis of governance mechanisms employed by blockchain-based distributed autonomous organizations. 2018 13th Annual Conference on System of Systems Engineering, Paris, France, 2018, pp. 195-202.

Fabrice L., Wang W. & Schilke, O. (2021). Blockchain governance—A new way of organizing collaborations? Organization Science 32(2):500-521.

Fama, E.F. & Jensen, M.C. (1983). Separation of ownership and control. The Journal of Law and Economics. 26(2), 301-325.

Harvey, C.R., Ramachandran, A. & Santoro, J. (2021). *DeFi and the future of finance*. Wiley & Sons, New Jersey.

Hassan, S. & De Filippi, P. (2021). Decentralized autonomous organization. Internet Policy Review, 10(2).

Luna (2022). https://www.lfg.sg/missionandvision/

Klein, P.G., Mahoney, J.T., McGahan, A. & Pitelis, C. (2019). Organizational governance adaptation: Who is in, who is out, and who gets what. The Academy of Management Review. 44(1), 6-27.

Markets. (2022). https://markets.businessinsider.com/news/currencies/terra-backers-keep-luna-alive-abandon-stablecoin-ust-crypto-crash-2022-5

Mehar, M.I., Shier, C.L., Giambattista, A., Gong, E., Fletcher, G., Sanayhie, R., Kim, H.M., & Laskowski, M. (2019). Understanding a revolutionary and flawed grand experiment in blockchain: The DAO attack. Journal of Cases on Information Technology (JCIT), 21(1), 19-32.

Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. Internet: https://bitcoin.org/bitcoin.pdf.

Popper N. (2016). Paper points up flaws in venture fund based on virtual money. NY Times, May 27, 2016.

Swarm City. (2017). https://press.swarm.city/parity-multisig-wallet-exploit-hits-swarm-city-funds-statement-by-the-swarm-city-core-team-d1f3929b4e4e

Swarm City. (2020). https://press.swarm.city/swarm-city-association-f097c0342e7e

Szabo, N. (1994). Smart contracts. https://ethereum.org/en/smart-contracts/

TerraDocs. (no date). https://docs.terra.money/develop/module-specifications/spec-governance/

TheDefiant. (2022a). https://thedefiant.io/makerdao-radical-makeover-plan

TheDefiant (2022b). https://thedefiant.io/makerdao-plan-christensen

Turnbull, S. (1997). Corporate governance: It's scope, concerns, and theory. Corporate governance: An international review, 5(4), 180-205.

Vitaris, B. (2017). White hats step in to save funds from vulnerable ether wallets. Bitcoin Magazine, July 20, 2017. https://bitcoinmagazine.com/business/white-hats-step-save-funds-vulnerable-ether-wallets

Weill, P. (2004). Don't just lead, govern: How top-performing firms govern IT. MIS Quarterly executive, 3(1), 1-17.

Williamson, O.E. (1996). The mechanisms of governance. New York: Oxford University Press.

Williamson, O.E. (2005). The economics of governance. American Economic Review, 95(2), 1-18.