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School of Business and Governance

Ragnar Nurkse Department of Innovation and Governance

The DAO: A Million Dollar Lesson in Blockchain Governance

Francisco Santos

MA Thesis

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Supervisor: Dr. Vasileios Kostakis

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Hereby I declare that this master's thesis, my original investigation and achievement, submitted for the master's degree at Tallinn University of Technology, has not been submitted for any other degree or examination.

Author: Francisco Santos

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Supervisor: Dr. Vasileios Kostakis

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Abstract:

Blockchain is an underexplored research topic with increasing societal relevance. The majority of available literature deals with technical aspects, overlooking topics like governance. The Ethereum programmable blockchain and its permissionless network is steered by different actors intervening through the system and adjacent software layers. The Decentralised Autonomous Organisation (The DAO) is an autonomous Ethereum application whose functions execute a democratic investment fund. After collecting 150$ million dollars, its code was exploited to siphon funds into private control. The devised solution led to a hard-fork and a remaining duple of the Ethereum blockchain, providing a rich case study. To characterise blockchain governance, this dissertation provides a heuristic set of actors composed of developers, cryptocurrency exchanges, the Ethereum Foundation and miners. Considered the low formalisation and distributed authority in this permssionless system, micro-governance practices and mechanisms are unpacked to reflect its stewardship and associated decisions. Their influence is contextualised trough a retrospective of The DAO, detailed in relation to each`s episodic relevance within the case-study, with its governance mechanisms synthesized trough a framework of analysis of freedom and power in systems. With mapping of the existing governance systems, Peer-to-Peer theory is utilised to provide a critical point-of-view of the technology. The conclusion is this way enriched with ways forward for the different actors to engage in peer-governance of the Ethereum ecosystem and its disruptive potential of blockchain`s technological development for societal transformation.

Keywords: Blockchain, Cryptocurrencies, Blockchain Governance, Ethereum, The DAO, Power and Freedom, Cryptocurrency exchanges, miners, developers, open-source foundations

Introduction

Blockchain technology is a novel, but increasingly important technical foundation of the internet infrastructure (Benkler 2016, p. 30). Blockchain governance presents a new set of challenges informed by different sets of protocols, actors, and ecosystems which will define the way this technology develops.

The few studies of blockchain technology (and fewer of non-technical nature) (Yli-Huumo. et al. 2015) makes it an underexplored research topic. Perezian technological trajectories and their early-stage definition (Perez 2002, p. 29) stresses their importance, as does the general-purpose use technology (Davidson et al. 2016a). As a disruptive innovation, a number of industries will have to rearrange their operations as new economic and financial activities are set to emerge. The creation of new business logics allows for the redefining of our economy globally. With the risk of the technology being captured, its disruptive potential is likely undermined as it is undertaken by the same dominant players of today`s systems (Åslund 2016, p. 69).

Thus far, The DAO is the most contentious episode in the history of the Ethereum blockchain and one of the richest case studies to understand blockchain governance. Other hacks, bugs, forks, and controversial episodes across the cryptocurrency space exist, but hardly as contentious. Whilst it was a time critical event, it serves to understand the governance dynamics of governance in Ethereum`s ecosystem. Studying the layering technical infrastructure provides an analysis of its configurations, but it leaves out important information pertaining to the different roles taken in its governance. Taking example from Science and Technology Studies and their case study approach, coupling a technical analysis with institutional arrangements, dealing with questions of politics and power (Badouard et al. 2016), allows for the scope of results under for the premise of a core research question:

- Why did The DAO fail?

The mainstream approach to internet governance focuses on formal institutions and the role of the state (Epstein et al. 2016). At its current stage, studying blockchain governance is better suited under

internet governance`s blind spots of "environments with low formalization, heterogeneous organizational forms, large number of actors and massively distributed authority and decision-making power" (Van Eeten & Mueller 2013, quoted by Epstein et al. 2016). This leads to an alternative that allows "(...) unpacking the micro-practices of governance as mechanisms of distributed, semi-formal or reflexive coordination, private ordering, and use of internet resources."(Epstein et al. 2016)

The management of this new technology makes an overhaul of our political economy possible thanks to its peer-to-peer (P2P) features: "As political, economic, and social systems transform themselves into distributed networks, a new human dynamic is emerging" (Bauwens 2005). Blockchain`s infrastructure closely resembles the P2P infrastructures necessary for the emergence of P2P processes within this new human dynamic. Blockchain could be described as the first infrastructural need for the emergence of P2P processes: "(...) individual computers that enable a universal machine capable of executing any logical task are a form of distributed 'fixed capital,' available at low cost to many producers(...)" (ibid. 2005), in the case of Ethereum, extending this access beyond the protocol layer. The second infrastructural need, as explained by Bauwens, is the existence of alternative information and communication systems, followed by the existence of "software" infrastructure for autonomous global cooperation. Communication and collaboration platforms such as GitHub or Reddit are examples of such systems used by the Ethereum community. Whilst the legal infrastructure meant to enable use-value and prevent private appropriation is not in place, blockchain suggests the availability of its code since it confirms agreements between two or more agents. The last requirement is cultural and focuses on "(...) creating the type of cooperative individualism needed to sustain an ethos which can enable P2P projects."

To understand the different possibilities offered under different outcomes of The DAO, human behaviour within such technical systems, along with the array of options possible, need to be framed. Benkler`s "Networks of Power, Degrees of Freedom" framework (2011) gives us the chance to empirically analyse the case study by using its set of concepts. Whilst it does not deal with governance directly, Tapscott & Tapscott (2017, p. 6) usage of the term *governance* as the *stewardship* of a global resource such as the Internet, through a diverse ecosystem, such that of Ethereum, appropriately describes blockchain governance. Benkler exemplifies "(...)

democratization needs to be detailed in terms of who has the freedom to do what, and who has the power to do what within the system or set of systems claimed to be democratized by a given change or attribute of interest, relative to previous circumstances.(...)" (2011, p. 723). *Ceteris paribus*, the system's governance needs to be detailed, along with the *network*`s intervening actors. Under the concept of network will be those whose behaviour affects and/or is affected by the system.

Whilst technical knowledge is a limitation present for the assemblage of quantitative statistical data, much of this information has been developed and presented across the web, making use of mixed methods but with a qualitative focus[1]. A further attempt is made through the abduction method of immersion in the study of the empirical phenomenon and blockchain related local manifestations in the form of conferences, Meetups and topic-related events to better sustain empirical reason. It is further enriched by pertaining forums, access to Slock.it`s internal project communications (the original purveyors of The DAO), two semi-structured interviews to an individual from Slock.it and an organiser of The DAO community, and an informal interview with developers of the Parity client. This approach attempts to complement and complete previous conclusions so as to contribute to the field of internet governance and emerging blockchain related topics.

Most information on the topic revolves around different organisations and their white papers, specialised media, or resides in community channels such as Slack, Reddit forums, or self-published blog posts on platforms like Medium. This remains true for the Ethereum community, posing a challenge to its study. Since there is no single authority over the cryptocurrency space, it is necessary to source non-academic analysis to better understand the different players partaking in the community, taking facts and events and confronting them. Freedom and power can be described by accessing perceptions or beliefs, preferences, policies and principles, along with actions, outcomes and configurations (Benkler 2011, p. 724).

These roles taken in the governance of the infrastructure are largely open and overlay different users of the network. Even if a structureless hierarchy exists, the "tyranny of structurelessness" emerges in groups over time (Friedman 1970 cited in Kostakis 2011, pp. 22-23). These roles are informed by

[1] It should be noted that much of it is no longer public and has been accessed through the Internet Archive's Wayback Machine, scattered links across the web and private communications.

the larger blockchain ecosystem, allowing the prescription of different sets of actors. Researchers have identified core developers, miners, investors, merchants, and payment services as the definers of consensus (Narayanan. et al. 2016, pp. 146-147). Conceiving that these actors deal with different layers of functionality devised from a blockchain protocol, the agonist configuration of blockchain decision-making in its different interacting layers is recognisable. Contentious decisions, therefore, inform the choice of a different set of actors upon context. Admitting the continuous development of Ethereum and the cryptocurrency space, the heuristic set of actors includes the Ethereum Foundation in addition to developers, miners and exchanges, identified by Gavin Andresen, the lead developer of Nakamoto`s vision. These groups have all taken part in the development of outcomes in The DAO crisis. Their characterisation will provide important data for future studies of these evolving groups. Through this process, a sub-question is answered:

- How does blockchain inform the distribution of power in the ecosystem?

	Behavior		Outcomes	Configuration		
	Ps (Perceptions, preferences, policies, principles)	Actions		Pathways of power within the system	Completeness/ tight- or loose-coupling within system	Closure/openness of between-system transitions
Power						
Susceptibility						
Freedom						
No-power						

Table 1. Overall schema for analysing Freedom and Power in a System, adapted from Benkler 2011.

This informs the *context*, a "temporally bound characterization of all systems that can influence the behaviour or outcomes of the entity or entities analysed." (Benkler 2011, p. 725). A retrospective approach allows to detail with precision the context in which The DAO crisis unfolded. Considering the topic`s complexity, the set of actors are detailed and singled in accordance with their episodic importance along with relevant concepts. To assert the relations between them, the dis/empowering

governance-related motifs of the infrastructure are examined. This assessment is made by looking at the contentious actions and points of disagreement throughout. Freedom as the absence of susceptibility of an entity to some other entity's power in a given configuration (ibid. 2011 p. 724), and power as the capacity of one entity to alter the behaviours, outcomes, or configurations of others (ibid. 2011, p. 726) are the core concepts used for this assessment. This is further systemised with table 1, as first displayed by Benkler.

Admitting the P2P motifs of the infrastructure do not presuppose the emergence of an alternative mode of production, governance and property, this same characterisation of Ethereum`s ecosystem of governance can be informed by the emerging practices of peer-governance. Adding this conceptual framework will substantiate research with a critical viewpoint of the management of P2P infrastructures, even if limited by the unique development of the Ethereum ecosystem. Other blockchain ecosystems could be compared, if they would be characterised first. This theoretical addition aims to answer a sub-question:

- How can the Ethereum ecosystem constitute peer-governance?

The DAO`s open-source collaborative code development is the first episode relevant to the analysis. An overview of its coded architecture is undertaken with a description of the developer role aided by open-source development practices and consequences considering the availability of the code. Its overview grants us an understanding of the network's configuration.

Following the code deployment, The DAO tokens sale was activated, earmarking 150$ million invested by the community. With the pseudonymity of investors as a condition, the sale is studied alongside the role of cryptocurrency exchanges. Understanding these mechanisms as financial innovations within the wider scope of technological trajectories, they are chronicled to enrich governance solutions within the realm of peer governance. The focus of this chapter is the between-system openness and their influence in the blockchain since cryptocurrency exchanges present a different system for users to interact with, along with the notion of The DAO as a Dapp within the blockchain`s infrastructure.

With the hack, the Foundation`s steering role is highlighted and its different options and resources discussed in the light of the technological possibilities and their consequences as a way of understanding its centrality in the chain and its development. It's within this broader context that the *freedom* allowed to the Foundation is explored since it's the actor who has an advantage in "(...) the capacity to behave, alter one`s own configurations, and change the probabilities of one's own outcomes. (...)" (Benkler 2011, p. 728) within the context of the Ethereum blockchain. The effort of the White Hat Group is highlighted within the context of the decision-making procedures.

Finally, the "birth" of the Ethereum Classic project and the role of counter-power within blockchain systems and communities. The basic maintenance of the infrastructure is conducted by miners whose organisations undergo analysis of its minority-led domination disruption.

Whilst it is hard for such a project to be replicated, the community gathered a number of lessons and projects that will take shape in the future, evidencing the need of understanding the community and the different stakeholders involved in its development. Several of the concepts will be explored to provide a good understanding of the ecosystem and its current terms and conventions. The author would like to remind the reader that this dissertation is explorative in nature. As joked in the cryptocurrency community, years in the crypto-space count as dog years. It is hard to jump on the blockchain bandwagon, but it is even harder to keep pace with all its developments. This dissertation is an attempt to contribute to a clear view for the future of blockchain, the internet and our global society.

1. What is Blockchain?

1.1. Peer-to-Peer Technology

"*would the community hard fork ethereum if there was a critical bug in the DAO? :p*" Vlad Zamfir, 14/04/2017, Twitter

Benkler brings the theory of moral sentiments and individual production motives to the networked society in "*The Wealth of Networks*" (2006). His predictions on how we are going to live in this new environment would be dictated according to the developments "(...) over the next decade or so" (ibid. p. 27). He presents examples on the production of information and the advantages of producing non-proprietary goods as something novel and unaccountable to our institutional framework and economic models (ibid. pp. 460-463).

The Internet is the core enabler of these developments, and its P2P infrastructures are becoming a general condition for work, life, and society (Kostakis & Bauwens 2014, p. 33). These communication, cooperation and common value creation infrastructures allow for the ownership and control over participatory platforms, which capture the value of social exchange and distributed labour that have been labelled as a neo-feudal model of cognitive capitalism, as opposed to the hypothetical model of mature peer-production (ibid. pp. 35-36 and 33). Private ownership and centralised control are not pre-conditions for the existence and management of the technical infrastructures that sets the conditions for our social relations. The management of new technologies like blockchain have a real chance to steer the way we organise our society as made evident by Perez and her work on techno-economic paradigms (2002).

1.2. Bitcoin

In 2008, an individual or a group under the pseudonym of Satoshi Nakamoto published in a cryptography mailing list a paper outlining the first cryptocurrency titled "Bitcoin: A Peer-to-Peer Electronic Cash System". The software was then released in 2009 (Lons 2016). Due to its technical features, it is processed in an open and decentralised fashion since each contributing computational

node has incentives to encrypt the transactions that take place on the network through a mechanism called Proof-of-Work. This protocol rewards node operators called “miners” for confirming the veracity of the data transactions, solving the previously studied problems of double-spending and anonymity within a network of transactions (Nakamoto 2008). Many cryptocurrecies have since been created (Litecoin, Dash, FairCoin, Dogecoin etc).

Most of the mining process of encryption occurs in China where cheaper hardware and electricity converge and produce more competitive nodes. The incentives of the Proof-of-Work protocol make such locations great “mines” in comparison (Barton 2015, pp. 67-68). Within its protocol, the reward number of bitcoins to be distributed is limited to 21 million (Brito & Castillo 2013 cited in Barton 2015, pp. 15-16), making a digitally native scarce commodity behave as a deflationary currency. This makes prices unfavourable to producers and sellers possibly leading to crisis, whilst it incentivizes the concentration of capital along with gradually more centralised governance. As explained by Kostakis and Bauwens (2014, pp. 46-47), this is made evident by the already emerging oligarchies and aristocracies within the network.

The Bitcoin Foundation could be considered as the guiding lighthouse for the decentralised management of the currency, focusing on education, advocacy, adoption, venture capital, poverty and financial inclusion, and regulatory affairs, according to its website (Bitcoin Foundation 2016). However, it has fallen into discredit since board members have called for its dissolution and near-term insolvency (Rizzo 2015). It is worth noticing that the community's efforts have resulted in collective institutional entrepreneurship, resilience, and the growth of the market value held in the network, despite the faced difficulties (Teigland et al. 2013, p. 2) with a developing ecosystem of products and services revolving around the network and its growing community of users.

1.3. Blockchain

The technology that enabled Bitcoin composes sets of validated transactions which form blocks, adding new information to the “chain” and updating the status of the data compiled. If someone tries to change previous sets of transactions or the software`s coded rules, they would only achieve it by the theoretical loss of having computational power invested through the Proof-of-Work protocol to

have the other nodes agreeing with the presented or altered data. If a consensus on the state of the network (or incompatible software) is not achieved, then the chain can effectively fork, resulting in a parallel duplication of the network (depending on the type of proposed update). This is a feature of the blockchain in its original and public way of operating - in contrast to the permissioned or shared ledgers, varying in accordance to access and control (Government Office for Science 2016, pp. 17-18) and corresponding governance mechanisms.

Whilst here is presented a simplified idea of what blockchain (and Bitcoin) are, the technology has been labelled as "(...) the new Google" (Mougayar 2016) or even the "(...) next generation of the internet" (Tapscott & Tapscott 2016, p. 214) for what at its core is a decentralized interoperable database ledger. From this layer, a myriad of "ownerless" and collaborative networked applications are facilitated with their use likely to disseminate in the near future.

A number of dominant players in the field of digital technology and finance are creating blockchain projects of different nature. R3 created a consortium of over 70 financial institutions having as one of its projects, "Corda" with restricted access to transactional data, having its chief technology officer precising that they "(...) are not building a blockchain." due to the envisioned data sharing model in Corda (Brown 2016). Corda`s code was contributed to the Hyperledger Project (Reuters 2016) - an open-source collaborative effort of a significant number of organisations led by the Linux Foundation to "(...) advance cross-industry blockchain technologies" (HyperLedger Website). Microsoft has started using its Azure cloud services to have "Blockchain as a Service", providing a platform to implement blockchain solutions (Microsoft Azure Website).

Whilst still in its infancy, blockchain technology has attracted a lot of attention and around 1 billion dollars have been invested in 2014 and 2015 alone. Close to doubling annually, its growing rate is resemblant of the 1990`s dot-com bubble (Tapscott & Tapscott 2016, p. 21). Herian (2016a) considers the emergence of closed blockchains as the imposition of property definitions on a common cyberspace in relation to the developments made by the global financial corporations who caused the 2007-2008 global financial crisis calling the technology's disruptive aura a fallacy (ibid. 2016b). Having distinguished this above, blockchain is in its original definition, permissionless.

Ethereum would arguably be the largest contrasting example to these developments and the most prominent example of a blockchain, coming second to Bitcoin and its code.

1.4. Ethereum

Gavin Wood, a founder of Ethereum, describes it as being the world`s computer and calls it an "innovation commons" (Ethereum, 2015a). Launching the first version of the Ethereum platform in July 2015 as a versatile blockchain platform, Ethereum allows for code-based transactions, unlike the safer yet simpler token-based financial transactions the Bitcoin blockchain allows. This is possible thanks to its Turing complete blockchain and innate programming language "Solidity" (Buterin 2013). Another difference from
Bitcoin`s blockchain is Ethereum`s blocks containing the transaction list and the most recent state of the ledger, not limiting the block size but instead charging more "gas" according to the computational resources necessary for the process. This enables coded
scripts to be aware and store information about other information in the network, allowing for contracts (a type of account that programmatically executes different transactions), to interact directly on the network (Coindesk 2016, p. 9). To avoid
Bitcoin`s mining centralisation, the system´s specifications favours processing by graphics processing units as opposed to the processing capacity of specialised processing hardware developed for bitcoin mining (ibid. p. 12).

Gas, the transaction cost mechanism, is accounted in gas units, being the cost of 1 gas unit the equivalent of 10 Szabos, 1 million Szabo the equivalent to 1 unit of Ether (ETH), Ethereum`s reward token and original currency (ibid. pp. 15-16). Unlike Bitcoin, it has no fixed finite limit, having a stable declining inflation rate ("disinflationary") of ether set through its creation rate (Lubin 2014). Ethereum includes a "difficulty bomb" which after a number of blocks increases the mining difficulty, thus making the activity unprofitable unless a fork/update is provided. This is planned to oblige miners to adopt future changes in the protocol and its planned shift to the Proof-of-Stake protocol in which mining is no longer a reward mechanism for securing the blockchain (Tual 2014). Figure 1 (Pfeffer 2016b) semantically represents the Ethereum blockchain and its most basic operations.

To fund the platform's development, launch and sustainability, the Switzerland-based Ethereum Foundation adopted a method that has become common practice within the space: it directly sold tokens with an Initial Coin Offering (ICO) and amounted 18$ million, jumpstarting the community-driven and developed platform`s adoption (Ethereum Community 2017). To encourage its development, the Ethereum Foundation also started a grant program in 2015 for "(...) applicants creating an open source public good for public benefit (...)" which has been renewed in January 2016 (Davis 2016).

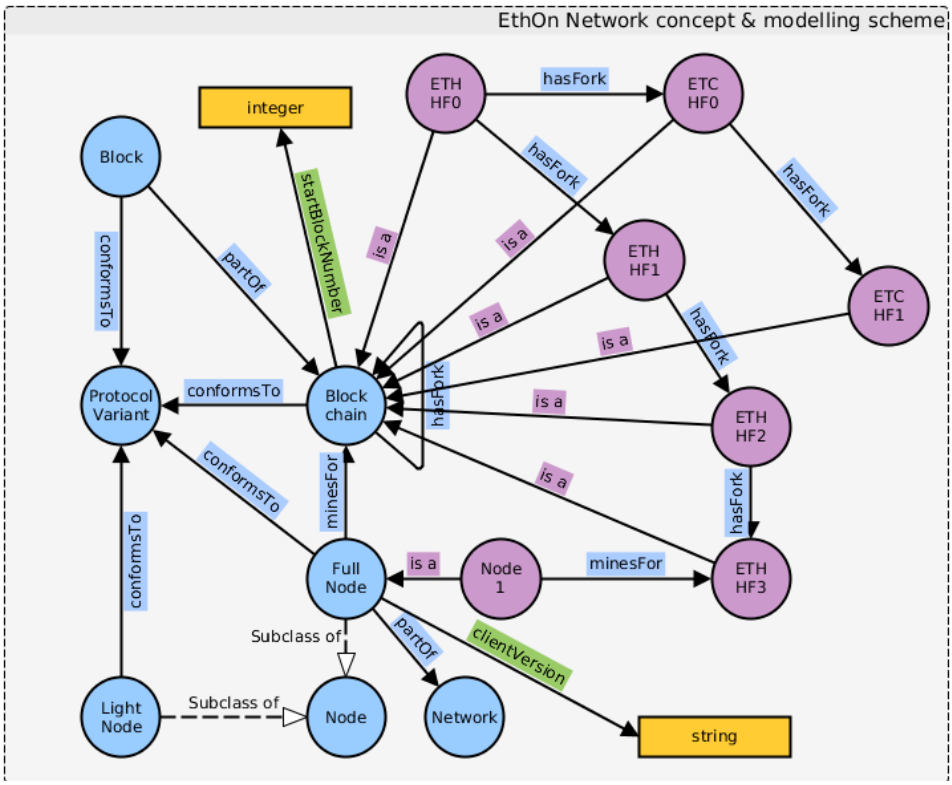

Figure 1. Ethereum semantic representation by Pfeffer 2016b

"(…) the decentralised platform that might displace today`s institutions" (De Filippi & Mauro 2014) is observing organisational experiments around the idea of a Decentralized Autonomous Organization (DAO). Vitalik Buterin, the creator of Ethereum, has in a number of blog posts presented ideas related to the uses of the Ethereum blockchain with related concepts and applications. The premise starts with the idea of a smart contract, or, accounts that interoperably execute a set of transactions, automatically or when ordered to do so, between two or more parties. These smart contracts, when participation is not limited, would be considered a Decentralized

Application (Dapp). A Decentralized Organization (DO) would be a set of humans interacting according to rules specified in code. The addition of the word Autonomous would be used for an organisation whose primary functions are automated, and human activity and interaction not as necessary, leaving a grey area in what would each of these entities be purely constituted of (Buterin 2014a).

1.5. The DAO

The DAO project is in this grey area. Presented and developed by Christoph Jentzsch, it was an organisational solution to be implemented on the Ethereum blockchain. First illustrated in his white paper detailing the control of distributed funds by participants in formalised, software-based governance structures (Jentzsch 2016a), constituted on the used governance model that the Slock.It developers (Jentzsch team) had created for shareholders to vote on where the company should invest its funds.

After further development, around 5000 members joined The DAO Slack (an online communication channel) as a community was structured around the open-source project. Deploying “The DAO” in Ethereum on the 30/05/16 and accumulating close to 150$ million (ibid. 2016a), equivalent to 14% of the total ETH supply (Tual 2016b) in 4 weeks, made it the largest crowd-funded project at the date. It would have been used to invest in projects submitted to it (Jentzsch, C. 2016a) and voted upon.

1.6. The Moratorium, The Attack and The Schism

On the 26/05/17 at the end of The DAO`s third week of existence, a group of researchers called for a moratorium on the project. Using a game-theory approach they detailed 10 different ways in which its structure could lead to attacks and abuses (Mark et al. 2016). On the 05/06/16, one of the developers of Ethereum, Christian Reitwießner who had the role of Curator, discovered a condition in the programming language Solidity that could be used to attack smart contracts, later identified in The DAO by a The DAO Hub forum user (Jentzsch 2016a).

Whilst it was announced that it put no ether at risk, the bug was to be found elsewhere within The DAO. On the 17/06/16, the user ledgerwatch posted on Ethereum`s subReddit “I think TheDAO is getting drained right now”. The “attacker” moved around 50$ million worth of ETH from The DAO into a child DAO (Jentzsch 2016a).

The only solution became a hard-fork to allow all of The DAO`s tokens to be withdrawn. The community sided most with this solution by updating their software client. However, the old chain remained in existence and kept being mined on, resulting in an older copy of the Ethereum blockchain (ibid.) renamed Ethereum Classic.

ETH, for Ethereum`s Ether tokens, are now traded in cryptocurrency exchanges alongside ETC, the Classic chain`s new currency. Value on the old chain was recognized by cryptocurrency exchanges, meaning that Ethereum ether holders saw a “replica” of their tokens gaining market value. The new Ethereum Classic community is keen on continuing their chain and have achieved moderate success. “Code is Law” in the Ethereum Classic chain and miners can switch between chains, as well as investors trading the two cryptocurrencies (Ethereum Classic 2016) along with the possibility of choosing in which Ethereum chain to specifically develop for.

3. The DAO Development

3.1. Developers and Cryptocurrency

"*Would be nice if we @slockitproject had time to write a book about the #DAO and its ecosystem. Oh wait* .. [image]." Lefteris Karapetsas, 19/04/2016, Twitter

Lessig has asserted that "code is law" (2006 p. 5). For cyberspace and the internet, it defines what is possible and corresponding consequences. With code being a human construct, the development of cyberspace is to be considered a continuous human endeavour. Its in-progress construction is conditioned by different factors alike the design of human law. Whilst it would be hard to establish a direct parallel between cyberspace governance and established political systems, each of these is defined by its own code, connections, protocols or laws.

Alike law, "code has embedded values" (Lessig 2006, 114) which regulate and define our online polities and corresponding political systems. There exist cultures and communities that precede it. Before Satoshi Nakamoto, a community of Cypherpunks existed. Part cryptography part P2P, Bitcoin`s software came to "materialize" the imagined digital cash of the privacy wary 1990`s born Cypherpunk community, who developed their ideas through mailing lists in which they envisioned privacy solutions to keep governmental tracking efforts at cyberspace bay (Jansen 2012, p. 15).

Remembering code serves to "(...) mediate, supplement, augment, monitor, regulate, facilitate, and ultimately produce collective life." (Kitchin & Dodge 2011, p.9), that with the arrival of a mean to establish digital property through the adoption of distributed trust, comes a back-end to a libertarian ideology. The idea that Bitcoin embraces non-governmental monetary policies sets a taste of technological libertarianism which Nakamoto himself seemed attracted to (Karlstrøm 2014, pp. 24, 29). Kostakis and Giotitsas argue that in theory, there would be equipotential individuals but the result is concentrated capital and centralized governance, highlighted by the emergence of a Bitcoin aristocracy (2014, p. 437). Thus, the progressive adoption of Bitcoin and other alternative blockchain based systems empowers (a community of) software developers in constructing a

transposing digital world, making them capable of embedding their own interpretation of the law into the created digital artefacts (De Filippi & Hassan 2016).

Blockchain can be re-interpreted to create different systems. Ethereum`s planned mutations are included in its roadmap (Ethereum, 2015b), pre-disposing its community for the platform`s scalability efforts and altering systems of governance. According to its developers, “Ethereum can serve as a new kind of law” (quoted by Reijers et al. 2014, p. 136). Decaling social contract theories on top of the system, researchers argued that this example of that which is to be transformative of our political systems, coincides with Rawls's “veil of ignorance”, but negates it due to pre-defined power-relations - his distributive justice, as well as Rousseau's idea of the common good have not been incorporated. Finally, the analysis converges the three authors mentioned when it gathers Hobbes sovereign Leviathan, through Rousseau`s decentralized governance, fairing Rawl`s equal rights and liberties for all, but noting this type of governance is so for all the nodes, in this way affording that power to the node operating miners. Assuming a “Leviathan” has been coded, its maintenance is allowed or disallowed by the nodes, leaving users without participative technical knowledge at the hands of the contracted sovereign, if no assistance is conveyed or provided outside of the system.

Whilst it fashions libertarian ideals, Bitcoin's design enables the creation of interchanging classes with different functions and powers. The developers, both maintain and correct its code as well as develop new applications surrounding the technological infrastructure, acting through individual contributions, or by assembling in startups and tech departments of different institutions. Contrasting the role of cryptocurrency exchanges in determining the market value of a token, developers influence is done by design instead of intervention. Whilst a deflationary token-policy in principle leads to the increase in market value, once instanced, trading has a bigger influence in the market price fluctuation.

Considering the different code layers that operate in and of a blockchain, the usage of a particular software grants specialised developers a privileged role over necessary changes and the freedom to negate further developments based on their unique knowledge over specific software. This is particularly visible not only by the attribution of The DAO exploit to an individual (or group)

knowledgeable of the code that was used in The DAO, but also the necessaty of having the resolution implemented by node client developers providing updates, key for the forking of the chain. Client is a type of software used to access specific services or servers through a network. The two most widely used Ethereum node clients are the Parity implementation developed by Gavin Wood`s company now known as Parity and the Go-Ethereum referred to as Geth (Ethereum Homestead 2017[2]) developed by the Ethereum Foundation alongside community contributions.

Developers are able to understand and construct in programming languages which`s literacy is highly restricted. They are the only ones capable of defining and implementing human will through code development, leaving any community which is dependent on the maintenance of software, dependent on a group whose legitimacy is taken from technical knowledge. It should not be ignored that these same solutions can go through popular scrutiny, yet much like referendums, updates to the software can lead to alternative software projects or changes to code known as forks, which democratically would presume conceiving, developing and presenting before voting. Agency upon the development of software is only truly afforded to developers and people with technical knowledge, even if its design can have a more inclusive approach. Parity`s (2016b) response to the hack describes the position afforded to developers: "It is important to note that throughout this process the developers are not expected to remain agnostic or indifferent. They are important players in the ecosystem and will likely voice their opinions on how best to evolve the network. However, assuming they wish to protect their own existence and relevance, they will inevitably provide support to as much of the user base as possible, even those who do not share their opinion. They will create clients that are capable of switching to a new fork if the users desire it - pretty much the greatest contribution to the common good they can make."

With the possibility of software becoming relational, Vinay Gupta notes that through such conceptions, the possibilities change in the architecture of trust brought forward by the smart contract technology might just be the next evolutionary step of capitalism. Considering lawyers as being predominant within our government systems and mediators of trade, he envisions the passage from Buckminster Fuller's "lawyer capitalism" to technical capitalism, in which the rule of law is

[2] "As of September 2016 (…)" (Ethereum Homestead), still prevalent at the time of writing (Ethernodes.org).

coded, and programmers take the role provided by lawyers, and instant executable code, the rule (Epicenter 2016b). They design the rules to put forward for consensus.

Developers	Behavior		Outcomes	Configuration		
	Ps (Perceptions, preferences, policies, principles)	Actions		Pathways of power within the system	Completeness/ tight- or loose-coupling within system	Closure/openness of between-system transitions
Power	Infrastructure improvement	Developing; Maintenance	Improved infrastructure; Safer infrastructure	Technical knowledge	Loose; Decentralised	Closed; Technical knowledge
Susceptibility	Mining consensus; Bugs; Software specialisation	Forks; Exploits	Hacks; Forks; Exploits	Consensus protocols; Exploits	Tight; Specialised	Closed; Blockchain architecture
Freedom	Software specialisation	Improvement proposals; Forks	Dependence	Technical knowledge	Tight; Specialised	Open; Several clients
No-power	Token market-value	Speculation; User adoption	Variable revenue	Token-policy; Exchange policy	Loose; Decentralised exchanges	Closed; Concentrated capital

Table 2: Developers Freedom and Power in Ethereum`s Ecosystem

Blockchain`s given consensus over the code makes it highly unpractical to change both the live blockchain code as well as the components of its smart contracts and respective applications, whilst allowing for off-chain changes, for example in smartphone applications or internet websites feasible. The more trust is put into a blockchain, the harder it is to update the software or to fix any unintended consequences after its deployment and use. Whilst developers have some power over the software, once deployed on the blockchain they are susceptible to any bugs, code failures or exploits, with any off-chain mechanisms also likely to be targeted.

3.2. Slock.it and The DAO "Movement"

There were several visions for decentralized autonomous organizations prior to the development of The DAO, but Slock.it is the first team to develop a common framework and set standards. In order to enable an idea for the "sharing economy", Slock.it would be contracted through such an organisation, instead of funding their idea through traditional means.

The DAO`s original code was first publicised on an Ethereum foundation blog post (titled "Ethereum in Practice Part 2: How to Build Better Democracy in Under a 100 Lines of Code") in which Alex de Sande (2015) details a number of contracts published in GitHub by Christian Reitwießner, one of the creators of the solidity language, whereas the D stood for democratic. They would become the core contracts of The DAO, from which Christoph Jentzsch would add the ability to split and associated functionalities (Jentzsch, C. 2016b), along with a wider use of its now infamous name "The DAO". His original intent was the use of it by Slock.it and its funders, as introduced on the Devcon1 Ethereum presentation on the 12/11/15 (Ethereum 2016a).

Realising its possible applications, they developed The DAO alongside the community that gathered around Slock.it`s DAO white paper made publicly available on two blog posts, on the 10/01/15 (Tual 2016c. 2016d) and re-announced on the 01/03/16 (Tual 2016e). They would have the code audited by Deja Vu Security on the 25/03/16 (Deja Vu Security 2016). An independent team set up the DAOHub 02/04/16 (DAOhub 2016a) as a communication and discussion channel which would later select and announce the account of The DAO (van Orden 2016), one day after the final release of the framework 1.0 on the 29/04/16 (GitHub).

Whilst The DAO slack channel reached around 5000 members (Jentszsch 2016a), the deployed version of the code only benefited from the contributions of 8 individuals according to its GitHub page, of which four worked directly for Slock.it and a 5th contributor was a verification engineer for the Ethereum Foundation. Apart from Deja Vu Security, Ethereum and Slock.It related contributors, Christoph Jentszsch thanks Gavin Wood and Christian Reitwießner (the two biggest contributors to Ethereum`s Solidity programming language) for having reviewed the smart contracts, along with the community in The DAO`s white paper (Jentszsch. C. 2016b).

3.3. The Governance of The DAO

The white paper titled "Decentralized Autonomous Organizations to Automate Governance" by Christoph Jentzsch of Slock.it (2016b) holds the promise of automated governance. Whilst the word automated hasn`t been chosen, the mechanisms for autonomous governance, greatly dependent on human input, are well detailed. The software does present a foundation in which automating through

the deployment and utilisation of smart contracts is possible, this meaning the inter-contract interaction within the Ethereum blockchain.

Ethereum`s The DAO`s smart contract allows for the two actions mentioned above. The "organisation" nomenclature subsists as an abstraction of the code, even if it is not dismissive. As an organisation, The DAO collectively manages a collected fund. Contractors (who need to hold The DAO tokens) request the transfer of funds to another smart contract whose own set of rules can orchestrate a project`s allocation of funds and presumably, send back the ether, therefore its labelling as automating governance. As for the direct control of funds, its allocation through The DAO requires voting and a 20% quorum of the existing tokens for approval and a 53,33% quorum in case the requested ether surpasses the total amount that The DAO has ever received. The time frame for this decision to be made is defined in the contractor's proposal. After this period, a token holder can call a function to verify the decision made on the application, which is then closed or enforced depending on the result of the voting. The necessary minimal deposit for a proposal is refunded if the voting reaches the necessary quorum. The publicity for each project is made outside of this coded environment.

A more unique function in The DAO is the ability to split. This "re-allocates the ether correspondent to The DAO`s tokens held by the user to a newly created DAO. This is presented as a solution to the "Majority Robs Minority Attack" to protect the disagreeing minority from decisions made by the majority. Such an attack could be made when some users holding the majority of voting rights decide to send the entirety of the funds to their own proposal, and consequently to their account. A user intervening through the mentioned solution would be able to keep his reward tokens from the "unsplit" DAO (acting as I Owe You tokens) and effectively leads to the creation of a new DAO altogether once the debating period is over, not needing the mentioned quorum for traditional proposals.

Believing voter apathy would be a problem against malicious proposals, the solution was to assign curators to The DAO which hold the final word on the transfer of ether from The DAO to the approved proposals. The first step for splitting is to propose a new curator. Those who approve of the new curator, will then confirm it in their second vote and chose on becoming part of the new

DAO over the 7-day debating period and then confirm this by transferring their funds to the new DAO which enters its creation phase.

The first period of The DAO is the fuelling period. It lasts 27 days when ether gets created in exchange for The DAO tokens. These get more expensive over the passing days of the fuelling period, gradually escalating from 1 ether for 100 The DAO tokens in its first 15 days, to 1,5 ether for 100 DAO tokens on the 24th, when the creation cost is maintained until the end of this period. It then enters its operational phase, where proposals are approved and disapproved, and the mentioned tokens are exchanged instead of created.

The DAO functioning has been visually represented by Baylina (2016) as observed in figure 2.

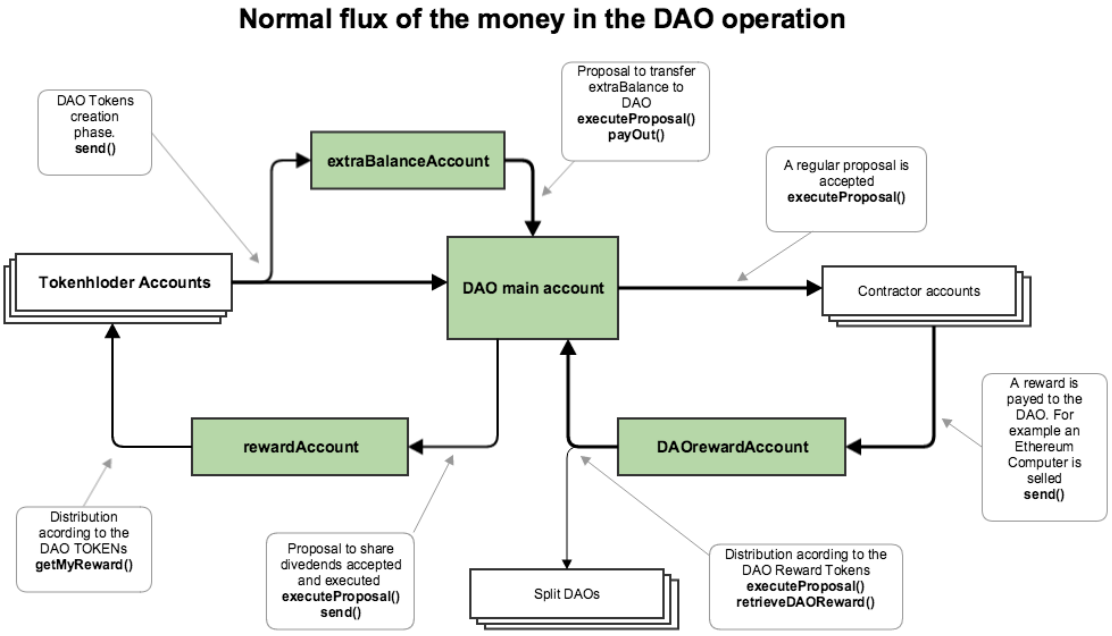

Figure 2. Normal flux of the money in The DAO operation by Baylina 2016

To make it as anonymous as possible, the community both through the slack channel and The DAO Hub forum articulated the deployment of the code. They found 10 equal versions and flipped a coin to decide on which of the two accounts belonging to exchanges (as this would grant extra anonymity) and chose it. The bytecode match was confirmed and the address got selected and publicised on the forum (Dameron 2016) and in the Medium platform (DAOHub 2016b).

On the 25/04/16, the curators got announced through a blog post on Slock.it`s medium account (Tual 2016f). Whilst Tual mentions that a partnership was made with The DAO Hub for the selection of the curators, as The DAO Hub users confirmed thanks to a comment by one of the forum founders, user FelixA (Albert 2016), revealed that the discussion was made outside of the forum with the managers of the forum and Slock.it being identified. As written in the white paper: "The address curator is set at the creation of the DAO and defines the Curator." (Jentzsch, C. 2016b) The function of the curator is the whitelisting and approval of the transfer of ether to outside of The DAO as well as the made proposals, making curators assessors of identity and code verification, acting as a human point of control.

Thanks to the respected profile of the personalities announced as curators, the author was unable to identify any discussion on this move, apart from Jeffrey Anthony who raised this point in The DAO Hub forum (Anthony 2016). The DAO now had 11 curators on the multi-signature account, a multi-party signing mechanism previously suggested by Tual (Tual 2016a). The whitelisting of addresses for the movement of ether were now dependent on 5 signatures of names like Vitalik Buterin, Christian Reitwießner or Gavin Wood, amongst others. Wood would announce his resignation as curator on the 13/05/16 (Wood 2016), two days before the price increase when the amount of ether collected was already considerable. Members of the community have since joined, and the roles and number of curators have since then changed several times, reflecting both the expertise and willingness to sort out the coming situation by the revolving members.

Highlighting the role of the curator, the critiques led by Cornell University Professor Emin Gün Siren (Mark et al. 2016) on the 26/04/16 called for the moratorium on The DAO, which never went into full effect thanks to the autonomous functioning of the infrastructure as well as the necessary voting diligence through it. Those same critiques started to turn into solutions as part of a The DAO 1.1. Version, whose improvements were introduced within a working framework for DAO Improvement Request by the curators and Slock.it (Tual 2016g), which did not get implemented. They also presented a security contracting proposal by Slock.it for The DAO which was not well received by the community (Tual 2016j) which considered the high fee unfair and that there would be a conflict of interests. The "to-blame" mistake in the code was later presented a solution within the mentioned framework, only that it accounted for the solution in only one segment of the code.

4. The DAO`s ICO

4.1. ICOs: Buying into The DAO

"*The DAO could be a cool new investment vehicle, or it could easily turn into a $150M bug bounty if poorly implemented.*" Emin Gün Sirer, 27/05/2016, Twitter

Initial Coin Offerings (ICOs) have become a common way in the cryptocurrency space for the funding of development. It became an innovative financial investment vehicle and the tokens being sold, the bearers of a new way to jumpstart communities and ecosystems around certain protocols and social contracts, which in turn revolve around these same procedures. How this is first done provides a defining moment of the structure of its pseudonymous user base.

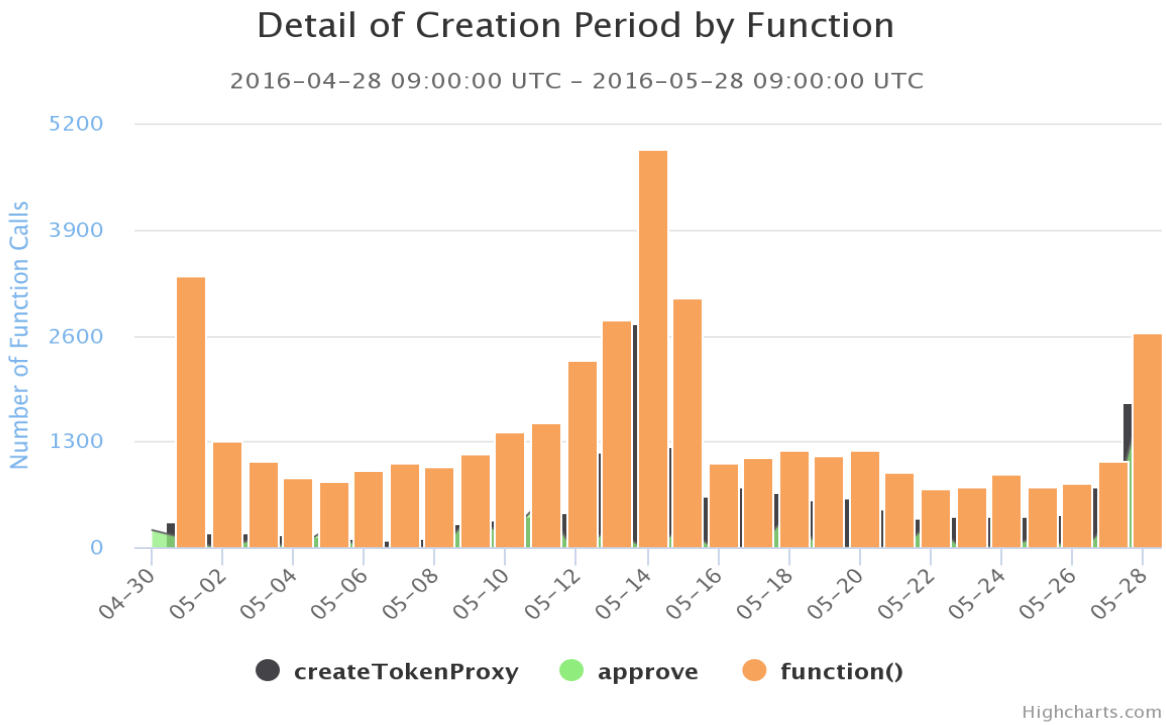

Figure 3. The DAO`s creation period by Great Hill Corporation 2016

One of the first chains to have inaugurated this concept (and making it prominent) is Ethereum and its ICO. Investors bought the promise of ether, as in the currency of the to-exist blockchain (having become a platform for the launch of other ICOs), to be developed in the following months in

accordance to the roadmap and vision presented, allowed in this way by the crowdfunding of that same platform. Once it started, users were already able to hold ether in their wallet client, which would be transactable once the genesis block was mined. In this operation, the Ethereum foundation also reserved ether to the contributors of the project and to the Foundation (Buterin 2014b).

The buying of ether was paid for in bitcoin. The sale lasted 42 days. In its first 14 days, ether was sold at a discount rate before linearly increasing until the last day on the 02/09/14. Two weeks into the sale, Buterin`s overview shows a spike in its beginning, and another one in the end of the discount rate period (ibid. 2014b), also observed in The DAO with another spike in the last days of the creation period represented in "function()" in figure 3 (Great Hill Corporation 2016). Here, the tokens bought after the discount period only represent 14,9% of the total (Pfeffer 2016b). The peak that before the price increase can represent a standard investing practice of gathering as much information as possible before making a decision[3]. This stands in parallel to the first initial smaller peak, which could be composed of individuals with a different set of knowledge that invested once the information was available. With this hypothetical profiling, it can be proposed the first peak is made of individuals with technical knowledge, representing approximately a quarter of the peak-made investments in accordance with the data presented by Petty (2016). If we generalise this assumption then one-quarter of the investors had a technical background, whilst the other three-quarters are associated with financial investors behaviour.

As noticeable in figure 4, the biggest clusters of investments on The DAO derive from cryptocurrency exchanges, totalling 30,8% (Pfeffer 2016b), further confirming the hypothetical profiling. These exchanges facilitate and make it their business to enable transactions and act as intermediaries. They are obliged to comply with jurisdiction-based rules, with different types of security guarantees and obligations than the Internet enabled blockchain infrastructure. Considering the legal liability of exchanges, this is an alarmingly high number to hold responsibility. It also lays bare the individual technical knowledge of a big part of the people investing in The DAO, which saw the operation facilitated through their interfaces, acting as custodians instead of supporting voting mechanism for The DAO found in some wallet clients.

[3] The price increase caused some confusion as this only happened one day after it was first announced since the first increase was 0 (McCLure 2016).

The clusters in figure 4 represent accounts that have had transactions amongst each other. As observable, it is clear there are different sets of groups taking part. It is also noticeable that a number of accounts which, to receive The DAO tokens relied on some sort of intermediary. Transfers in black are the ones made to The DAO whilst the ones in orange are arbitrary transfers. Also, black nodes account for genesis accounts (pre-launch accounts), which were created on the Ethereum ICO, which account for 19,6% of the total (Pfeffer 2016a).

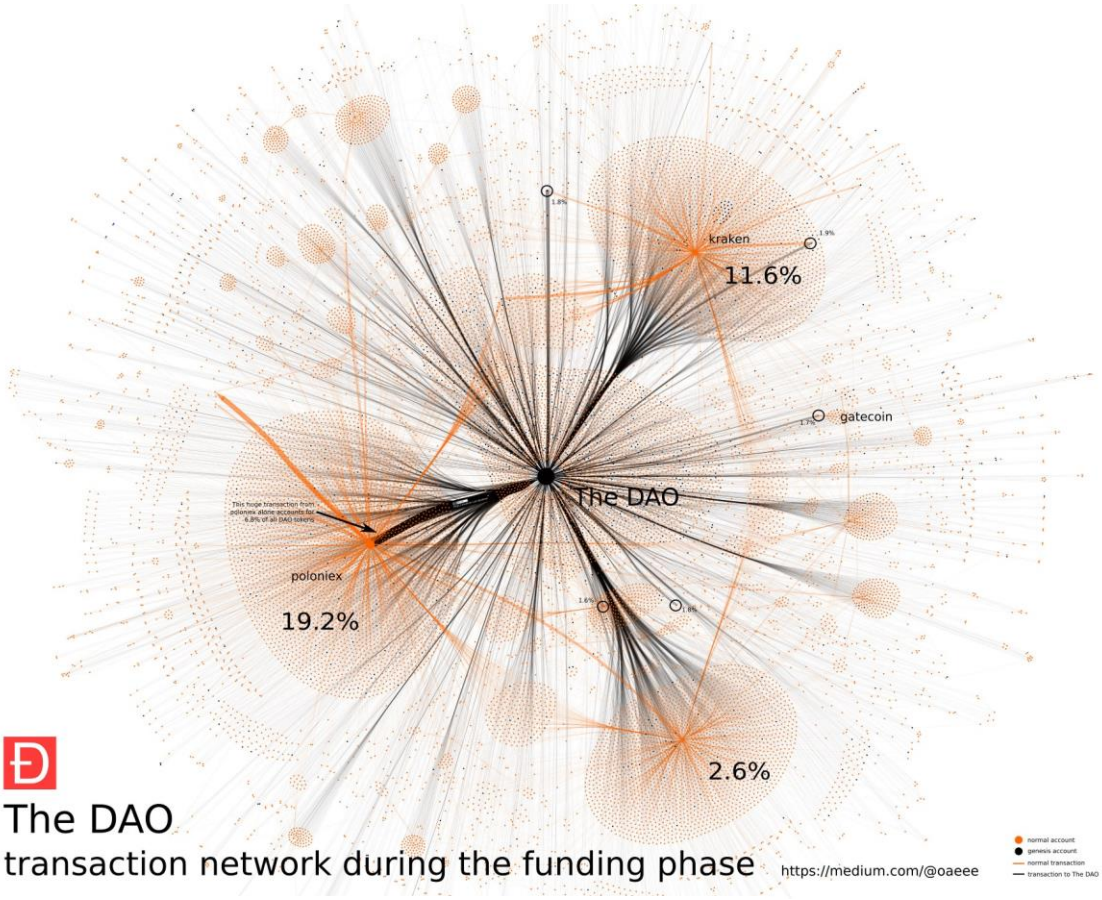

Figure 4. The DAO funding by Pfeffer 2016a

It should be noted that this operation is done in an extra-legal space. Since blockchain transactions are mostly unregulated, it adds the question of which jurisdiction they ought to obey. Furthermore, the anonymity (or pseudo-anonymity) that comes with the use of cryptocurrencies for which law systems have not yet come up with effective solutions to regulate. This is partly permitted to new and innovative sectors so as not to "stifle growth". Often, this is the justification for the lack of regulatory processes (as approved, for example, by the European Parliament in Committee on

Economic and Monetary Affairs 2016, p. 10) for maturing technologies and corresponding ecosystems, particularly relevant in highly uncertain markets (Blind et al. 2016). These processes highlight Perez`s techno-economic paradigms (2002) which describe the traditional cycles of technology as being dependent on the role of financial capital looking for large returns on investment whereas "existing large firms are likely to be both agents and victims of paradigm closure" (ibid. p. 33). As an example, the R3 banking and financial sector blockchain consortium and its permissioned chain. Within Perez`s tentative typology of financial innovations, ICO`s are either in the "Profit-Taking and spreading investment and risk" or in "Questionable innovations" if not in 4 out of the 6 categories presented (ibid. p. 139) thanks to the myriad of applications possible through such a mechanism.

76% of ICO investors cite investment and speculation as their primary motivations (CoinDesk 2017). Cryptocurrency based gambling applications like Vdice or Crypto Rock Paper Scissors are proving quite popular within a sector whose betting investments increasingly describe the emergence of the postulated "casino economy" (ibid. p. 142).

Recalling there is no absolute security code, developers are much better at analysing the risk of investing through and in software, as reflected in Gavin Wood`s withdrawal from the role of curator once the amount of ether invested in The DAO could be considered substantial. The investments of users with technical knowledge would then differ from the patterns observed in The DAO, further confirming the hypothesis that the greatest number of investors were not aware of the risks of investing in The DAO. Furthermore, were unable to procure the active role of decision-makers. In-chain voting participation rates were less than 5% in the 11 non-split proposals of its operational phase (Great Hill Corporation 2016). In any case, The DAO`s code development did not receive any initial funding, either for no attempt was made, or there was no interest to finance the facilitating of a public structure capable of enabling social interaction through smart contracts. The only business model to come out of it would be created from the projects that were to come out of it, none of which got proposed in The DAO likely due to the moratorium (ibid. 2016).

4.2. Financial Innovation and Smart Contract Commons

Ethereum`s pool of smart contract allows for the development of an infrastructure of operations. In this way, it facilitates innovative processes thanks to the sharing of software and development costs, becoming an "innovation commons" as Gavin Wood described it (Ethereum, 2015a). The doubling of chains and subsistence of Ethereum Classic as well as the news of permissioned ledger Burrow, a project of Hyperledger, who is to use Ethereum`s Virtual Machine (which executes blockchain contracts) contributes to this understanding. Enabling the use of Ethereum`s smart contracts on a different blockchains (Dhaliwal 2017), contributes to the understanding of a "commons" pools of smart contracts and code. The author did not identify the existence of any copyrighted or patented Ethereum smart contracts. As a contractual mechanism, the code should be verifiable to enable the verification of its lawfulness. Whilst bytecode can be retrieved from the Ethereum blockchain, is very hard to compile the format into programming language code, meaning that in order for the code to be used or copied, it needs to be accessed through code-hosting platforms such as GitHub. Pseudo-anonymity further facilitates these processes against legal and proprietary systems.

Incentives to produce truly public smart contracts that enable group-making, need to be further enhanced. This is one road which needs to be consciously built. Communities will be dependent on these mechanisms to build their own structures and the promise made by The DAO can be interpreted as one for such a mechanism. The existence of a pool of smart contracts facilitates the development of Dapps. DigixDAO, for example, created crypto assets pegged to gold, whilst Golem aims to decentralise and rent computing power funding its development through an ICO. These applications and corresponding methods for collecting funds work in parallel with The DAO`s method for collecting funds[4]. The DAO, which can be considered an instance of a Dapp, did go one step further in approximating the definition of a Dapp and "(...) something else (...)". Characterising different classes of smart contracts, Buterin mentions a grey area in which some applications "(...) create ecosystems and there is a concept of virtual property that has value inside the context of this ecosystem (...)" (2014a). In The DAO`s case, The DAO tokens.

[4] It should be noted that these applications are continuously being developed, used, and under increased scrutiny and criticism.

The DAO tokens grant the users with a number of different abilities. It grants the right to participate in the “organisation”, it holds equity in the form of decision-making, it allows to make proposals to The DAO, and its trading value is priced in accordance with the market. Whilst the infrastructure of The DAO respects privacy in principle, off-chain, it privileges reputation and requires identity for the approval of projects since communication is done off-chain and, as observed, started to have an ecosystem built around it. This represents a change in the original Bitcoin anonymity prescription and a shift in the audience that cryptocurrencies cater to.

Along with members of the financial industry pointing out Bitcoin and cryptocurrencies represent a new asset class (Burniske & White 2017), a range of services have emerged to evaluate crypto assets and ICOs. Tokenmarket.net, ICORating.com, ICOTracker.net, and TokenHub.com, enlist the concept, the financial model, the total token distribution, white paper, roadmap, the team behind the project, the legal risks and overall social media presence amongst other indicators of their ratings and evaluation of ICO`s.

As an innovation, there would not be a common answer by all of the users/investors, making it necessary to reach for a different kind of value-theory to appreciate what constitutes token-value. Bauwens and Niaros (2017), discuss value as “the allocation of resources in human societies, but more specifically in our “digitalized”, “networked” societies where emerging knowledge commons are playing an increasingly vital role?” (ibid. p. 2). The authors conclude that there is no consensus about the definition of value and that it is culturally dependent along with many other factors that influence it. Much alike the heterogeneous groups within Ethereum and The DAO community.

There is an interesting correspondence in the use of words by the authors of this report and the words used by different high-profile individuals in the blockchain scene. The words community, decentralized, distributed and P2P all serve as comparable words to describe the mechanisms held within these infrastructures and how their are managemed. This advances our analysis whilst transposing to the case of The DAO as well as advance the empirical establishment of a theoretical framework for the analysis and development of comparative data alike. Finally, to describe these communities and the social contracts embedded in its structure (Reijers 2016) allowing for the definition of a political spectrum.

The necessity of having to develop a smart contract to "contractualise" a contractor's proposal with The DAO in itself also acts as a contribution to that commons pool. Any person would easily re-enact their own operation and their own set of transactions since the code ought to be made public so that it can be analysed by the community before approving a contractor`s proposal. This dissertation`s scope however, is limited to postulate and describe the different valuations based on the functions of The DAO (to invest a stake into a future project) and as a consequence of the Ethereum blockchain.

4.3. Value typology of The DAO tokens

As more individuals buy cryptocurrencies and the technology improves, tokens gain market value in relation to the total contained within the network. Those same tokens exchanged by The DAO smart contract were accounted as being 14% out of the total ether in Ethereum (Tual 2016b). The crowdfunding operation in itself encouraged a number of projects, reproducing the collective investment with a nearly instant valuation of The DAO tokens since The DAO would allow for the high visibility and possibilities for collaboration between different groups centred on this structure.

Figure 5. Relation between the commons and the market as proposed by the Backfeed blockchain project. Adapted from Bawens & Niaros 2017

Bauwens and Niaros (2017) take a step further in noticing that broader streams of value can be recognized. They first mentioned new forms of value-accounting systems that incorporates the idea of "transvestment", and insulates the purpose-driven activities from capitalist extraction. An alternative would be the creation of value-sovereign distribution systems. A wider use of these systems would represent a change of paradigm, which as they mention, represents a Value Shift. Their last case study describes Backfeed, which was one of the projects that attempted to apply to The DAO. It would instill the development of a new DAO structure to which the community would migrate to. They describe what the value of tokens would be within the implementation. This confirms the understanding that communities are built around these structures labelled "decentralized cooperation (DC)".

Whilst Backfeed`s implementation considers the protocol level of a blockchain, the principles can be applied at the Dapp level, and are partly found within The DAO. Akin to Backfeed:" a peer-to-peer evaluation system used to determine the perceived value of the various contributions; (b) a reputation system for allocating influence according to the contributed value and the alignment with the overall perception of value within the organisation and (c) a token-based economic model, where the token market value is determined by the perceived value of the goods and/or services that the organisation provides" (Davidson et al. 2016, quoted by Bauwens & Niaros 2017).

The investment in a particular token is an act of transvestment and a decision that can both be made by a collective and an individual by the way they practice the exchange of this value. Furthermore, Backfeed`s economic model illustrates the evolution, function and value of digital tokens, first as equity, second as a commodity and third as a currency. Looking back at The DAO, these tokens can be defined by the first two: as equity and as a commodity, both presuming a return on investment. The DAO`s patterns of investment and exchange indicate this focus. Whilst The DAO`s structural proposition did not include as many processes to be made on-chain, other channels could be accounted for the evolution of the token. Its weeks-long processes for the return of investment was meant to slow down its use as a currency, according to one of the interviewees.

The graphical representation of the value of Backfeed understands that value is both created for the market and as a commons, visually represented in figure 5. The same holds true for The DAO, since

the development of smart contracts adds to a larger pool of programming resources that can be reused. Only that in The DAO, that same created value would be recognized once that the project proposal shaped as a smart contract would be approved by The DAO token holders as a whole instead of smaller division of labour in code.

De Filippi, who is working on Backfeed, discusses the value of metrics when evaluating cryptocurrencies. As she writes, "(...) the logic of accumulation characteristics of the capitalist economy does not properly apply in a commons-based ecosystem characterized by a growing abundance of non-rival resources. (...)" (2015). The same holds true for those who facilitate guides and guidance to those entering the community and hold less technical knowledge. Notably, The DAO`s slack was filled with beginners trying to understand what exactly was The DAO or Ethereum trough these resources. Whilst it can be used as a mean of exchange, the return on investment on The DAO tokens was meant to be realized through the funding of projects instead of the tokens appreciation. In contrast, an experiment based on Backfeed poses the reluctance of quantificatying cooperation by a community (Pazaities et al. 2017). Furthermore, "In the Backfeed case, through the creation of tradable cryptocurrencies, it is possible to directly 'marketize' the contributions. This could be problematic as the market incentives could 'crowd out' the commons-based contributory logic (…)" (Bauwens & Niaros 2017). In The DAO case, it was just as problematic.

4.4. Cryptocurrency exchanges

Cryptocurrencies first exchange rate was established by the New Liberty Standard (Jeffries 2017) by calculating the electricity cost necessary to generate a bitcoin, thus setting the price for the first website that facilitated its exchange for fiat currency (Popper 2016 cited in Bear 2017). The market share of such platforms equates with the information share they have on the market, providing another price discovery mechanism for cryptocurrencies and allowing the largest trading-operators to lead the market pricing trough publicly available data (Brandvold et. al 2015).

Cryptocurrency exchanges became facilitators of crypto-tokens and are often the first time providers for new users. Whilst acting as intermediaries for blockchain based transactions within this new

"decentralised" paradigm, most act as custodians of users' tokens by default (Poon & OmiseGO team 2017). As middle-man alternatives, P2P trading LocalBitcoins.com charges a small fee upon trading facilitated by their advertisement services. They also provide specialised services like market research. There are a number of projects like Bancor, Internet of Coins or OmiseGO which promise to automate token trading, reducing the number of intermediaries. Contrasting custodian and identity dependent cryptocurrency exchanges are software wallets, which normally give users access to their private keys granting direct access to their accounts on the blockchain. These wallets give access to specific tokens and often allow exchanging between tokens trough in-wallet services.

Exchanges	Behavior		Outcomes	Configuration		
	Ps (Perceptions, preferences, policies, principles)	Actions		Pathways of power within the system	Completeness/ tight- or loose-coupling within system	Closure/openness of between-system transitions
Power	High trading; Decentralised blockchains;	Custodian interface; Token facilitation;	Centralised users; Trading-value based tokens	Identity; Concentrated capital	Loose; Largely unregulated	Closed; Platform ownership
Susceptibility	Exploits; Legal jurisdictions; Decentralised exchanges	Hacks; Legal prosecution	Bankruptcies; Reduced adoption	Technical knowledge; Legal jurisdiction	Loose; Blockchain openness	Closed; Concentrated capital
Freedom	Mediate exchanges	Encouraging adoption	Centralised users	Market dominance	Loose; Blockchain openness	Open; Unregulated markets
No-power	Decentralised exchanges; Technical improvements ; Legislation	Automated exchanges; Prohibition	Peer-to-peer trading; Blockchain adoption	Technological innovation; Adoption	Loose; Dependent on adoption	Open; Dependent on technical innovation

Table 3. Exchanges` freedom and power in Ethereum`s ecosystem

In the early days of Bitcoin, Mt. Gox cryptocurrency exchange was by far the leading exchange (Brandvold et.al 2015) (Feder et. al 2016). Considering the importance of Mt. Gox within the Bitcoin ecosystem, an analysis of the distributed-denial-of-service-attacks was undertaken, correlating it to a reduction in trading activity (Feder et. al 2016), signalling their importance within blockchain ecosystems. However, the holding of cryptocurrencies turns these institutions into profitable targets. The findings of the research paper mentioned (ibid.) were only possible thanks to the leakage of the trading activity history of the platform. This was one of the problems affecting an exchange now known for poor management, legal prosecution, and for being hacked and stolen (McMillan 2014). It declared bankruptcy in 2014, prompting regulatory action by Japanese authorities (Ishikawa 2017). Ever since the Mt. Gox scandals, "Know-Your-Customer" policies of

requiring cryptocurrency exchange users to provide state-identifiers became prevalent (Jeffries 2017). This grants them oversight over the identity of blockchain users creating a liability in respect to legislative and state authorities, depending on the organisation`s jurisdiction and policies to come into law.

As previously explained, crypto-tokens have different properties and use-cases. As much as cryptocurrencies exchanges facilitate their adoption, their business model is based on the capture of value from exchange trade fees, thus highlighting the market price of tokens and their trade value against dedicated wallets or interfaces, thus decreasing their usability (Kazan et al. 2015). The DAO`s report made by the Securities and Exchange Commission (2017) and the necessity of The DAO tokens complying with U.S.A. securities legislation further stresses this development. The dependence on exchanges for token facilitation is made evident by Slock.it`s request for an exchange to trade these tokens (ibid. 2017), as well as the trading made available by 5 cryptocurrency exchanges operating in different markets.

5. The DAO gets Hacked

5.1. The Hack Explained

"*We have to return all the ether, and wipe the existing DAO tokens. The legal problems of the DAO are far worse than tech issues.*" Vinay Gupta, 20/06/2016, Twitter

Laying on line of code 666, was what made The DAO hack possible. The attacker was able to exploit this line of code, finding it a feature. The devised hack used on the 17/06/16 has been attributed not to a lone wolf, but to a group (Leising 2017) due to the high level of expertise required to understand the problem in the code.

The reward mechanism of the software acted as an enabler of a recursive call of any of the DAOs composed from the code to a split/child DAO (Daian 2016). According to an unconfirmed online interview, the attacker stopped because the depletion of the Ether equivalent DAO tokens would drive down the value of ether as a tradeable currency (Quentson 2016). Confirmed or not, the attack was hampered by the shared benefit of the market valuation of the network and shared tokenized interest. Remembering that the total ether contained in The DAO amounted to 14% of its total (Tual 2016b), the hack prompted the search for a solution.

Once noticed, a number of high profile individuals, pertaining and not pertaining to the Ethereum community started privately discussing a resolution for the hack. Presenting an *ad-hoc* solution for an unintended consequence on a blockchain has been done before but, at a much earlier stage of adoption and development of the technology. Leaked conversations held by these individuals was made public (Unidentified Author 2016). Whilst its veracity has not been denied, even if taken as a hypothetical exercise, they serve to understand the steps taken to resolve the issue, being particularly insightful if articulated with network theory and the study of open-source development.

To the dismay of decentralised digital governance proponents, the mechanisms and procedures for solving a crisis did not appear to have been in place at the time of The DAO. According to Green, 1-2 hours after it was found, the plan for a soft-fork and a hard-fork was made. During and after this

time, related individuals started to spam the network hoping to slow the attacker down (Let's Talk Bitcoin 2016a).

5.2. The Foundation, Curators, and Overlaying Decentralisation

According to its website, the Ethereum Foundation mission is to "promote and support Ethereum platform and base layer research, development and education to bring decentralized protocols and tools to the world that empower developers to produce next-generation decentralized applications (dapps), and together build a more globally accessible, more free and more trustworthy Internet" (Ethereum.org/foundation). Whilst the development of its base layer is reinforced, Ethereum`s foundation power over the Ethereum blockchain is, apart from the trademark over Ethereum, not proprietary. Theoretically, it cannot make any more changes to the Ethereum blockchain than the Linux Foundation could. However, it`s founder`s role, Vitalik Buterin, much like Linux`s Linus Torvalds, can be ascribed to that of a benevolent dictator along with "(...) early project adopters create an essential social fabric by establishing and asserting project mores, protocol and ethos" (Coffin 2016).

Looking at the original list of curators (Tual 2016f), out of the 11, 9 were indicated as being part of the Foundation, whilst the other 2 had worked for the Foundation before. Ultimately, a centralised point of control within a network enables agile decision-making processes. The Foundation's role in the founding of the chain, the rotating groups that interact with people from the Foundation, as well as the technical skills and connections of those individuals grants it the necessary reach to have miners implementing changes on the state of the network. This gives it the capacity to develop solutions as well as the required centrality to propose and implement solutions.

In comparison, there is not much that regular users can propose or do, that fundamentally alter the chain`s protocol. In accordance with Shen and Monge (2011), similar levels of performance and experience in open-source SourceForge, corresponded with increased collaboration. As previously noted, a great majority of the investors of The DAO did not interact in its decision-making processes. Along with having individuals acting at individual capacity, though centrally coordinated, communication regarding any development came across a range of off-chain channels, with different

comments and conversations happening across the web simultaneously, in contrast with the more restricted envisioning of possible solutions and mitigation.

Ethereum Foundation	Behavior		Outcomes	Configuration		
	Ps (Perceptions, preferences, policies, principles)	Actions		Pathways of power within the system	Completeness/ tight- or loose-coupling within system	Closure/openness of between-system transitions
Power	Protocol and technical upgrades	Software proposals	Protocol upgrades	Coordinated decisions	Loose; Blockchain openness	Closed; Foundation Structure
Susceptibility	Concerted critiques; Division; Software clients	Media attacks; Developers division	Reputational damage; Development support	Media channels; Software client adoption	Loose; Largely uncensored; Blockchain openness	Open; Internet media; Blockchain openness
Freedom	Foundational role	Coordinate decisions	Consensus	Technical centrality	Tight; Specialised knowledge	Open; Open source
No-power	Bugs; Hacks	Software proposals	Contentious forks	Specialised knowledge	Loose; Specialised knowledge	Open; Open-source

Table 4. Ethereum Foundation`s freedom and power in Ethereum`s ecosystem

With the initial online conversation in reaction to the hack, leaked (Unidentified Author 2016), the Foundation acted precisely against Coffin`s (2016) recommendations for project transparency of open and recorded dialogue. It should be considered that little information about the hack was available and that a publicly announced solution could nullify it. Saikh and Vaast (2016, p. 7) write about the notion of a digital fold as a way to balance openness and transparency in open-source communities, conceptualising it as a temporarily inhabited secluded space of work. Whilst unfolding makes it visible, the content of the discussion made the matter particularly noticeable. The comparison and usage of terms associated with the development of open-source software gain a different magnitude with blockchain development since it can have visible financial and economic consequences due to the protocol-enabled scarcity of currency-like tokens.

Within the mentioned conversation, we can identify members of the foundation, DAO token supporting exchanges, and Slock.it. Exchanges were being requested to stop all their trades since the attacker could easily convert the taken DAO tokens to a different cryptocurrency and evade tracking. Exchanges representatives also mention that the Ethereum Foundation owes them money, that is after members of the Foundation said that they would refund the losses coming from the

halting of trade, bringing up other previously held agreements. Whilst referring to the possible solutions, those were being further discussed on another communication channel. This level of discussion proves that decentralisation of technical systems can only go so far when attempting to make agile decision-making.

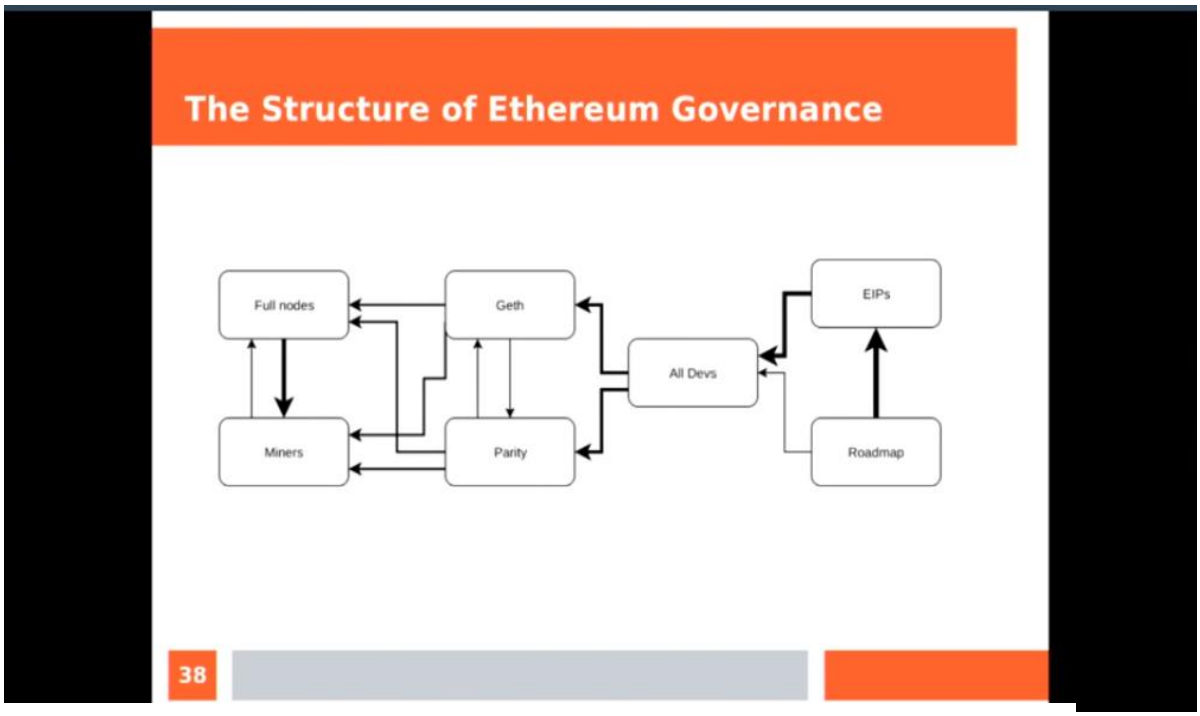

Figure 6: The Structure of Ethereum Governance, taken from Vlad Zamfir`s presentation on Ethereum Governance on the Taipei Ethereum Meetup 2017

The Ethereum Foundation is the one actor with formalised governance meant to alter and maintain the Ethereum blockchain. Planned mutations are considered part of its roadmap. Discussions take place every twice a month through an open-Skype gathering in the “All Devs” call with the core developers from the main client implementations, highlighting the role of Geth and Parity`s software development . The call often includes other relevant names like Vitalik Buterin. These developers are tasked with deciding by unanimous consensus, with someone from the Foundation organising the call. Part of this discussion includes Ethereum improvement Proposals (EiP), a proposal format hosted on GitHub. These are informally selected based on their maturity and relevance, with the Reddit platform facilitating this method, according to an interview with client developers. Any major changes get detailed in their respective white papers. Figure 6 shows the structure of Ethereum Governance as presented by Vlad Zamfir, a researcher from the Ethereum Foundation (Taipei Ethereum Meetup 2017).

The Foundation has a great interest in remaining politically neutral in the improvements it makes due to the loose infrastructure that blockchain remains. Considering the contrasting disarray of the Bitcoin Foundation, Ethereum`s has been mostly successful reamaining recognised as the Ethereum`s blockchain steering body, with The DAO being the one contentious episode and exception to its formal governance structure.

5.3. White Hats and Soft Fork

In response to the hack, a team of developers calling themselves the Robin Hood Group took upon the mission of securing The DAO`s funds.

On the day of the hack, Buterin (2016a) published a post through the Foundation, making it public and presenting the soft-fork being developed (supposedly attacked according to Green in Let`s Talk Bitcoin 2016a). Two days after the hack, Lefteris Karapetsas, of Slock.it, published a medium post listing of the different solutions available for The DAO token holders. First was the adoption of the soft-fork that would blacklist any transactions happening in and out of The DAO. This temporary freezing would not return the funds unless further action was taken. Another solution presented was for The DAO to approve the creation of The DAO tokens in the attacker's child DAO, to repeat the same exploit and syphon those tokens to a trusted child DAO (Karapetsas 2016a).

Since the process of token retrieval from The DAO involves calling a split and creating a new DAO to which the ether corresponding to one`s amount of DAO tokens is transferred to, it would take 34 days for the ether to be extracted. Following the hack, the exploit was performed by other users, most notoriously by newly formed Robin Hood Group as a response to concurring ones. First announced on the 21/06/16, they gathered The DAO tokens in order to perform the counter-attack and sequentially creating and taking control of splits and child DAOs, securing curator control as well as a majority. The name of the group would later alternate between Robin Hood and White Hat Group.

Of those identified, there are employees of Slock.it and the Ethereum Foundation, as well as people who were interested and wrote about The DAO. They were able to syphon the rest of the tokens held in The DAO, but unable to infiltrate the "Dark DAO" split. Whilst the full implementation of the soft fork would prevent changes by the attacker, without it, the hacks would be concurrent by the white hats and the attacker.

In order for the soft fork to go into effect on a block targeted for the 30/06/16, miners would have to flag their opinion by collectively targeting the gas level limit above or below a revelatory level, potentially forking-off miners who did not adopt the software update, as described by the Foundation on the 24/06/16 (Szilágyi 2016). On the 28/06/16, Cornell's university students Hess and Keefer, along with Professor Emin Gün Sirer (2016a), posted a blog post detailing how the activation of the soft fork could easily create a distributed denial of service attack vector by returning long and computationally expensive transactions as invalid, thus unpaid, if it involved an account related to The DAO. Finding of this "censorship proof" feature of Ethereum, miners quickly changed their opinion against the soft fork.

5.4. The Hard Hard Fork: Polling the Community

Looking at the options from the onset of the hack, the returning of The DAO tokens without reversing the transactions made, would only be possible through the soft-fork. However, this option involved a number of successive steps to be successfully completed. Some of these meant a longer period for their retrieval in comparison to the hard fork, whilst being vulnerable to the attacker stalking the different splits unless his/hers transactions were censored by the network. Taking majority control over the "dark DAOs" would mean risking funds to overtake the attacker. Not implementing the soft fork meant there was no solution for the retrieval of the taken The DAO tokens. Summing up, the no-fork solutions were "really quite weak" (Macmillan 2016). Out of the 4 counter-attack proposals made to The DAO (Karapetsas 2016b), only one passed its required quorum by 0,39% at 10% of The DAO tokens.

With the soft fork negated, the other option to refund The DAO investors was the hard-fork. Parity Technologies, Gavin Wood`s company was the first to admit the necessity of the hard-fork on the

same day of the hack in case the soft fork and the "DAO wars" failed (Parity Technologies 2016a). Gavin Wood also proposes a reward mechanism for the miners to implement the change, more akin to the idea of decentralised governance.

Considering the number of necessary steps, the hard fork would technically be the easiest solution to implement, but the risk of splitting the network obliged to a network consensus over its implementation. Since this was not perceived as given, the development of the hard fork was done throughout the post-hack developments without assured deployment. As put in the Parity blog, it is the responsibility of the developers to accompany the community and to develop the appointed solutions, by separating their stated opinion from their work and responsibility towards the community of users (Parity Technologies 2016b). It also states that "(...) All types of users will be faced with a choice - no one group of users can dictate to another that the alteration should happen or not. Miners, users, exchanges and developers can 'vote with their feet' if necessary. A hard fork's success is measured in the level of acceptance it garners with users." (Parity Technologies 2016b)".

The hard fork`s code was developed by the programmers of the different clients, with several institutionally recognisable names contributing to the effort. The hard fork returned all The DAO tokens to a refund smart contract from which users could exchange corresponding tokens for ether, leaving the cases in which tokens bought at a more expensive price to be reviewed by the curators (Wilcke 2016).

On the 15/07/17, the Ethereum Foundation presents the hard fork specification for the Geth client update. In the same blog post, it presents the voting tool carbonvote which keeps track of the assigned ether to a yes or no vote serving as a signalling mechanism that would set the default option in the coming update for the most used clients (Wilcke 2016). As Jorijn Jacko Smit puts it: "(...) Block 1894000 occurred on July 15th, 2016. The same day as this article was posted! Twitter timestamped the article at 11:02, said block occurred at 23:20. This gives a difference of 12 hours and 18 minutes (...)."Whilst the soft-fork had been negated on the 28/06/16, it took the teams working on it around 17 days to come up with not only a coding solution but a simpler voting tool to be used for a period of 12 hours, voted in accordance with ether ownership. In this short time period, around 5% of the total ether was used to vote. Whilst overwhelmingly in favour, this governance

mechanism is a solution which served as a largely underrepresented tally of votes of the community against the miner's adoption of the fork update settings. This represents the interesting dynamics and challenges of blockchain governance. On a different tier, 85% of the miners moved to the new chain with the hard-fork happening on the 20/07/16 (Buterin 2016b).

6. The New Old Chain

6.1. Ethereum Classic

"*A year ago today, The DAO was hacked. Today, it's not even a blip on the charts, thanks to a fantastic community.*" Emin Gün Sirer, 17/07/17, Twitter

What became known as Ethereum Classic is the unforked Ethereum blockchain. After the hard fork, a number of miners kept running it. The project was first announced the day after the vote. Bit Novosti, a specialised Russian website about cryptocurrencies, then launched a dedicated mining pool for the subsistence of the chain once hard-forked. They also started a website, a GitHub page, as well as communication and discussion channels for the effort (Bit Novosti 2016). Pseudonymous Arvicco, part of Bit Novosti, was followed by one Ethereum founder, Charles Hoskinson who became one of the most visible developers of the project. He proposed a discussion on the roadmap for Classic, partly dedicating the work of his company (2016).

Being aware that the hard fork could mean the existence of two chains, Ethereum developers nevertheless did not place any preventive safety measures for replay attacks (Hertig 2016). Once there are two chains in existence, the chance that a call for a transaction in one of them gets duplicated and leads to double-spending or undesired transactions to take place. The chances of such a replay attack taking place is further mitigated as both chains develop.

Noticing "over-the-counter" trading in peer-to-peer trading websites was taking place, the Poloniex exchange listed ETC, institutionally recognizing its market value. Soon after, other exchanges followed and ETC became one of the top 10 tokens in market value. It has been claimed that Barry Sillbert has been behind the rise of Ethereum Classic and that "cryptocurrency wars" justified the amount of noise in the community. (Charles Chancellor-Mackay 2017)

6.2. Miners

The current Proof-of-Work protocol of the Ethereum blockchain rewards nodes for processing its transactions. Node operators are called miners and the computers used to run Ethereum mining software clients, mines. The more computing power a miner employs to the network, the more likely it is to be rewarded (Dannen 2017).

Miners	Behavior		Outcomes	Configuration		
	Ps (Perceptions, preferences, policies, principles)	Actions		Pathways of power within the system	Completeness/ tight- or loose-coupling within system	Closure/openness of between-system transitions
Power	Equilibrated Decentralisation; Profit	Gas flagging; Dedicated Mining Pools; Client Update; Equivalent protocols	Identify consensus; Fork	Proof-of-Stake Protocol; Mining pools	Loose; Mining pools	Open; Pool-hoping; Protocol-hoping
Susceptibility	Centralisation; Protocol-hoping; Pool-hoping; Concentrated influence	Media; changes of protocol; Anonymity	Decreased blockchain security	Token policy; Market-value; Constrained innovation; Developers	Loose	Open; Depends on Exchanges
Freedom	Fork	Alter clients and configurations	Signal preferences; Fork	Loose coupling; Equivalent protocols	Tight; Game-Theory	Open
No-power	Technological developments	Disruption of Mining technology	Mining disruption	Exchanges; Processing rates	Loose; Constant	Open

Table 5. Miners freedom and power in Ethereum`s Ecosystem.

As more computing power is contributed, the more secure the network can be considered. Within this competitive process, the fastest mine to process transactions gets rewarded. With the rise of the market value of a token, the process gets more competitive. This makes it harder for a malicious actor to alter or add new transaction blocks since it has to compete with added processing power for a proposed network state to be considered valid by all nodes.

This game-theoretical model has proven be secure enough to guarantee distributed consensus over the state of the network. Whilst the centralisation of mining can decrease its security, it provides an

actor with enough incentives to maintain the integrity of the data. State-based centralisation also increases the risk of state intervention. Despite the discovery of several ways the Proof-of-Stake protocol can be compromised by miners, these have not altered the belief in the data integrity provided by blockchain technology.

To increase their reward, miners collaborate in mining pools and reward collaborators according to their contribution, with reward schemes being one of the few differentiating factors amongst them. Bit Novosti`s mining pool altered their configurations to keep running in the now called Ethereum Classic blockchain. Whilst the profit-motive of mining is generally assumed, political motives should also to be considered.

Several mining governance mechanisms have been observed in The DAO context. The voicing of opinion by gauging the gas level, the adoption of a client update along with respective changes to its configuration, and protocol-specific dedicated mining-pools. In addition, some mining-pools have polled their miners. As collected by Reddit user econoar, data from 98,9% of Ethereum`s hash rate (measuring unit of dispended processing power), signals 77,6% of mining-pools siding with the hard-fork. Several of these pools did not present this data or it was not collected in the referenced forum thread (econoar 2016). It should be noted this polling is an expression of opinion and non-binding, contrary to the client update and configuration adoption. When prominent Chinese miner Chandler Guo announced he would dedicate his mines to attack Ethereum Classic, other miners added processing power for its defence and deterred this move. Chandler would change his mind and later support Ethereum Classic. (Demartino 2016). The permissionless nature of mining also reflects the fluctuation of the different polls held. As noted by Reddit users, the number of nodes shifted throughout the updated client adoption (econoar 2016).

In the un-forked chain, the White Hat group still held The DAO tokens. Once it got access to the rebranded ether classic (ETC), the group attempted to cause the value of the tokens to crash by selling their large quantity of tokens lower than its market value on the 10/08/17. Their attempt came out frustrated. The exchange froze their funds as they attempted to perform this action, whilst dumping on different exchanges some ETC at 20% below market price as pointed out by pseudonymous Jack Sparrow (2016), displaying a leaked part of the plan off Skype. Eventually, they

would make the ether classic refundable to the original holders of The DAO tokens in the classic chain alike.

Whilst consensus amongst all the stakeholders of the ecosystem is important, ultimately the maintaining of a chain is dependent on miners. If miners recognize the worthiness of mining a particular token, then the chain can subsist. If more miners dedicate more processing power to a chain, the harder it is for there to be a majority attack on it.

Considering Ethereum`s hashing implementation, Ethash is an ASIC-resistant algorithm. ASICs are application-specific integrated circuits capable of making Bitcoin mining much more efficient. Bitcoin ASICs were first made by Butterfly Labs (Taylor 2017), ushering the competitive production of a new class of specialised hardware. This is but one of several innovations taking part in the cryptocurrency mining sector. Cloud-mining (ibid. 2017), "website-request" based mining, or "hostage" mining are several hardware and software innovations that disrupt mining competitiveness. Apart from Ethash`s specifications, Ethereum`s coming protocol change from Proof-of-Work to Proof-of-Stake make a thorough analysis of Ethereum mining less relevant since the dependence on miners is set to be reduced or non-existent.

7. Conclusion

"*Whatever path we take, the DAO will leave a deep scar on Ethereum's Blockchain. We shall wear it with pride.*" Alex van de Sande, 03/07/2016, Twitter

The aim of this dissertation is to understand the reasons of the DAO schism through a retrospective study of its different stakeholders, characterized in relation to their involvement. Developers, cryptocurrency exchanges, the Ethereum Foundation and miners consist the core set of actors involved in the Ethereum ecosystem and The DAO. Through their characterisation, it has been possible to describe the governance processes present throughout the Ethereum Blockchain, along with the ecosystem`s stewardship on and off-chain. Finding the way power is distributed, several empirically confirmed observations can now inform the users of Ethereum to strive for a fairer ecosystem. Blockchain`s role in the development of the Internet, its disruptive potential and use as a general-purpose technology, point to an increasing adoption of Ethereum and highlight the importance of Internet governance for a global society. If Ethereum is to correct blockchain`s technological trajectory, it can start by following some of the conclusions here present, made evident in researching The DAO.

Blockchain governance is hard. Consensus over a protocol-based network meant to upgrade can become highly political and differently affects each actor. With it, comes the promise of global autonomous governance and the decentralisation of different institutions. As blockchain becomes increasingly adopted as part of the Internet`s infrastructure, several problems will appear as first proposed by The DAO, out of which several lessons should be taken into account when designing and managing such systems.

As a decentralised organisation, participation in its processes was not accessible enough for the common user to participate. This is made clear from the beginning when only few people were able to contribute to its code, and more so when looking at the few interactions made by token holders in its deployed version. Whilst the facilitation of The DAO tokens did allow for interest in the project to mount, financial gains seem to be the primary objective since there was not a clear understanding

of its operations or risk incurred, instead leading to a record amount of currency to be collected in an autonomous computer program.

Having surged a number of projects, the majority of these are yet to be developed as the opportunity for projects that are not based on tokens or in initial-coin-offerings came to a halt. Whilst a community was built around The DAO, there was not enough time for it to mature and build the necessary governance processes off-chain to ensure autonomous governance. The centrality of the Ethereum Foundation in responding to the hack, as the involvement of related individuals that included Slock.it personnel in the White Hat Group, proved necessary to overcome inaction by The DAO community and predicted legal hurdles. Following the usage of Bitcoin in darknet markets, came the professionalization of the blockchain sector, with developers publicly scrutinising new projects and questioning the attacker`s identity through social media platforms. Blockchain is decentralised, but the Ethereum blockchain suffers from network effects independent of jurisdiction, as it competes for adoption. The coming together of the Ethereum community to solve the crisis led to an overall positive result of increased smart contract security and new developer tools, improving the practices of the developer community.

However, without the right governance processes in place across the different interacting code layers, updates on mining node client implementations will continue to be the fallback mechanism for any problems found, stressing the Foundation`s steering role beyond technical aspects and client developers as implementers of the community`s will. There is hardly any governance mechanisms that can be put into place to achieve total consensus against the measuring of different interests in a dynamic blockchain which`s results affect more than just the Ethereum community. If Ethereum does manage to scale and upgrade its blockchain infrastructure to accommodate more transactions, a number of projects will become dependent on the different Ethereum clients. Different technology layers will increasingly complicate the protocol`s steering. Each of these projects will have to find ways to cooperate in accommodating new changes as well as to both contribute and to have a voice in these decisions, with technical specialisation across the technological stack a leverage that can be used in service of its community of users. Without an inclusive roadmap, the Ethereum Foundation will need to find new sources of legitimacy, perhaps by opening up institutionally and going beyond developer meetings for a new institutional logic and coordination across projects.

Whilst there is little doubt that blockchain is going through a phase of exuberance, bootstrapped autonomous governance needs to find a way to attract both users and developers to experiments of smaller proportions with good scaling solutions. Depending on the type of effort, much like the type of DAO envisioned, this can be hard to achieve with immutable code. Either the cloning of the Ethereum blockchain or off-chain solutions interacting with Ethereum are options that could allow for their development with natural trade-offs to their implementation. The DAO has shown how hard it is to develop an autonomous application and the risks associated. Sole reliance on code first needs the development of a cohesive and participant community capable of interacting with the blockchain at different capacities and facilitate different roles. Token utility and use must be promoted against its financial leveraging as facilitated by exchanges. There needs to be an easier ways of encouraging adoption as well as token generating and distributing.

Exchanges can promote these interactions. Opening up their trading operations to serve as a platform for blockchain applications usage would both strengthen token utility as well as the economy of blockchain-based transactions. As these markets become automated, exchanges are likely to remain as first-entrant gatekeepers for the cryptocurrency sector unless an easy to use alternatives for the trading of fiat-currencies into cryptocurrencies is provided. In relation to miners, if any cohesive governance is meant to be implemented, it could be done through mechanisms capable of securing membership in mining-pools to approximate a better representation of miners opinions. The coming change to Proof-of-Stake however, makes future Ethereum governance by miners an incognito.

The blockchain sector is continuously expanding. A vertical software stack means that all it takes is one actor at a governance tier to shift the entire balance built around the blockchain, as it was the case for developers deploying the autonomous The DAO`s code, the Foundation`s and client developers fork proposal, miners maintaining the Ethereum Classic blockchain, and exchanges recognising Ethereum Classic tokens. Each of these actors governance mechanisms will define the development and adoption of Ethereum and blockchain technology at large. Its disruptive potential as a P2P technology is both blessed and cursed by its role as a financial innovation propelling investment into the technology and crowding out other incentives for its tokens. Once the bubble

bursts, the most resilient communities will re-discover the usage and applications of their blockchain. Until then, the balance of developments will be found between the development of new intermediaries and/or autonomous applications. The best way for peer-governance to inform this developments is to find new iterations for blockchains applications to be built around equitable and sustainable business models possibly based on the implementation and adoption through fair and democratic, open-source cooperative models off-chain. The integration of these processes into disintermediating blockchain transactions will be dependent upon the cooperating networks and institutions securing these values.

Summary

The present Information and Communications Technology Techno-Economic paradigm has enabled the creation of blockchain technology, a new Peer-to-Peer (P2P) and cryptographically secure internet layer. Within the programmable blockchain platform Ethereum, an application called The Decentralised Autonomous Organisation (The DAO) was hacked. 50$ million of the 150$ million crowdfunded in this investment fund application were syphoned to private control. A majority of the network`s nodes changed the consensus protocol for the return of the funds. This led to a split of the network with the altered Ethereum blockchain and the unaltered Ethereum Classic blockchain both remaining.

As a case study, The DAO is the richest and most contentious episode of the development of the technology, largely informing Society and Technology Studies. The dismissal of The DAO raises the question: Why did The DAO fail? A retrospective approach allows detailing the several choices made in the process. Its development, its deployment, the hack and the fork are episodes in this analysis, along with an explanation of the digital infrastructure and corresponding configurations.

Considering the role that blockchain is to play in the development of the Internet, the analysis would be incomplete without examining the way blockchain governance is undertaken. The stewardship of the ecosystem partaking in the Ethereum blockchain ecosystem is observed to answer the question on how power is distributed within the blockchain ecosystem, characterising the different actors of an environment with low formality and a set of heterogeneous actors in the process. Admitting that these roles are never dominant, blockchain`s technical configurations will relay this heuristic set of actors. Considering that blockchain governance is done on and off-chain, Yochai Benkler`s framework is used (2011). This helps identifying contentious points throughout the DAO context, highlighting the roles taken by an heuristic set of actors composed of developers, cryptocurrency exchanges, the Ethereum Foundation and miners, each described in accordance with their episodic relevance.

The paradigmatic-shift that blockchain can represent is partly characterised by its P2P infrastructure. Answering a related last question enriches a conclusion for future developments of the technology: How is blockchain`s ecosystem informed by peer-governance? Michel Bauwens essay (2006) and the school of P2P theory informs the theoretical framework to present a critical viewpoint on the organisation and influence of the set of actors in the technology`s development, informing its possible technological trajectories.

Admitting it was active for a very brief period, the analysis shows a heterogeneous community with respect to investment patterns and in-chain interaction related to The DAO, revealing differences in digital literacy. Blockchain`s openness does not allow for total control by any actor. It is noticeable that developers distributed power rules over the capacity to make changes over the infrastructure, in and out of the blockchain, as well as specialised roles over parts of the infrastructure. Cryptocurrency exchanges are the largest holders of identity on blockchain users and became market value creators, definers and facilitators through their mediation of tokens. The Ethereum Foundation's power largely looms over the protocol changes due to its centrality and foundational role. As for miners, their role is lessened by its loose configuration, creating a layer of counter-power and freedom over the network infrastructure.

Regarding peer-governance, the mediation done by exchanges is the most centralised power in the ecosystem, in part pertaining to regulation in different jurisdictions. This stands in parallel with the Ethereum Foundation's role being counterbalanced by the freedom granted by the Ethereum blockchain, along with its governance processes being transparent and akin to being scrutinised. Barriers to entry need to be decreased by an increased effort in education which should be facilitated in the coming years by off-chain front-end development. The loose coupling of developers represent a systemic risk for less-informed users, that is if the development is not accompanied by responsible individuals, capable of providing maintenance and information regarding new changes to the system. As for miners, any possible lessons are likely to be altered by Ethereum`s coming protocol switch to proof-of-stake.

Blockchain`s pace of development will likely be dependent on these set of actors. With the ecosystem characterised, and points of control detailed, the lessons retrieved can inform further

empirical studies on blockchain and internet governance, as well as providing guidance for the development of a fairer ecosystem, informed by its commons-oriented infrastructure and P2P theory.

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These memories are soothed not only by a realisation of the present of those we are blessed to have around us, but also by the hope of making memories anew in a not so distant future. Our existence is however, bounded by permanent loss. Recently, I have lost Martijn van der Geest, my friend and welcoming companion from whom the last words I heard were of support and encouragement. His inspiring curiosity and adventurous spirit shall accompany his memory here present, and provide animus for his loved ones, for which we are thankful.

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Danke wiel, heita, obrigado, afgaristou,
For your companionship making a better world,
Francisco Santos

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