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Blockchain and Institutions (I): trust and (de)centralization

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Blockchain and Institutions (I): trust and (de)centralization[1]

Abstract

It has been argued that the adoption of the blockchain technology may lead to the disruption of many current institutions such as markets, property rights, public registries, and so on. The academic literature exploring the potential institutional applications of blockchain technologies is in its infancy but is proliferating. This literature review focuses on certain institutional critical aspects of the blockchain. Trust and (de)centralization are pivotal to the functioning of markets and society in general; blockchain promises to profoundly transform both and their correlated institutions. Technology and behaviors have a reciprocal influence. Results show several issues that must not be underestimated to develop the applications of the blockchain properly, and therefore reach shared benefits and avoid unintentional negative impacts at both micro (individual) and macro (societal) level.

Keywords: blockchain, trust, decentralized governance.

JEL: A13; D26; P48; O33

1. Introduction

The blockchain has induced high enthusiasm for the potential outcomes deriving from its implementation on a large scale which could drive societies' decentralization, rendering the need for central authorities and intermediaries obsolete, being replaced by the "4 Cs" of code, connectivity, crowd, and collaboration (Fenwick et al., 2018). Yet, its potential to facilitate new forms of governance remains mostly unexplored (Rozas et al., 2018). Much attention has been dedicated to the positive or disruptive changes envisaged. Aside from technological issues, less attention has been given to the challenges it may pose. Little research has focused on blockchain technology and its ability to address societal needs (Ølnes et al., 2017), ignoring applications, value creation, and governance (Risius and Spoher, 2017). Moreover, the relation between what is made possible by technology in its practical application could differ from what is envisaged or desirable from a societal or legal perspective. The development of technologies such as blockchain is indicative of a type of politics, understood as interactions between social discourses and social imaginaries (Reijers and Coeckelbergh, 2016).

[1] An: the article presented is the first of two parts of a literature review focused on the institutional elements that the blockchain promises to disrupt. Technological and cryptocurrencies related issues were discarded being not functional to the focus of the research. This first part is focused on trust and decentralization, while the second investigates the application of the blockchain within the realm of law.

The debate is currently hinging on two leading positions: techno-determinism and market-driven values versus those who consider central institutions as pivotal for democratic forms of governance (Rozas et al., 2018). However, institutions are social technologies, which affect not only production but also social organization (Berg et al., 2018). Therefore, as Rozas et al. (2018) point out, can we build perspectives of blockchain-based governance that go beyond markets and states?

Different approaches have been developed to analyze the blockchain according to the scientific or industrial sector involved[2], and several definitions have been generously given.[3] Several literature reviews have been published to depict the state of the art: Yli-Hummo et al. (2016) provided a systematic review of the blockchain as a technology; Conoscenti et al. (2016) scrutinized the application of the blockchain for the Internet of Things; Risius and Spohrer (2017) published a research framework; Hawlitschek et al. (2018) focused on blockchain and trust in the sharing economy; Reyna et al. (2018) investigated how blockchain could potentially improve the IoT. All of these studies brought the pros and cons of this technology to the surface in specific potential fields of applications, while not placing a particular focus on the potential consequences and changes that will be required for the large-scale implementation of this technology to fulfill its potential.

We are experiencing a fundamental rearrangement of institutions that assure societal functions (Faber and Jonker, 2019). Government, governance, and classical socio-economic paradigms could be challenged by the development of non-centralized political and socio-economic systems, which in turn could revolutionize interaction in society. "We are in a phase of human development where the power to develop codes and select algorithms has – and it will increasingly have – major implications in contemporary society: this power entails assertion of authority, calling into question the egalitarian nature of technology and networks" (Atzori, 2015, p. 27). At the same time, a "hypothetical global society only run through organizational patterns based on individualism […] would inherently lack legitimate mechanisms to regulate the convergence of the particular into the general, which is the traditional role of centralized political institutions" (Atzori, 2015, p. 25). This role has been played considering the objectives that a society envisages for itself. The mistrust towards institutions today (De Filippi, 2018), and the birth of a technology that allows the creation of autonomous networks, can pose severe challenges in striving for a just, inclusive, and sustainable society.

Our research aims to highlight the importance of questioning how this technology will impact social aspects, freedom, and people's interaction in general. Blockchains are a technology for the distribution, maintenance, and verification of social facts (Berg et al., 2019), creating the chance to reshape "the ways and means through which individuals, enterprises and bureaucracies interact in the pursuit of gains achieved economically, socially or politically" (Novak, 2018, p. 6). We decided to prioritize the concepts which should receive attention for evaluating the impact on the development and functioning of societies by the application of the blockchain on a large scale. We, therefore, aim

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[2] E.g., *through a Schumpeterian lens of ICT productivity* or *through an institutional lens of efficient governance* (Davidson et al., 2016), as an *institutional technology of coordination* (Berg et al., 2019; Davidson et al., 2018), in terms of *competition* (Lianos, 2018) or *innovation* (Catalini and Gans, 2017); in light of an *entangled political economy approach* (Allen et al., 2018).

[3] E.g., as a *non-discriminative technology* (Koletsi, 2019), as *a foundational technology* (Werbach, 2018), as *an innovative technology in search of use cases* (Glaser, 2017), as *a new and foundational mode of configuring reality* (Swan and De Filippi, 2017), as *a coordinating institution for creating new economies* (Berg and Berg, 2017), as *a new institutional technology of governance* (Davidson et al. 2016b), as *a new type of economy* (Davidson et al., 2016), a *catallaxy* (Davidson et al., 2016b), as a narrative technology (Reijers and Coeckelbergh, 2016), as a *new general purpose technology* (Evans, 2014).

to highlight those aspects which, to date, have been identified as uncertain or problematic: i) trust, and ii) (de)centralization. Other critical aspects, such as those related to technology or cryptocurrencies, were not taken into consideration, being not functional to the scope of this research. The following sections present the issues addressed singularly to reach conclusions.

2. A primary on the blockchain

The advent of the blockchain has been compared to the invention of double-entry bookkeeping (Abadi and Brunnermeier, 2018) or of the Internet (Akgiray, 2019), showing the potential for groundbreaking transformations within many industries (Beck and Muller-Bloch, 2017). The financial sector is seen as a primary user of the blockchain (Akgiray, 2019; Nofer et al., 2017) since, in 2008, Satoshi Nakamoto's paper, "Bitcoin: A Peer-to-Peer Electronic Cash System," underlined the basis of modern blockchain-based cryptocurrency innovation. According to Yermack (2018), although a first analogical example of this technology was given by Haber and Stornetta's work (1991)[4], Nakamoto's attempt was the first to provide a trusted non-territorial digital currency not dependent on centralized financial institutions such as banks, "allowing any two willing parties to transact directly with each other without the need for a trusted third party" (Catalini and Gans, 2017, p. 1), disseminating new ways of market making (Harper, 2018).

The first stage was the creation of a cryptocurrency (i.e., bitcoin) to which other *altcoins* followed, giving birth to the so-called *cryptoeconomy* (Babbitt and Dietz, 2015, quoted in Davidson et al., 2016b). However, the potential applications of blockchains are much broader than currencies (Allen et al., 2017), and go well beyond financial services (Tapscott and Tapscott, 2016).

A decade later, the blockchain technology has moved beyond cryptocurrencies, but little remains known about its promised disruptive potential (Beck and Muller-Bloch, 2017). The fundamental characteristics of this technology enable the implementation of a wide range of processes for hard and intangible assets (Swan, 2015, quoted in Ølnes et al., 2017). The blockchain opens the door to the liquification of the physical world, to the economy of real-time micro-transactions and smart data sharing (Waelbroeck, 2018, p. 1). Its applications are foreseen in almost every human field; it is recognized as an alternative to ownership ledgers based on traditional double-entry bookkeeping (Yermack, 2017) which, according to Max Weber, was the foundation of modern capitalism (Werbach, 2018; Markey-Towler, 2018). The purpose of a ledger is to record and verify facts in their economic, political, or social manifestations (Davidson et al., 2018). In contemporary society, trusted intermediaries generally play this function. Au contraire, the goal of the blockchain is to create a public record kept without the requirement of a public authority (Markey-Towler, 2018, Glaser, 2017; Risius and Spohrer, 2017; Hawlitschek et al., 2018), being the double-spending problem solved (Swan and De Filippi, 2017).

The blockchain makes use of three primary features to ensure these results: distributed ledgers, consensus, and smart contracts (Werbach, 2018, p. 10). These technologies can be used independently or jointly, within any combination (Akgiray, 2019). Therefore, despite the common characteristics, there is no unique implementation of "the blockchain", since it may come in many different forms

[4] They proposed a distributed ledger published in public media outlets (e.g., newspaper) for time-stamping the creation of intellectual property.

and with different properties (Ølnes et al., 2017, p. 360), including "(i) who can propose new transactions to be added to the ledger; (ii) who stores a copy of the ledger; (iii) who can add new blocks to the ledger; (iv) who can view the ledger; (v) whether users are identifiable; and, (vi) who controls the platform's underlying software" (Bacon et al., 2017, p. 49). Considering the different combinations, Beck and Muller-Bloch (2017) categorized the blockchain as "public and private, also called unpermissioned and permissioned." However, there is a third type to be considered, the so-called "consortium model," which is partially decentralized (Reyna et al., 2018). The three types have varying configurations of permission, by which the economic properties of rivalry and excludability differ (Waelbroeck, 2018, p. 7), resulting in the production of private, club, common and public goods (Glaser, 2017).

Public blockchains are distributed systems without a single owner that can freely govern the network (Risius and Spoher, 2017); anyone can operate a mining node and maintain a copy of the shared ledger. Permissioned ledgers are a different story, in which elements of control dictate the rules of the game and decide which grade restricts the rights of members. Moreover, "private blockchains and public blockchains differ in three other dimensions: the effectiveness of the validation process,[5] the governance[6] of the blockchain and the issue of legal responsibility[7]" (Waelbroeck, 2018, p. 11).

In summary, despite the high expectations raised by the blockchain reflected by the variety of approaches and definitions (Avital et al., 2016), a paucity of knowledge regarding where and how blockchain technology is effectively applicable and where it can provide notable societal effects remains (Risius and Spoher, 2017, p. 1).

3. Discussion about the findings of the literature review

The literature review led to identifying several issues to be addressed considering the intrinsic characteristics of this technology: i.e., anonymous, trustless, immutable, transparent. These features present a wealth of technical challenges and limitations that must be addressed (Yli-Hummo et al., 2016). If not, the blockchain may not fulfill the enormous expectations raised (Avital et al., 2016). "Its implications are significant because the applications that the technology affords can reconfigure economic, legal, institutional, monetary and ultimately broader socio-political relationships" (Reijers et al., 2016, p. 147). Researchers must investigate the associated costs of blockchain systems for individuals and society (Risius and Spoher, 2017). New technology applications "amplify" each other, increasing their social impact and effects (Fenwick and Vermeulen, 2018), often resulting in a change in human behavior that, in turn, influences technology applications (DeSanctis and Poole, 1994, quoted in Ølnes et al., 2017, p. 362).

As Koletsi (2019) stressed in recalling Heidegger, any technology is not ideologically, socially, or culturally neutral, but inherently political. De Filippi and Hassan (2016) strengthen this concept. Furthermore, as Hacker et al. (2019) affirm, "technological development and innovations profoundly

[5] The author refers to different types of *consensus*, whereby an increase in the speed of block validation can come at the cost of security, for example.
[6] Governance includes questions such as who dictates the rules, and maintains the system, how the rules are executed, and how a Blockchain system would be closed out (Lapointe and Fishbane, 2019).
[7] It could be much easier to establish responsibilities in the case of a private (and national) blockchain, while the question is under debate in international public blockchain (Waelbroeck, 2018, p. 11).

rely on the social forces that promote their use, being accompanied by a narrative of a broader change of the social, economic and legal processes that govern value generation." Reijers and Coeckelbergh (2016) and Koletsi (2019) confirm these dynamics within the blockchain narrative. It is to be noted that these social forces may represent different social groups with different interests and interpretations of the technology, changing its design accordingly and thereby influencing (if not dictating) human behaviors.

The blockchain seems to promise the liberation of individuals and value creation, but, as highlighted by Wright and De Filippi (2015), increased automation may result in *algorithmic governance*, leaving the mere illusion of freedom to ordinary people. Besides, blockchains still have significant technical, operational, and scaling shortcomings (Fenwick et al., 2018). "Faith in technology should take into consideration blockchain's operational risks in large-scale application: "(i) software has bugs, (ii) software is vulnerable to attack, (iii) software is ever-changing through new releases, and (iv) few people understand how software works" (Walch, 2015, quoted in Kakavand and De Sevres, 2016, p. 25). There is much to be considered, especially for a technology defined as disruptive and applicable to everything.

3.1 Is the blockchain a trust-free environment?

Trust is arguably the primary input in economic cooperation, and in economic theory it is usually understood as being exogenously provided (Berg et al., 2018). "Trust is a psychological state comprising the intention to accept vulnerability, based upon positive expectations of the intentions or behavior of another […] Trust is neither a behavior (e.g., cooperation) nor a choice (e.g., taking a risk), but an underlying psychological condition that can cause or result from such actions" (Rousseau et al., 1998, p. 395). Trusting relations, which consist of the qualities of vulnerability, risk, expectation, or uncertainty (Davidson et al., 2018), are the foundational resource of any economy and allow extensive economic cooperation, and therefore value creation (Berg et al., 2018). Trust is a fundamental precondition underpinning exchange and economic coordination since information asymmetries can create moral hazard (Graafland, 2020). It reduces the need for costly monitoring and ex-post sanctioning of breach (Mccannon et al., 2018). However, it is costly to maintain (Davidson et al., 2018), and it is not transitive (Werbach, 2018).

"An essential quality a ledger must possess is trust in the ledger itself. A high trust ledger creates a low transaction cost economy, which is a precondition for economic efficiency and prosperity" (Nooteboom, 2002, quoted in Davidson et al., 2016, p. 5). "The blockchain technology will fundamentally transform the way trust is built" (Hawlitschek et al., 2018, p. 51). Distributed ledger technology allows participants to trust the outcome of a system without trusting the individual participants (Werbach, 2018, p. 6), reducing the cost of opportunism and galvanizing trust with respect to data integrity (Davidson et al., 2018).

The blockchain reaches the endogenization of trust thanks to the combination of three underlying technologies: i) cryptography, ii) smart contracts, iii) peer-to-peer networks, and distributed ledger design (Akgiray, 2019). The ledger is based on cryptographic techniques [namely the *hash function* and the *digital signature* (Ishmaev, 2017, p. 674)], combined with game theory (Catalini and Gans, 2017), capable of solving the so-called double-spending problem and the Byzantine Generals problem. While the double-spending is a potential problem unique to digital currencies and assets since digital information can be reproduced relatively easily, the latter is endemic to distributed systems (Berg et al., 2019), and questions how distributed computer systems could reach a consensus without relying on a central authority, in such a way that the network of computers could resist an attack (Wright and De Filippi, 2015, p. 5). Although theoretical solutions were highlighted in a 1982 paper by Leslie Lamport, Nakamoto's implementation of blockchain technology was the first to provide a de facto Byzantine-Fault-Tolerant consensus[8] (Huckle and White, 2016, p. 5).

The combination of security and transparency makes the blockchain a trust-free technology (Beck et al., 2016), a trustless system, a trust machine that can constitute the foundation for *trust-free economics* (Glaser, 2017, p. 1543). "Introduced by Greiner and Wang (2015), the notion of trust-free systems proposes the utilization of the capability of blockchain technology to automatically create an immutable, consensually agreed, and publicly available record of past transactions that is governed by the whole system to mitigate trust issues in peer-to-peer systems" (Hawlitschek et al., 2018, p. 58). Within the blockchain, the creation of the immutable, consensually agreed, and publicly available record of past transactions takes place through the so-called *consensus*; this ensures the transactions' data integrity (Werbach, 2018; Ølnes et al., 2017).

The way a consensus can be reached may vary depending on the rules and the type of blockchain being implemented (i.e., public, private, or hybrid). Public blockchains can be almost impossible to alter (if the will of the majority of its participants is lacking), while private blockchains are not. The nature of the network has consequences on the rights of its participants (Bacon et al., 2017), and consequently, on their trust with respect to data integrity or the ledger itself. This aspect must not be underestimated, since "in the context of the digital revolution "who, what, when, and how people trust is changing" (Fenwick and Vermeulen, 2018, p. 11). Therefore, researchers should fully understand what this means. If the blockchain endogenizes the manufacture of trust (Davidson et al., 2018), constituting a new type of trust (Wright and De Filippi, 2015), what kind of trust will it be? How will it influence users' behavior? Therefore, the central question is not how to regulate blockchains (Werbach, 2018, p. 1) but how blockchains will regulate human behaviors and trust. Technologies can operate as a kind of law, regulating the users' behavior (Werbach and Cornell, 2017). The blockchain's set-up allows actors to trust the technology, which originates from the need to trust involved actors (Finck, 2017). Is the need to trust other people in a blockchain network eliminated by using the technology, or is trust just displaced onto other parties? (Walch, 2017b, p. 4).

In their analysis of the sharing economy, Hawlitschek et al. (2018) categorize trust in i) peers, ii) platform, and iii) product, applying the same distinction to blockchains. As recalled by Keymolen (2013, p. 135), "in analyzing trust online, one has to take into account the specific workings of online technology, its mediation" since inter-organizational and interpersonal trust differ because of the different focal point (Rousseau et al.,1998). For example, the blockchain's varying nature has consequences on the trust needed among its participants, e.g., private blockchains can make use of more lightweight consensus mechanisms than public blockchains (Buterin, 2015, cited in Risius and Spoher, 2017, p. 8).

According to some scholars, a new form of *algorithmic trust* (Swan and De Filippi, 2017) is created with the blockchain, representing "a shift from trusting people to trusting math" (Antonopoulos, 2014

[8] However, as it will be shown further, this robustness can be overcome by the so-called "51% Attack".

quoted in Atzori, 2015, p. 2). Thus, trust must be placed in the underlying cryptography (Hileman and Rauchs, 2017, p. 17) that allows participants to scrutinize every operation that occurred (Wright and De Filippi, 2015). This transparency and the confidence placed in "the security and auditability of the underlying code" (Wright and Filippi, 2015) is what appears to be enough to claim the superfluity of trust and correlated institutions.

As stated, trust concerns the expectations and vulnerability of the parties involved (Rousseau et al., 1998), and can be expensive to manufacture conventionally (Davidson et al., 2018). Conversely, a technological system plays active roles in shaping our activities, experiences, and relations with other people (Reijers and Coeckelbergh, 2016). In distributed ledgers, trust is enforced by the rules governing the network; hence, the blockchain seems to operate a shift that replaces trust among participants with technology's properties. In this process, there is no space for the actors' willingness to accept vulnerability. Does this constitute *trustless trust* (Werbach, 2018, p.58)?

The blockchain promises do not lower expectations, generate value, and reduce or remove vulnerability – rendering relations a simple matter of choice and technology[9] (Reijers and Coeckelbergh, 2016) – through immutability and consensus. Will this be enough?

3.1.1. Immutability and Forks

Blockchains are permanently distributed spreadsheets or ledgers in which information can only be added and never deleted (Gabison, 2016, p. 328). Information on a blockchain is seen as "immutable" or "indelible" (Yermack, 2018, p. 14), which serves as one of the primary selling features of blockchain technology (Walch, 2017, p. 736). Data accuracy and immutability are the two features that have shaped the blockchain as an alternative trust-reinforcing mechanism in our societies and economies (Akgiray, 2019).

There is an active debate on how immutability in blockchain systems is created (Walch, 2017). However, absolute immutability does not exist, since blocks comprising transactions can be reversed, in theory, if enough nodes decide to collude (Hileman and Rauchs, 2017, p. 17). This feature is strictly intertwined with the "nature" of the implemented blockchain, i.e., public, private, or hybrid. For example, while public blockchains can be considered immutable in the sense that it is costly to rewrite history on a blockchain and there is no single point of failure[10] – SPOF (Abadi and Brunnermeier, 2018) – private blockchains could simplify reversing transactions (Hileman and Rauchs, 2017).

Immutability may also refer to the distributed system's resilience, which, in missing the single point of failure, may not be easily attacked or shut down, thus becoming invulnerable. However, "blockchain-based systems are not invulnerable. […] Nakamoto's solution to the Byzantine Generals problem is remarkably robust, but a '51% attack' can overcome it" (Werbach, 2018, p. 25); this could occur if a party or colluding group controls at least 51% of the computing power of the network, having the authority to determine what is recorded and what is not, and even potentially to revise the

[9] The authors affirm that within a blockchain environment, social relations may become increasingly rigid due to the constraint and the modus operandi of the technology itself. In line with the characteristics of the blockchain, "our social relations are transformed in such a way that they become rigid, irreversible and non-negotiable." See: Reijers and Coeckelbergh, 2016, p. 121

[10] A single point of failure (SPOF) is a part of a system that will prevent the entire system from working, should it fail.

existing records[11] (Walch, 2017, p. 739). Moreover, a blockchain can be partly rewritten if the majority of a community supports a (*hard*) *fork* (Yermack, 2018).

Real-world events have demonstrated that the unchangeable nature of a blockchain record is always limited by the decisions taken by its human governors to change it (Walch, 2017, p. 713). Blockchain coordination changes and adapts to the technological limitations of the available protocols and the mutual expectations and influence of interacting stakeholders (Berg et al., 2018) by reaching a consensus. If a consensus fails to form, as for adopting new rules, either temporarily or persistently, we describe the event as a "fork" (Atik and Gerro, 2018, p. 7). Generally speaking, forking is an event that occurs in an open-source project when the code base is copied and changed, creating a new project (Berg et al., 2018, p. 4), but on a blockchain, a fork is created whenever the rules governing that blockchain are changed. We speak of a *soft* fork when some users on a single blockchain may continue to use the old rules without using the features in the new software; a *hard* fork occurs when part (or all) of the community decides to change the rules governing the blockchain (Abadi and Brunnermeier, 2018). It concerns the split of a unique system in two, where each one will have its own independent rules and functioning. The transactions that occurred before the hard fork will be found on both blockchains (Shakow, 2018, p. 2).

Practically, forks are blockchain-specific events that evoke elements of both "exit" and "voice" as set out by Hirschman (Atik and Gerro, 2018, p. 2). Forking can be considered a form of group secession (exit) that takes an existing set of institutions and creates a new "society" with a shared history but divergent futures (Berg and Berg, 2017), eliminating the inefficiencies arising from switching costs in centralized record-keeping systems (Abadi and Brunnermeier, 2018). If certain participants do not like the output of a governance process, they can choose a hard fork, starting their independent chain (Barrera and Hunder, 2018). Practical examples are provided by the occurred bitcoin forks[12] or the 2016 DAO case.[13]

Perhaps the blockchain could be considered "censorship-resistant" (Werbach, 2018, p. 22) – information can be published and distributed across hundreds of thousands of computers, rendering it virtually impossible for any single entity to censor (Wright and De Filippi, 2015, p. 13) – but it is not immutable. It is subject to the will of its participants and their appreciation of the outcomes. Thus, the possibilities offered by this technology make it feasible for individuals "to exit political-socio-economic systems at the level of the system itself, and elect to accede freely to institutional systems which formulate, promulgate, keep and verify institutions and public records without a centralized authority" (Markey-Towler, 2018, p. 1). This process could result in controversial situations in which converging the conflicting private interests into the common interest will not always be possible without the leadership of a central and recognized authority.

Therefore, we suggest that the current state of the art of blockchain implementations has not yet matured enough to replace institutions' role when it comes to trust. As seen, trust comprises vulnerability, risk, and expectation; in the blockchain environment, there appears to be no space for

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[11] The chances of suffering a 51% attack decrease or increase depending on the size of the network [e.g., major public networks are considered large enough to resist a 51% attack since it would prove too costly to represent (or convince) 51% of the network and also very expensive to recalculate all the blocks].

[12] The first hard fork splitting bitcoin occurred on the August 1, 2017, resulting in the creation of Bitcoin Cash. Many other examples can be found at: https://bitcoinexchangeguide.com/bitcoin-blockchain-forks-history/

[13] We refer to Distributed Autonomous Organization. References to this case can be found in Walch (2017), Sulkowski (2018); Ishmaev (2018), among many others.

vulnerability. Conditions are set ex-ante, and as in the case of forks, the community can change these. This process does not ensure that all participants' rights will be weighted in the same manner, and these rights will be respected. In this process, there is no space for compromise, in which people are given the simple option of leaving the network (fork). The same logic is applicable both at the micro and macro level. Will it be possible to fork from community and society?

3.2. Will the blockchain enable decentralized governance?

Blockchain technology claims to disrupt any centralized system by providing a more efficient decentralized alternative (Davidson et al., 2016) and allowing individuals to coordinate common activities directly, and govern themselves in a more secure and decentralized manner (De Filippi, 2018b).

Even if some skeptics argue that no one knows the meaning of decentralization (Walsh, 2019), according to Kaal (2019), the four general types of decentralization refer to 1. Technology; 2. Organization; 3. Market; 4. Society. These decentralization types are subject to iterative decentralization processes and affect each other by way of feedback effects. A plausible pattern of the blockchain may alternatively be described as follows: (1) the blockchain is considered a viable substitute for central ledgers; (2) in the long-run the effect of blockchain is to disrupt the economic value of hierarchy (Berg et al., 2018), perhaps with a system of distributed, bottom-up cooperation (De Filippi, 2018); (3) decentralized technology inaugurates new forms of economic exchanges; (3bis) the comparative efficacy of blockchains in coordinating information between decentralized agents [which, following Hayek, (1945) is perhaps the most fundamental economic problem of creating an orderly economic system (Allen, 2019, p. 7)] results in new configurations of the market; (4) distributed ledger technology affects industrial capitalism, which is based on centralized ledger technology (Berg et al., 2018), transforming it and thus current societal institutions. Therefore, is the blockchain environment capable of leading to the experimentation of new forms of governance and relations (Berg et al., 2018)?

To interact in society, we must be guaranteed certain reciprocity and security concerning exchange and property (Markey-Towler, 2018, p. 6); centralized states have traditionally made it possible. Decentralized architectures are currently gaining popularity to protect one’s privacy (De Filippi, 2016) because of citizens' progressive disengagement in politics and growing distrust in existing institutions (De Filippi, 2018). It is a matter of public trust (Maupin, 2017) to which the blockchain responded as a social and economic movement that aims to provide transparency, self-regulation, and efficiency (Koletsi, 2019). The idea to protect citizens’ freedom and privacy from governments and big corporations, thanks to cryptography, originates within the cyberpunk and crypto-anarchist culture of the late 1970s (Atzori, 2015). The blockchain revitalized the cyber-libertarian flame (Werbach, 2018); anarcho-capitalists conjoin decentralization, individualization, and privatization (Flood and Robb, 2017). Conversely, we find some authors, such as Markey-Towler (2018), who see the blockchain as revolutionary since it could make the anarchist utopia a reality, or Huckle and White (2016), who investigate the applicability of this technology to socialism since a public blockchain advocates community ownership.

Nevertheless, does community ownership mean *social* (or socialist) ownership? Can socialism be considered a synonym of community government and governance? According to Kaal (2019), decentralization transcends the traditional economic notions of capitalism and socialism, combining both for the simultaneous generation of profits and redistribution of resources. So, the blockchain could help implement new forms of decentralized models of commons-based management, since it "enables collective organizations and social institutions to become more fluid and promote greater participation" (Wright and De Filippi, 2015, p. 3).

Blockchain technologies open a discussion on the necessity or possibility of a new social contract (Koletsi, 2019). A first and intriguing analysis of the philosophical background that may lay behind the blockchain is provided by Reijers et al. (2016), who examine how blockchain technologies can produce governance models and how these models of governance are justified. The authors start from the consideration that the social contract for blockchain technologies can be understood as the underlying model for the governance of blockchain-based interactions. Reijers et al. conclude that blockchain governance justification relies on a Hobbesian conception of human nature while reflecting Rousseau's idea of "decentralized" sovereignty.

Atzori (2015, p.21) states that public institutions' central coordination was created for protecting the common good and collective rights in the long term from transitory individual interests and profit. Thus, if the centralized institutions are working for the general interest, it is natural to ask ourselves: "Is decentralization a good idea? Is it economically feasible? What are the social consequences of decentralization?" (Narayanan et al. 2016, p. 282, quoted in Oh and Wallsten, 2018).

The possible decentralization has the advantages of missing a single point of failure (Atzori, 2015) with the provision of a complete, transparent, and intrinsically valid historical transaction log (Hawlitschek et al., 2018, p. 52). The blockchain may provide a technical solution (i.e., a cryptographic consensus) to the problem of cooperation in joint or group production at scale,[14] while still maintaining the benefits of commons-type (i.e., polycentric) institutional governance (Davidson et al., 2016b, p. 13). It may facilitate new non-hierarchical governance models where intelligence is decentralized and can operate over a network of computers without any human intervention (Wright and De Filippi, 2015). On these bases, it can be considered a hyper-political tool, capable of managing social interactions on a large scale and rendering traditional central authorities obsolete (Atzori, 2015, p. 1).

As seen in the fork case, this technology makes viable the Hirschman "exit" response to the decline in organizations (Markey-Towler, 2018). "Blockchain technology is by design a multi-user system. It is designed for continuous, non-centrally governed interaction among (large) heterogeneous groups of participants. Furthermore, it supports the independent development and deployment of autonomous, collaborative, and highly interoperable services by every user of the system" (Glaser, 2017, p. 1550). Blockchain technology is expected to facilitate direct interaction between citizens, providing administration without a governmental administrator and tailoring services provided by governments (Keyser, 2017 quoted in Ølnes et al., 2017, p. 362). Some even believe that it represents the coming of a stateless global society (Atzori, 2015) or a *decentralized autonomous society* (DAS)

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[14] The authors refer to the to the eight core design principles for the efficacy of groups identified by Wilson, Ostrom and Cox in 2013. See: Wilson, D. S., Ostrom, E., and Cox, M. E. (2013). Generalizing the core design principles for the efficacy of groups. Journal of Economic Behavior and Organization, 90, S21–S32. doi: 10.1016/j.jebo.2012.12.010

with no space for centralized forms of power and control (Garrod, 2016). DAS supporters start “from the assumption that there is no trust and no community, only individual economic agents acting in self-interest” (O’Dwyer, 2015 cited in Garrod, 2016, p. 67) where there is no space for the notion of a social contract (Reijers et al., 2016).

Although it will not be addressed here, the adoption of the so-called *smart-contracts* could also make it easier “to create custom legal systems, where people are free to choose and to implement their own rules within their own techno-legal frameworks” (Wright and De Filippi, 2015, p. 40). The development of non-centralized political and socio-economic systems could derive from “polycentric systems [which] are more likely than monocentric systems to provide incentives leading to self-organized, self-corrective institutional change” (Ostrom, 2010; quoted in Shackelford and Myers, 2017, p. 35). Blockchain technologies can configure specific forms of political organization (Reijers et al., 2016), in which “individuals could find new ways to spontaneously organize and coordinate themselves into transnational cloud communities and even acquire their own self-sovereign identity that subsists independently of any nation-state” (De Filippi, 2018, p.1).

The terms of comparison are only possible with previously known or experienced models of society. However, looking at the potential shift from trust in people to trust in technology, the institutional structure of society could shift to one that is computationally based with a diminished need for human-operated brick-and-mortar institutions (Swan and De Filippi, 2017, p. 4), and thus resulting in something completely new.

Just as the platform economy, the Internet of Things, and Big Data, distributed ledgers pull in online systems and business processes previously conducted offline (Finck, 2017, p. 20), pushed by societal trends towards a networked society and platform-mediated services (Glaser, 2017). Without proper steering, this transformation may lead to significant problems, especially concerning power dynamics. As Atzori (2015, p. 29) warns: “In a world increasingly reliant on technology and ruled by networks, whoever owns and controls these platforms always has significant power over civil society.” How will we deal we this phenomenon? What kind of instrument can we rely on?

As seen, decentralization may work on several levels, having a twofold impact:1) within the economic domain, converting the hierarchical structure into a horizontal one; 2) the disruption of public institutions, which have the role of representing the general interest, and thus the introduction of issues with power relations dynamics among individual and network, and network(s) and network(s). We need to understand the potential liberties and restrictions that come with decentralized networks of cryptography-based economic activities (Risius and Spoher, 2017) and understand how to tackle and judge these possible outcomes.

4. Final remarks

A limitation of previous work on blockchain technology is its limited mono-disciplinary approach or its focus on specific cryptocurrencies that only constitute a single purpose instantiation of a blockchain system (Glaser, 2017, p. 1544). There is great potential for multidisciplinary research since this technology integrates many fields of studies, and due to the need for clarity since the vocabulary currently used is notoriously confusing (Walch, 2017).

As stressed by Akgiray (2019), the establishment of global standards is needed in three critical areas, such as 1) terminology, 2) architecture, 3) governance. Without these standards, the adoption process may lead to uncertainty that could result in a lasting and clear gap between the potential and actual achievements of this technology. Moreover, no normative implications can be derived from a phenomenon that is not correctly understood (Reijers and Coeckelbergh, 2016).

Gans (2019) affirms that blockchains can be considered trustless technologies because of their potential ability to work independently of social mechanisms for trust; however, according to Hawlitschek et al. (2018, p. 59), "blockchain technology in and by itself is not able to provide an environment that renders trust-building outside the closed blockchain ecosystem obsolete." Regarding more complex social relationships involving the sharing of resources and assets, blockchain technology alone does not suffice in enabling people to develop trusted interactions (Pazaitis et al., 2017, p. 17). Blockchain and other institutional and physical technologies supporting impersonal exchange replace trust between counterparties with all parties' trust instead pointed towards a third-party intermediary (Arruñada, 2018, p. 32), namely the blockchain and its technological features. As previously shown, the blockchain is neither invulnerable (e.g., 51% attack) nor immutable (i.e., soft or hard fork). Abadi and Brunnermeier (2018) proclaimed a blockchain trilemma since no ledger in their analysis can simultaneously satisfy all three ideal qualities (1. correctness, 2. decentralization, and 3. cost-efficiency) of any record-keeping system.

Moreover, Akgiray (2019) identifies several shortcomings and weaknesses of the blockchain that must be addressed: 1. scalability; 2. data and user privacy; 3. governance. Gomez et al. (2019) lengthen the list to: 4. jurisdiction; 5. encryption; 6. service level agreements and performance.

Notwithstanding these shortcomings, the idea of a "decentralized autonomous society" (DAS) is spreading. However, there has been little investigation of how the DAS might function (Garrod, 2016, p. 62). In a world in which code is the law, social sciences and cyber sciences are at a crossroads where society and technology are integrating to create a mixed socio-technological or techno-social reality (Koletsi, 2019); a new societal configuration could result in the constitution of new forms of social and political elites. Software developers and engineers nowadays have the power to embed their interpretation of the law into the technical artifacts that they create (De Filippi and Hassan, 2016). The power of developing codes and selecting algorithms has significant power implications in contemporary society (Atzori, 2015), and the dynamics among different layers of power within and among networks are highlighted by Koletsi (2019).

This scenario naturally recalls the reasons identified behind the birth and raison d'être of the state and central institutions in general, mitigating the particular interest into the general interest in light of the principles and rules that the community gave itself. As highlighted by Reijers et al. (2016), blockchain design may lack any conception of common interest and the common good that goes beyond facilitating autonomous individuals contracting between themselves. The possibility of creating a distinguished (and conflicting?) network that operates based on different interests calls the issue of power relations directly into question, as investigated by Koletsi (2019).

Politics is about a question of compromise. An opt-in or exit-based political system essentially eliminates the notion of politics because it removes the need for compromise (De Filippi, 2018). Accordingly, blockchain technology represents an alternative vision of the economic system that envisages a shift toward a decentralized international order in which politics may be completely absent (Hacker et al., 2019). People with different values or opinions would no longer need to argue and deliberate to reach a consensus because they can leave if they are in disagreement (De Filippi, 2018).

Blockchain technology can be an instrument, but not an end in itself, or a panacea (Reinsberg, 2019). "Radical technological innovations should not be considered a panacea to humanity's problems but as social technologies leading to new organizational paradigms that transform the thought and action of societies, providing, at the same time, new structures of distributed and decentralized power, reshaping social relations and humanity's understanding of social reality" (Koletsi, 2019, p. 30). A utopian society characterized by greater individual freedom and autonomy and a dystopian society driven by market-based incentives and self-dealing could be created with the blockchain (De Filippi, 2018). Thus, the rules by which different blockchains will be developed and implemented will have to comply with regulatory provisions for large-scale adoption that take general interest into account. Moreover, it is difficult to imagine the blockchain replacing governments in such domains as external security or the monopoly on violence (Potts, 2019). Is this a goodbye to the crypto-anarchist dream? Reinsberg (2019) highlights that the blockchain can be complementary rather than substitutive of traditional institutions since it generates a multifaceted, heterogeneous, hybrid institutional system (Frolov, 2020).

Concluding, we believe in the possibility that the blockchain could have a significant impact in the future, but the problem of converging particular interests into the general one still persists. We believe that there is enough space to declare that centralized institutions will still play a role, at least until we will adequately investigate and address the challenges ahead and provide solutions in line with the view and goals established by a sustainable, fair, and inclusive society. After all, as Atzori (2015, p. 22) remarks, "we must not forget that empathy and conscience are irreplaceable components of any social and political interaction, and information efficiency and automation are not the ultimate purposes of human communities."

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