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Blockchain and Institutions (II): The Realm of Law

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Blockchain and Institutions (II): The Realm of Law[1]

Abstract

Blockchains promise to bring disruptive changes at several levels well beyond the realm of cryptocurrencies, in which they were first deployed; centralized institutions are challenged. The present survey focuses on the potential frictions between the application of blockchain technologies and the realm of law. Several subtopics are highlighted as problematic. Findings show that the current state of the art does not sufficiently support the blockchain's implementation on a societal level. Shortcomings and confusion among legal and economic concepts are highlighted to be addressed, and therefore clarity and uniformity are needed to ensure the benefits that may derive from the application of this technology.

Keywords: Blockchain; Law; Regulation; Smart Contract; Property.

JEL: D23, K10, K11, P14

1. The blockchain and the law

The blockchain is a public record kept without a public authority (Beck and Muller-Bloch, 2017; Markey-Towler, 2018). A shared database to transact valuable assets in public and pseudonymous setups without having to rely on an intermediary or central authority (Glaser, 2017; Risius and Spohrer, 2017; Hawlitschek et al., 2018), avoiding the double-spending issue (Swan and De Filippi, 2017, p. 2). A new species of economic coordination (Davidson et al., 2016), representing a network consensus of every transaction that has ever occurred (Tapscott and Tapscott, 2016a). There are currently three different yet complementary definitions of the blockchain (Mougayar, 2016): technical (open and distributed database), business (exchange network), and legal (replacement of third parties and validation of transactions).

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), enabling the disintermediation and decentralization of all transactions of any type between all parties on a global basis (Swan, 2015). The central idea is that goods' rights can be transacted, whether they are financial, hard assets, or ideas (Tapscott and Tapscott, 2016b). Regarding applications, Mougayar (2016) suggests considering the acronym ATOMIC: assets, trust, ownership, money, identity, contracts. Swan (2015) is much more generous, foreseeing the potential benefits basically in every domain. In such a system, all property could become smart property; this means encoding every asset to the blockchain with a unique identifier, ensuring that the asset can be tracked, controlled, and exchanged (M. Swan, 2015).

[1] An: the article presented is the second 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. While the first part focuses on trust and decentralization, this second article investigates the application of the blockchain within the realm of law.

However, there are serious concerns regarding these claims, as in the case of property (Arruñada, 2020).

The blockchain challenges two of the central legal devices of modernity: the ledger and the contract (DuPont and Maurer, 2015, p. 2). These domains are both ruled by the law to ensure standards, maintain order, resolve disputes, and protect liberties and rights in a substantially analogical world. Things are changing quickly since law and technology can influence each other (De Filippi and Hassan, 2016). Hence, technology has the potential to alter our conception of the law (Werbach and Cornell, 2017), and results in a new subset of law – *Lex Cryptographia* (Wright and De Filippi, 2015), or even function without a legal framework (Sulkowski, 2018).

The blockchain is implemented in a space where *code is law* (Lessig, 1999), "code controls behavior as the law might control behavior" (Zetzsche et al., 2017, p. 24). Thus, as markets and norms, code is just one modality of regulating (Werbach, 2018). Platform-based technological applications possess working rules conceptualized as constitutional rules (Rajagopalan, 2019; Berg et al., 2018). Wright and De Filippi (2015) warn that law and code may merge so that breaking one of those will mean breaking both. However, the two languages currently still differ, and the complete mixing of legal and code rules will still not occur (Frolov, 2020). "Legal code is primarily extrinsic; technical codes are primarily intrinsic […] compliance is ensured through the employment of the codes. […] even where compliance generates undesirable or unforeseen outcomes" (Yeoh, 2017, p. 5). This kind of "inflexibility" will be addressed later with smart contracts. The differences between the two languages are an obstacle to consider since this could be translated into legislative risks (Walch, 2017b).

Nevertheless, the relation between the blockchain and the law could be substantially threefold: i) as a supplement; ii) as a complement; iii) as a substitute (Werbach, 2018). In our understanding, the first two cases constitute what will be implemented most commonly, while the third hypothesis is the least plausible, since the implementation of a blockchain in an environment with no rule of law is unlikely to solve issues outside the digital realm (Cai et al., 2020; Graafland, 2020; Mccannon et al., 2018). However, the situation may evolve so much that there can be no certainty to prove this affirmation as necessarily true.

2. **Findings – Highlighted subtopics**

2.1 *Regulatory Challenges*

Although regulators have rejected the "code is law" maxim in its absolute version (Finck, 2017, p. 13), in the digital world, technology itself can be regarded as a form of regulation (Wright and De Filippi, 2015). Between technology and law, the former is increasingly used as a complement or a supplement to the latter (Reinsberg, 2019; De Filippi and Hassan, 2016). Therefore, the blockchain will need to integrate with the law's operations and institutions to achieve its potential and prevent failures (Werbach, 2018).

Many governments are now investing in blockchain solutions (Akgiray, 2019), although very few have adopted a comprehensive blockchain law (Zetzsche et al., 2017). Moreover, jurisdiction problems arise when it comes to transnational networks (Hacker et al., 2019). Legal challenges should not be underestimated (Millard, 2018). There are three significant types of controversy – illegality, classification, and legal validity (Werbach, 2018) – which may result in at least three major types of potential liability risk (Zetzsche et al., 2017): i) ledger transparency risks; ii) cyber risks; iii) operational risks.

The scope of legitimate practices for blockchain systems is a governance-related question, not one of computer science (Werbach, 2018). The ecosystem is currently not yet adapted to this technology, and rules and regulations will have to be modernized (Gabison, 2016). Nevertheless, it is crucial for regulators to wait until the pros and cons have been uncovered before moving on (Schakelford and Myers, 2017). Governments should focus on individual use cases (Maupin, 2017) since no "one-size-fits-all" legal analysis is possible. Instead, each application will need to be evaluated on its facts (Bacon et al., 2017), since the technical complexity and the delivery timeframe will vary, and so will the legal questions (Zetzsche et al., 2017, p. 23). Blockchain is a symbiosis of regulatory and algorithmic law (Frolov, 2020). There is the need to undertake a careful mapping of the respective roles of the "dry code" of cryptography and the "wet code"[2] of law (Werbach, 2018, p. 7) since distributed ledgers could be regulated by both (Yeoh, 2017). Nonetheless, blockchain technology still has a fluctuating terminology that can cause uncertainties for regulators, increasing the chances of (1) regulatory capture, (2) inconsistent regulation, and (3) perverse innovation (Walch, 2017b). To address these problems attempts to create a philosophy (Swan and De Filippi, 2017) and ontology (Tasca et al., 2018) of blockchains have been proposed.

Much of the regulation is a classification exercise (Werbach, 2018); e.g., from a technical standpoint, blockchains are only one subset of distributed ledger technologies (Maupin, 2017). Bearing in mind the difficulty of finding the right moment to regulate when it comes to new technologies and practices (Walch, 2017a), as Easterbrook has argued, new technologies do not necessarily call for new legal doctrines when fact patterns are fundamentally unchanged (Werbach and Cornell, 2017, p. 24). This principle seems to fuel specific approaches that have been taken into consideration by regulators. According to Akgiray (2019), there are three types of regulatory positioning: 1. Study-and-Wait-and-See; 2. New legislation and regulation; 3. Guidance and Sandboxing. This classification can be split into a small number of approaches to manage the adoption of the appropriate regulation to be implemented: i) *waiting and seeing*[3]; ii) the *safe harbor*[4]; iii) the *recycle box*[5]; iv) the *dark box*[6]; v) last but not least, the *regulatory sandbox*[7]. This last approach should have four distinctive features to be effective (Maupin, 2017): i) global reach; ii) cross-sectoral; iii) a start-up-friendly operating structure[8]; iv) use of case-tailored parameter-setting practices.

[2] Nick Sazbo introduced the distinction between wet code (what lawyers practice) and dry code (operations confined to and executed by computers) in 2008, available at: http://unenumerated.blogspot.com/2006/11/wet-code-and-dry.html
[3] I.e., how the technology unfolds while continuing to apply existing legal frameworks (Finck, 2017).
[4] When firms can take enough steps to police themselves, the safe harbor incentivizes them to do so by defining what specific conduct is necessary (Werbach, 2018)
[5] It is implemented when minor adaptations to existing national and international regulatory frameworks are required (Maupin, 2017, p.1)
[6] They call on regulators to develop more effective globally cooperating regimes for detecting, tracking, and prosecuting blockchain-based illicit activities (Maupin, 2017, p. 1)
[7] It can be defined as "a set of rules allowing innovators to test their product or business model in an environment that temporarily exempts them from following some or all of the legal requirements in place" (Finck, 2017, p. 14).
[8] This is clarified by the author by the fact that "most blockchain start-ups satisfying the sandbox criteria face a chicken-and-egg problem. They cannot scale without obtaining some modicum of regulatory certainty, but they do not have

Some jurisdictions have concluded that it is premature to bring in new regulation and risky to just wait-and-see, preferring the regulatory sandbox (Akgiray, 2019). In this way, the blockchain is replicating the regulatory curse of the Internet (Hacker et al., 2019). No guarantee that the path and results will be the same.

2.2 Identity and Pseudonymity

Identity is a crucial component of any economic exchange (Berg et al., 2018). Outside digital life, identity is typically social and intersectional (Immorlica et al., 2019), and, without it, it is impossible to engage in economic, social, and political activities (Allen et al., 2018). The problem of maintaining control over and preserving the transparency of our digital identity has become urgent (Gabison, 2016) and complex. Due to its pseudo-anonymous nature, blockchain technology is likely to offer a viable solution to this problem, fulfilling individuals' desires to maintain a wide range of identities while maintaining their privacy (Berg, 2018, cited in Allen et al., 2018, p. 16). However, in the blockchain, decentralization is associated with transparency, as interactions of those involved are visible to each node in the network (De Filippi, 2016, p. 1). This transparency may not necessarily conflict with privacy, but it is beneficial to data integrity, facilitating access to assets through identity theft (Zetzsche et al., 2017). Therefore, the pseudonymity within the (public) blockchain is not enough to guarantee total anonymity (Conoscenti et al., 2016; De Filippi, 2016). The picture may change in the case of public or private blockchains; the latter offers clear advantages in security and privacy (Yermack, 2018). In a public blockchain, it is possible to de-anonymize a user by analyzing network traffic or the blockchain itself. The transparency is such that it is possible to retrieve every performed operation's history and rely on big data analytics to extract potentially sensitive information (De Filippi, 2016). Being the definition of "personal data" very expansive, covering any information that relates to an identifiable person, i.e., a person who can be identified "directly or indirectly" (Bacon et al., 2017), this pseudonymity presents significant regulatory challenges (Wright and De Filippi, 2015) to be addressed, such as in the cases of agreements or contracts.

2.3 Smart Contracts

A contract is a promise that can be legally enforced (Rodrigues, 2018, p. 26). "Blockchain can be regarded as a 'paradigm-shifter' in the sphere of contracting; it allows automation of the process of contractual performance of both parties" (Savelyev, 2017, p. 121). Electronic contracts are nothing new; they come from "the fusion of two lines of technological development: electronic contracting and cryptography" (Werbach and Cornell, 2017, p. 5). Smart contracts can be considered as an example of a trend of computerized technologies purporting to displace or replace human decision-making (Werbach and Cornell, 2017, p. 56) being motivated by three well-known difficulties with natural language and human institutions: i) ambiguity; ii) corruption; iii) enforcement (Grimmelmann, 2019).

The interpretation of smart contracts has become an object of debate since there is no universally agreed definition (Savelyev, 2017, p. 120). The concept of smart contracts may result from a series of terminological misunderstandings due to inconsistent and incorrect use of legal terms (Mik, 2017). However, it is claimed that a blockchain is an economic world of complete contracts (Davidson et al., 2016b, p. 9). Nevertheless, agreements often come with uncertainty (Mccannon et al., 2018), and "no physical representation of an agreement can ever entirely represents the agreement. […] contracts are intangible. They are enforceable agreements" (Kolber, 2018, p. 219). The meaning of a legal

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sufficient bandwidth to engage in labyrinthine regulatory processes across multiple jurisdictions whose approvals they would need in order to scale safely" (Maupin, 2017, p. 16).

contract is a social fact (Grimmelmann, 2019), which explains the necessary incompletion of all contracts (Rodrigues, 2018).[9]

Based on the current understanding and properties revealed by smart contracts, Savelyev (2017, pp. 124-127) identifies the following features: (1) solely electronic nature; (2) software implementation; (3) increased certainty; (4) conditional nature; (5) self-performance; (6) self-sufficiency.

According to general opinion, considering their self-performing property, smart contracts are meant to be stand-alone agreements that are not subject to any third party (Rodrigues, 2018). Smart contracts are considered only those based on blockchain technology with electronic assets as their object to ensure its self-enforcing nature (Savelyev, 2017, p. 130), when specific conditions are validated (Allen et al., 2018). Therefore, smart contracts are more adequately understood as autonomous software agents (Finck, 2017) or algorithmic rules that automatically respond to pre-programmed parameters (Howell et al., 2019). The code itself is the ultimate arbiter of the deal it represents (Savelyev, 2017, p. 125), and everything beyond the code is just an explanation (Werbach and Cornell, 2017, p. 29). As Grimmelmann (2019) highlights, the way to change the consequences of contracts on a blockchain is to change the semantics.

Thus, smart contracts are not "contracts" in terms of legally enforceable promises with binding obligations on two parties seeking to broker a mutually beneficial exchange (Howell et al., 2019). A smart contract is merely the code for the execution of the contract (Gans, 2019). Max Raskin (2017) provides a different interpretation considering them as a form of self-help rather than constituting legal enforcement. However, a contractual agreement requires an offer and acceptance (to establish mutual consent), consideration (anything of value exchanged), and an intention to create legal relations (Zetzsche et al., 2017, p. 30), while smart contracts do not capture the dynamic processes of stipulating a contract (Howell et al., 2019). Furthermore, they do not create obligations in a legal sense since they miss an orientation towards the future and a "will" component (Savelyev, 2017); there is no exchange of promises or commitments (Werbach and Cornell, 2017, p. 22).

Therefore, smart contracts cannot be considered contracts because there is no possibility of uncertainty in their execution and thus no compliance; strictly speaking, they are merely an example of automaticity created by the verification game (DuPont and Maurer, 2015). In this perspective, there should be no legal point of intervention since the code is self-contained (Rodrigues, 2018). In fact, in contrast to traditional contracts, in which trust is placed in the other party in the contract, in smart contracts, such trust is placed in the computer algorithm behind the agreement ("trustless trust") (Savelyev, 2017, p. 123). "If two parties engage in a contractual agreement using a smart-contract application, performance of contractual terms is guaranteed not by the goodwill of parties or third-party arbitrage but rather by the encoded algorithm" (Ishmaev, 2017, p. 667). Hence, crypto-contracts tend to build social and functional properties within the system (DuPont and Maurer, 2015, p. 8), i.e., without the necessity for arbitrating third parties. As shown by the failure of the 2016 Distributed Autonomous Organizations (DAO), even if no code can anticipate all the problems that could arise (Rodrigues, 2018), smart contracts have been considered good at setting forth anticipated conditions and consequences ex-ante and then ensuring that the effects occur upon the fulfillment of the

[9] An intriguing and futuristic remedy for the incompleteness of contracts thanks to technological features (blockchain + artificial intelligence) is provided by Casey and Niblett (2017), who highlight "self-driving contracts" as a potential alternative to blockchain-based smart contracts. Recognizing the incompleteness of the contracts, the authors propose a "contract that writes its own terms or fills its own gaps. To be more precise, a self-driving contract has three key features. It is an agreement where (1) the parties set only broad ex ante objectives; but (2) the contract uses machine-driven analytics and artificial intelligence to translate the general ex ante objective into a specific term or directive at the time of performance; where (3) those terms are based on information gathered after the parties execute the initial agreement".

conditions involved (Werbach, 2018, p. 53). By default, they implement a zero-tolerance policy by which parties have no choice but to execute the contract (Wright and De Filippi, 2015, p. 26), eliminating the act of remediation by admitting no possibility of breach (Werbach and Cornell, 2017, p. 4).

Therefore, the critical distinction between smart contracts, other forms of electronic agreements, and contracts is enforcement (De Filippi and Wright, 2018; Werbach and Cornell, 2017). In fact, they make enforcement automatic and unavoidable (Rodrigues, 2018; Werbach and Cornell, 2017). However, apart from optimistic claims, smart contracts may nevertheless require enforcers for contract completion, in a more traditional sense (Arruñada, 2018, p. 9). The flaw in the rationale is the failure to distinguish contractual execution from enforcement: the first is automated, the latter is not (Werbach, 2018). Furthermore, "the core peer-to-peer structure of blockchain faces insurmountable difficulties to reach contractual completion and to interact with the real world, two challenges that regards, respectively, contract (in personam) rights and property (in rem) rights" (Arruñada, 2018, p. 19).

Smart contracts are limited by their nature to those contractual terms that can be specified in computer-readable code, and still further limited by any constraints imposed by the blockchain system on which the contract operates. The *fundamental smart contract challenge* is related to performance obligations that must be verified in interactions with non-digital activities (Gans, 2019). It means that they cannot capture real-world complexity (Bacon et al., 2017). At this point, a legal intervention does exist — not in the blockchain environment itself, but rather in the intersection of the blockchain features and the physical world (Rodrigues, 2018).

Moreover, another element of vulnerability is represented by the fact that smart contracts can have errors and security flaws like any other software code (Werbach, 2018, p. 25). Errors in computer code are prevalent and impossible to eradicate, and they increase with increasing code complexity as with conventional contracts (Arruñada, 2018, p. 15). Although proponents of smart contracts claim that many kinds of contractual clauses may thus be made partially or fully self-executing, self-enforcing, or both (Kakavand et al., 2017), specific contractual terms cannot be expressed through formal logic because they imply human judgment (Werbach and Cornell, 2017, p. 43). Several key legal concepts lack a binary nature, such as force majeure, material breach, and good faith, which cannot be translated into computer code (Vatiero, 2018).

Even considering the case of a smart contract operating precisely as designed, it may produce sub-optimal results because it is fixed (Werbach and Cornell, 2017). As previously stated, the concept of incomplete contracts acknowledges that it is rarely possible for parties to consider every eventuality in contractual bargaining due to a combination of bounded rationality, transaction costs, verifiability, or other strategic reasons (Howell et al., 2019; Allen et al. 2018). Concerning their inflexibility, smart contracts underestimate a central problem of transaction cost economics: the need for an efficient adaptive mechanism (Vatiero, 2018). So, even if smart contracts may economize on enforcement costs compared to traditional contracts, they also impose potentially higher costs of negotiating agreements (Allen et al. 2018). Moreover, in preventing ex-post external adaptation, transaction costs may emerge or increase, so that traditional contracts may incur lower transaction costs than smart contracts (Vatiero, 2018).

Even if smart contracts are not intended to be legally enforceable (Werbach and Cornell, 2017, p. 20), two different approaches at present dispute a resolution for smart contracts: 1. within the existing contract law framework or existing alternative dispute resolution (ADR) procedures (De Filippi and Wright, 2018); 2. considering them as different legal tools rather than digital alternatives to traditional legal contracts (Werbach and Cornell, 2017). This second approach may create new legal systems, a new *Lex Cryptographia* (Wright and De Filippi, 2015), or will require a “distributed jurisdiction” (Allen et al., 2019).

As noted above, smart contracts are subject to significant limitations (Kaal, 2019). However, there is no reason to suggest that they cannot coexist with the traditional contract (Werbach, 2018). From a practical perspective, it is possible to imagine that the choice between traditional and smart contracts will be a matter of economic efficiency and pragmatism (Howell et al., 2019). Even if the nexus of smart contracts of the blockchain represents a fundamental challenge to business and contract law more generally (Rodrigues, 2018), smart contracts will not replace contract law because contract law operates as a remedial institution to adjudicate on the legitimacy of a situation ex-post (Werbach and Cornell, 2017). Simultaneously, the impact of these self-executive software agents will be more evident in intrinsically contractual domains (Arruñada, 2018), such as corporations and enterprises.

2.4 *Distributed Autonomous Organizations (DAO)*

Business organizations have always changed because of technology. The decentralization and disintermediation will crucially disrupt traditional forms of organization (Fenwick and Vermeulen, 2018), resulting in an expansion of the role of markets and the contraction of hierarchy (Berg et al., 2018). The blockchain can undermine hierarchies' economic efficiency and relational contracting over markets (Davidson et al., 2016b). How? Thanks to smart contracts, which are intended to create certainty for counterparties, simplify and automate business, and remove transaction costs (Kaal, 2019); e.g., Allen et al. (2019) consider the lowering of verification costs and networking costs a plausible outcome. However, the scope of smart-contract applications is wide-ranging, from simple contractual agreements to self-governing organizations (Ishmaev, 2017, p. 667), “transforming Michael Jensen’s and William Meckling’s theory that firms are nothing more than a collection of contracts and relationships into reality” (Wright and De Filippi, 2015, p. 15). As Davidson et al. (2016, p. 21) state, “Blockchain distributed ledger technology is a rare and special general-purpose technology because it adds a further category to the suite of Williamson’s (1985) ‘economic institutions of capitalism’ – namely, markets, hierarchies and relational contracting with a new type of economic order”: Distributed Autonomous Organizations – DAO (Davidson et al., 2016b), and Decentralized Collaborative Organizations – DCOs (Novak, 2018). Both are built upon two concepts: autonomous agents and decentralized organizations (Rodrigues, 2018). A DAO involves a set of humans interacting with each other according to a protocol specified in code and enforced on the blockchain (Rodrigues, 2018); the standard corporate arrangements of equity, debt, and corporate governance could be encoded as a series of smart contracts (Werbach, 2018, p. 18); in short, a business form conceived as networks of contracts built exclusively on software designed to replace individuals (Finck, 2017, p. 7). The main question is therefore as follows: if a corporation is merely a nexus of contracts, why not encoding those agreements into digital self-enforcing agreements (Werbach and Cornell, 2017, p. 18) that can self-organize with distributed and decentralized profit margins, management, and services (Manski, 2017, quoted in Novak, 2018)?

The first challenge is the DAO's location within the range of legal business entities (Rodrigues, 2018). There are problems related to the requirements needed to operate similarly in real life; the firm concept is questioned (Waelbroeck, 2018). Moreover, since a DAO can be distributed into transnational networks, it raises several applicable legislation issues. At the same time, it can be logical to deduce that, until the challenges related to smart contracts would find a proper solution, DAOs will suffer from the same weaknesses. The rising of such organizations may have the power to reshape the notion of work and the firm (Waelbroeck, 2018). Will the institution of the property be affected as well?

2.5 The Institution of Property within the Blockchain

The blockchain seems to have the chance to disrupt the property institution by providing new means to assess ownership and manage it. Property relations in society could be replaced by or supplemented with blockchain models and implemented in new domains (Ishmaev, 2017, p. 682). Blockchains offer potential advantages in terms of cost, speed, and data integrity compared to classical methods of proving ownership (Yermack, 2018, p. 8). Devices and every tangible property can be registered onto a blockchain and turned into a smart property (Wright and De Filippi, 2015, p. 15) in which the rights associated with objects are attached to the objects themselves (Werbach and Cornell, 2017, p. 18). In this way, "property does not disappear but is instead enforced and exercised in different ways. If rights were previously exercised through norms, laws, markets, and architectures, today they are algorithmically inscribed in the object" (O'Dwyer, 2015, cited in Garrod, 2016, p. 70). This scenario is strongly linked to the radical claims that property rights may vanish in the future, becoming a subset of contract law (Ishmaev, 2017, p. 669).

Moreover, as Szilagyi (2018) highlighted, property law theories are not entirely suitable to address the unique issues presented by the blockchain. Allen et al. (2020) argue that it is possible to view the process of formalizing and developing mechanisms of property rights in a similar way to Demsetz (1967), looking at the blockchain as a form of self-bottom up-governance for enabling better coordination, which could lead to the promotion of new ways of organizing and distributing assets as *smart properties*. These assets (e.g., hard assets such as real estate) can be tokenized, valued, and mobilized in unprecedented fractional forms, allowing the development of new forms of consumption (Kaal, 2019).

2.6 *Smart properties and tokenization*

Tokenization is the digitalization of physical assets on a blockchain; it is the process of digitally representing an off-chain real-world asset on a distributed ledger (Akgiray, 2019; Hileman and Rauchs, 2017). It refers to the process of transforming the rights to act on an asset into a transferable data element (i.e., *token*) on the blockchain (Rozas et al., 2018). A token is a quantified unit of value that gives its holder the option to exercise specific rights embedded in the underlying code (Collomb et al., 2018; Tan, 2019).

Tokens can only appear in one entry in the ledger at a time (Gans, 2019); they are rivals, and only one person can use a given token at a given time (Waelbroeck, 2018). The potentially unique economics of each token are not based on legal rights but on their promises (e.g., claims and features) and functions (Lo and Medda, 2019), e.g., i) perks; ii) liquidity; iii) funding (Fenwick et al., 2018).

Taking into consideration the functions that tokens may perform, they can be classified into several categories. Taxonomies have been proposed in the literature by Hargrave et al. (2018) and Collomb et al. (2018). However, the interoperability of tokens (and their functions) is an increasingly important characteristic of token designs (Kaal, 2019), since it affects the rights of the holders, which can be: (i) rights of usage; (ii) rights of participation; (iii) rights to profits; and (iv) rights of ownership (Collomb et al., 2018). Of course, as well as functions, these rights are not exclusive to one another.

The mass adoption of tokens for fundraising[10] (Tan, 2019), the interoperability of their functions and rights of the holders, the consequent development of so-called *token economics*[11] (or *tokenomics*) has prompted legislators to begin tackling these issues. Not surprisingly, the many characteristics shown by tokens are reflected by the different regulatory regimes under which they may fall. The debate remains open, but proposals are currently being made (Hacker et al., 2019; Fenwick and Vermeulen, 2019).

It has been claimed that the pairing of tokens and blockchains may be able to create institutional orders that can be defined in Hayek's words (1945) as a *catallaxy*, "a special kind of spontaneous order produced by the market by people acting within the rules of the law of property, tort and contract" (Hayek, 1982, quoted in Davidson et at., 2016b, p. 11). We underline *within* the rule of law, not outside of it. Blockchain developments, as in the case of ICOs, have often been developed in a shadowy zone, where code is law until the moment the stakes are not too high. The law has been called upon to intervene when behaviors in the cybersphere do not respect the *recognized* rights of those involved in such operations. So, a point of legal intervention may exist wherever the blockchain has an intersection with human beings and their institutions. Among many, the institution of private property has played a major role. The potential switch that may derive from the tokenization of mobilizing properties (and their use) in fractional forms has to be considered, bearing in mind the distinction between economic and legal property rights (Berg, 2019; Hodgson, 2015). This second category seems to be underestimated at times in the narrative of blockchain development.

2.7 *Property Rights*

In academic research, the concept of property is anything but simple (Ishmaev, 2017). Property institutions include property rights and the various customs and regulations that structure the exercise and the transfer of such rights (Allen et al., 2020; Pryor, 1972). Property rights are not the resource itself but the right to use it (Tan, 2019; Low and Mik, 2020). Although Holcombe (2014) discerns between normative or positive economic theory of rights, property rights are in the sphere of public ordering (Arruñada, 2018, p. 21), since the essence of property is the exclusion of non-owners from the determination of property use (Schmidtz, 1994; Penner, 1997, quoted in Ishmaev, 2017). They are *in-rem rights*, creating negative duties for all non-owners even if they have no contractual relations with the property holder (Ishmaev, 2017, p. 678). Unfortunately, as stressed by Arruñada (2017), most of the economic literature on the topic ignores the distinction between *in rem* and *in personam* rights. The first are those which ensure that the same rules are applied to all rightsholders. As Arruñada (2003) stresses, when it comes to property *in rem* rights, a two-step procedure is needed: i) private contracting with *in personam* rights, ii) public procedure capable of granting universal (i.e., *in rem* rights) effects that involves public authorities since they represent all interested parties (e.g., strangers) and provide impartiality. This process is needed why "centralization and monopoly in registries are not rooted mainly in economies of scale but in the need to enhance the neutrality (with respect not only to parties of the contract but also to strangers to it) required to reach universal legal effects" (Arruñada, 2020, p. 14). Central institutions nowadays

[10] We refer here to the so-called Initial Coin Offering (ICO), or "token sale", or "token generating event", which can be described as "a means of fundraising whereby tokens giving their owners certain rights are sold in exchange for cryptocurrencies or fiat money" (Collomb et al., 2019).

[11] Token economics designs the model used to influence the use of tokens in a decentralized ecosystem, through incentive mechanisms and a defined token environment. Token economics is the foundation of tokenized ecosystems. It looks at the long-term and short-term goals and drivers of the ecosystem (Tan, 2019).

ensure such universality. Even if decentralization may or may not be chaos since it depends on institutional structure (Schmidtz, 1994), in a hypothetical, fully decentralized property system, all individuals should therefore be granted or denied consent to a wealth of intended transactions that might affect their property rights (Arruñada, 2018, p. 25). Therefore, the coming hybridization between real and digital assets presents new challenges that cannot be easily addressed within the current legal framework (Szilagyi, 2018). In fact, “in the case of smart property, however, ownership could be both defined and managed by source code. A person who qualifies as the technological owner (as opposed to the legal owner) of the smart property enjoys absolute sovereignty over that resource, which cannot be seized by anyone unless specifically provided for by the underlying code” (Wright and De Filippi, 2015, p. 35). Moreover, while blockchains guarantee transfers of ownership, some enforcement is required to ensure transfers of possession (Abadi and Brunnermeier, 2018).
However, Ishmaev (2017, p. 681) claims that transparency, “together with exclusion and separability, in fact, makes blockchain technology a self-sufficient alternative institution of property existing independently of any legal institutions.” It may be possible to consider this assertion as true for *native* digital goods (Szilagyi, 2018), such as cryptocurrencies. Problems may arise when it comes to real assets *tokenized*. Neutrality and universality requested by *in rem rights*, and “sequential exchanges” (Arruñada, 2017), are criteria that will have to be met if the blockchain architecture aims at being institutional, as it will be shown in the case of land registries.

2.8 The Case of the Land Registry

According to some scholars, the neutral role of public ledgers can be achieved by placing land registry records and public records of land ownership on the blockchain and thereby allowing the relevant stakeholders and agencies real-time access to ownership records (Kakavand et al., 2016, p. 18). Recognizing the technical and legal problems to be overtaken to reach a wide adoption, Graglia and Mellon (2018) consider the blockchain as a disruptive technology for land governance thanks to its ability to promote property formalization rights, registry modernization, and the collection and analysis of land-related data. This pattern may seem suitable for emerging markets (Reinsberg, 2019), given “the inadequacy of existing record-keeping systems, mistrust of corrupt and ineffective market regulators, and high penetration of information technology such as smartphones” (Yermack, 2018, p. 9). What these authors appear to forget is the fact that: i) if policymakers liberalize the economy in a situation of low trust, institutional misalignments may emerge (Graafland, 2020); ii) “the main problem of property registries is not archiving information but producing reliable information, […] purging them and making sure that transactions are not contradictory with preexisting property rights and do not create new collisions of claims” (Arruñada, 2018, p. 22). Registries are much more than mere public databases: they protect the interests of unrepresented third parties (Arruñada, 2020), which means that “all potential rightsholders and not only the interests of those in the chain of title” (Arruñada, 2018, p. 20).
Therefore, extremely high accuracy in the transposition and insertion of data is required. Blockchain registries do not become significant for land governance until after land rights have been formalized, which means addressing the primary challenge of emerging economies; how to bring citizens and properties into the formal system (Graglia and Mellon, 2018, p. 26). Moreover, the blockchain will not resolve the tedious and time-consuming process of collecting, verifying, and bringing *data* into the system in the first instance.

2.9 *Data accuracy*

Data serves as a necessary yet insufficient platform for providing information in economic, political, scientific, social and technical contexts (Allen et al., 2018, p. 2). One of the key promises of blockchain technology is to mitigate information problems. The blockchain ensures equal access to transparent and trustworthy information (Savelyev et al., 2017, p. 119). A blockchain database is likely to contain at least two types of data; i) metadata related to transactions, namely both the addresses of the sender and recipient and a timestamp; ii) data on the object of a transaction (Bacon et al., 2017).

Even if the technology works flawlessly, fundamental problems include human fallibility and corruption when creating the underlying records and enforcing consequences (Sulkowski, forthcoming 2018, p. 2). Moreover, distributed ledger technologies do not make inaccurate data accurate (Zetzsche et al., 2017, p. 13). The truth of data on a blockchain is limited by the quality or truth of the input on the ledger (Walch, 2017b). GIGO ("Garbage In, Garbage Out') applies to every blockchain that uses non-native digital assets and/or external data inputs (Hileman and Rauchs, 2017). The "zero state problem" is a major issue for blockchain-based provenance records for physical objects that predate the blockchain (Lapointe and Fishbane, 2019). Blockchain cannot assess whether a given input from the outside world is accurate/true or not. "If 'off-chain' assets or data sources are digitally represented on the blockchain, a trusted third party is required to verify and guarantee the accuracy of the input when inserting it into a blockchain" (Hileman and Rauchs, 2017, p. 18).

3. Conclusion

Capitalism relies heavily on markets and private property rights to resolve conflicts over the use of scarce resources (Alchian and Demsetz, 1973), while the law of property is concerned with the allocation of scarce resources (Low and Mik, 2020). Nowadays, there is an agreement that capitalism and its property relations need to change (Garrod, 2019) – although it is not clear how (Hodgson, 2020) – and the blockchain could be the instrument (e.g., Swan, 2015; Tapscott and Tapscott, 2016a; Mougayar, 2016). However, to prove this statement correct, analysis of further developments will be necessary. This technology's evolution and applications cannot be taken for granted since, similarly to the Internet, the blockchain could evolve from a highly decentralized infrastructure into a centralized system (Frolov, 2020; De Filippi, 2018). How this process may affect the participants' rights is to be addressed. The starting point could be the case of private, public, and consortium blockchains, where the rights granted to the participants of those networks may vary according to the structure and finalities of the network. Moreover, blockchain implementations still face several challenges: i) technical aspects (e.g., governance); ii) the development of business models and correlated incentive mechanisms (e.g., scalability); iii) legal aspects (e.g., applicable regulations).

The establishment of global standards is needed in three critical areas: i.e., terminology; architecture; governance (Akgiray, 2019). Regarding terminology, another criticality has to be highlighted. As stressed by Walch (2017b), the vocabulary currently used is notoriously confusing; economic, legal, and technical vocabulary are often used not properly, leading to a series of misunderstanding, as seen in the debate on the nature of smart contracts or the case of economic and legal rights in the case of property rights. As recalled by Berg et al. (2019), the complex interaction between possession and legal ownership is a core part of the “scaffolding” that sustains the market economy. Unfortunately, as stressed by Arrunada (2017), most of the economic literature on the topic ignores this distinction.

Although Allen (2017), Ménard (2017), and Lueck (2017) would disagree, as Arruñada (2017) argues, the law and economics of property is limited by its strong linkage to the single-exchange model developed by Coase (1960), while it is the sequential exchange that clarifies the link between economic and legal property rights. The central problem of property markets lies in the interaction among multiple transactions, which causes exchange-related and non-contractible externalities that public institutions are called to mitigate (Arruñada, 2017). In addition to its focus on single exchanges, the Coasian framework also implicitly focuses on *in personam* rights (contractual rights) rather than *in rem* rights (property rights), dismissing or ignoring the legal structure of the property (Lueck, 2017). Moreover, “by retaining a single-exchange simplification, the economic analysis of property has encouraged views that: overemphasize the initial allocation of property rights, while some form of recurrent allocation is often needed; pay scant attention to legal rights, although these determine enforceability and, therefore, economic value; and overestimate the power of unregulated private ordering, despite its inability to protect third parties” (Arruñada, 2017, p.753).

Without the establishment of standards, the process of adoption may lead to suboptimal achievements. Therefore, as Arruñada (2018) suggests, law and regulatory agencies will be responsible for regulating these new phenomena, assessing the limits that must not be overstepped. Thus, the identified shortcomings (Akgiray, 2019; Gomez et al., 2019) will have to be adequately addressed for a large-scale implementation that can positively affect the “evolution” of institutions like the one of property – e.g., Thomas (2019) consider the blockchain as unsuited for transactions of many high-value or unique assets.

This technology may have already impacted property (Garrod, 2019) since a distinction between tangible and intangible properties can be made (Low and Mik, 2020). Unfortunately, property rights’ universal nature needs a system that does not coincide with the current state of the art of blockchain implementations. Indeed, the exchanges’ legal effects would be limited to the transferring party (Arruñada, 2020). Perhaps, as seen in the land registry case, the blockchain could be a suitable solution where the rule of law and institutions are strong, and a balanced institutional mix can be reached thanks to an institutional assemblage (Frolov, 2020).

Therefore, blockchain can offer a complement, not a substitute (Reinsberg, 2019), for the existing institutional framework around property rights (Allen et al. 2019), since “the blockchain users are more like observing spectators than rightsholders […] while in rem rights require all rightsholders to grant their consent, not only those listed in a paper-based chain of title deeds or in the blockchain” (Arruñada, 2018, p. 20). At the same time, privacy and data issues persist, especially in the case of public blockchains. Though pseudonymity may not constitute total anonymity, systems will have to be developed in compliance with the relevant regulations in place in many practical implementations. Otherwise, it will prove challenging to imagine implementing such technology for public services, considering their role of mitigating externalities and making the rights of the parties involved (and not) respected.

The use of new tools, such as smart contracts, may work for specific business and industries operations, but the problems of identifying ex-ante all the conditions to be set and the possible ex-post sup-optimal results are still problematic. Moreover, the so-called “oracle problem” (Egberts,

2017) – introducing an external third party into the blockchain environment that may not be trustworthy – raises crucial issues regarding the security, privacy, and reliability of data. This last issue is particularly sensitive considering the integration between the blockchain and existing institutions (e.g., land registries). In rem rights, privacy and security issues, role, and finalities of law and regulations still have to find proper technical solutions to be implemented. As Arruñada (2018) argues, the blockchain will probably still rely on intermediaries and state involvement, especially for property transactions. Frolov (2020) goes beyond sustaining that the blockchain will lead to the reconfiguration of the old and the development of new transaction services and value-adding transaction activities, with new intermediaries focusing on creating additional transaction value in new areas and building trust capital. However, it is impossible to form a homogeneous system of blockchain-based institutions associated exclusively with the principles of decentralization, transparency, and openness (Frolov, 2020). It could be possible to explain it by the fact that: (1) the revolutionary potential of governance-by-network as an absolute, horizontal mode of political and social organization is often overstated and unrealistic (Atzori, 2015, p. 30); (2) "decentralization is limited in the real world because individuals tend to misbehave with respect to security […]. [I]ndividual freedom has a price in terms of individual responsibility that not all individuals are always willing to pay" (Arruñada, 2018, p. 24). The legal theory seeks to harmonize and find an appropriate balance between public order and security with private interest (Wright and De Filippi, 2015). The blockchain cannot assure this yet.

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