Authenticating Deeds / Organizing Society: Considerations for Blockchain-based Land Registries

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Abstract. This chapter steps back from specific empirical cases and discusses alternative theoretical lenses that can be used to study if and how blockchain-based registries in Africa will be affecting organizations and society. Those lenses are: Neoinstitutionalism, Structuration theory, and Actor-Network theory. Each of them is adopted to outline aspects of blockchain first, then to highlight specificities in Ghana, finally to suggest research lines. This plurality of theoretical lenses encourages to foster a more nuanced understanding of unconventional contexts of technology in use, thus to derive better recommendations than those based on reductionist frameworks, which often overlook specificities of developing countries.

1. Introduction

For years now the hype surrounding blockchain as a new and more decentralized architecture to facilitate transactions has led people to search for cases of application for this emerging technology. Before thematizing the hype that has been propelling blockchain on the global stage,

it is useful to mention the main novelty that blockchain brings: authentication of uniqueness of data in digital settings or 'native authentication', i.e. without relying on an external/non-digital intermediary. Without this property, it could not be used for digital currency, which, of course, must be unforgeable. Other relevant, and related properties are: decentralization (even if no unique guarantor is often substituted by clusters of miners), immutability (records cannot be deleted), auditability (mathematically provable), and pseudonymity (via key-pair identification), according to Maurer and DuPont (2015).

Specifically regarding land administration, two salient aspects of blockchains motivate the interest for it: immutability of records, which promises to reduce corruption to make land management more responsible, and so-called smart-contracts, which can facilitate transactions involving multiple parties (Griggs et al. 2017)[1]. Since digital innovation has not produced general theories that can direct the development of new technologies in organizations and societies, the innovation process remains idiosyncratic, i.e. based on people trying out things all around the world. Here, we discuss the prospects of blockchain for land registries from different theoretically informed angles. Those theories do not aim at predicting future successes. Rather, they provide distinct lenses to highlight different aspects and prospects of this technology in practice. Those insights may turn out useful for practitioners operating in very diverse settings. Although blockchain has the features of other global technologies like the Web, our aim is to make our views sensitive to the African context and developing economies more broadly.

In developing countries, it is not uncommon to have weak and often inconsistent systems to keep

[1] In a nutshell, blockchains are databases whose integrity is guaranteed by nodes. Their independence limits the possibilities of tampering with the records. More technological details are provided in the **3.1** Blockchain section on p.7.

track of land rights. For instance, customary land ownership may be family or clan based rather than individual, like in Western cadasters and land registers. When disasters strike, legal land registries may be lost, like it happened with the Haiti earthquake that left farmers fighting among each other. De Soto (2000), and international organizations, stress also the lost opportunity due to unregistered land, which cannot be used as collateral to grant people access to financial services. Other positive side effects of consistent land ownership registration have been put forward. For example, in Peru clear registration of land ownership reduced the racketeering that farmers were exposed to in areas where coca leaves were cultivated.

So, what are the gridlocks that obstruct the consolidation of basic tools of land management like land registries? Of course, there is no exhaustive answer to that. What is worth highlighting here is that corruption, vote of exchange, speculation, vested interests all undermine the basic agreements needed to establish a common land registry. In the domain of land registration, the promise that blockchain brings about is that of inherent immutability and transparency of the distributed ledger, which leaves less space for 'manoeuvring'. Before introducing the cornerstones of blockchain as a technology in the **3.1** Blockchain theoretical section (p.7), we are setting the scene of this work starting with the high expectations that surround blockchains.

2. Setting the scene

Why blockchain and why now? Agre (2003) states that the narratives in which new technologies always come wrapped do not explain technologies themselves, but the energy that propels them into societies. Blockchain, like other information technologies, can be considered as a statement of intent towards a target audience, designed to initiate and guide action (Bekkers and Homburg 2007). So, they can be also seen as a myth (Mosco 2004). Myths are tales providing shared

frames of reference that enable individuals, groups and organizations to deal with, or overlook, contradictions that cannot be fully resolved. From this perspective, the legitimation of blockchain applications derives from their persuasive power: whether the allure of blockchain mobilizes necessary resources from decision-makers, investors, developers, users (Miscione 2015). Homburg and Georgiadou (2009) explored how the narrative wrapping and legitimizing of spatial data infrastructures (SDI), a previous wave of technological innovation, travelled from North America to Europe, then to other continents since the 1990s. The kind of analysis they propose is discursive: SDI are conceptualized as a myth, able to organize human action and mobilize resources independently from the hard facts, often claimed to be the foundation of those projects.

The narrative of blockchain technology is recurrent and well-crafted: it originated during a global financial crisis and was built to overcome untrusted intermediaries like states and banks. Its most well-known application, which proved its functionality, has been for Bitcoin, the first and largest crypto-currency to date. Nakamoto (2008), the unknown and mysterious author of the Bitcoin seminal paper, together with others from the same crypto-libertarian circles, gave paramount importance to decentralization to circumvent intermediaries. A provocative paper by Atzori (2015) makes this attitude clear right from his article's title: "Blockchain technology and decentralized governance: Is the state still necessary?" The hype surrounding blockchain systems seemed endless until its peak: the cryptocurrency market capitalized close to 800 billion USD in winter 2017, not counting the initiation of a plethora of projects which explored the application of blockchain technology in domains other than finance. All these prove the forces that a convincing narrative could mobilize.

Bitcoin recently had its ten-year anniversary, establishing it as the first successful, apparently

independent global financial infrastructure. If Bitcoin had not increased in value so dramatically, it is very likely it would have had neither the global outreach nor the security it nowadays has. So, its hyped narrative had material, undeniable effects. One of the keys of its success is the incentive for miners to partake (1) in the distributed authentication process to seal rightful transaction – e.g. avoiding double-spending/forgery – but also (2) in the maintenance of the ledger – e.g. continuing the longest, thus most reliable, chain of transactions. However, Bitcoin's governance problems are undeniable as well. The never-ending conflicts about its block size, with consequences also on the incentives for miners, show the short-sightedness of thinking that such a financial system would organize spontaneously, without requiring governance.

Moving beyond its origin in financial applications and start-ups of all sorts, cryptocurrencies have put blockchains on the agenda of many multinational companies as well as governments and international organizations, which explore potentials of blockchain technology that would not have been tried otherwise. Land registries are one of those cases. So, the hype propelling blockchain is real, not because it predicts if this technology will be successful and for what purposes, but because it has real consequences for people and organizations trying to apply it to the most diverse domains and countries, including land administration in Africa.

Before moving our attention to three distinctive theoretically informed views on blockchain prospects for land registries, it is worth noting the common roots of De Soto's focus on land property and smart-contracts[2] as documented by DuPont (2019). De Soto started influencing the Peruvian economic system from the 80s and 90s, especially establishing land titles, which in turn

[2] Self-enforcing code when defined criteria are met. The term 'contract' is misleading; it rather regards encoded logic, which only in rare cases resembles contracts. Prominent use cases of smart contracts are blockchain-based crowdfunding (Initial Coin Offerings), exchange of values, auctioning, or property rights management.

helped in formalizing the Peruvian black economy, then gave impetus to economic development. Similar approaches were later embraced by international organizations like the International Monetary Fund and pushed to other developing countries. More recently, De Soto himself turned his attention to blockchain for land registration with a project in Georgia. In theory, pairing blockchain architecture with smart-contracts would facilitate a more dynamic economy. On the side of smart-contracts, it is remarkable to note that Szabo, a prominent figure in the crypto-libertarian scene, refers to land registration as prone to being forged if not maintained in a decentralized manner (DuPont 2019). So, the alliance of property rights and decentralized authentications are the cornerstones of his envisioned mode of organizing society.

In this chapter we do not speculate on the possible consequences of these views. The aim is to identify basic principles of and ideas behind blockchain in dialogue with essential characteristics of an empirical context (i.e. land governance in Ghana) through the use of different theoretical lenses. The final aim is then to distil future research directions and questions that are both empirically relevant and theoretically informed.

The structure of this paper reflects its theoretical foci and continues as follows: three theoretical angles are used to shed lights on different prospects of blockchain for land registries in Ghana and countries with comparable land governance in Africa. Those theoretical cornerstones are: Neoinstitutionalism, Structuration Theory, and Actor-Network Theory. After a brief introduction to each theoretical lens, each of them is considered sequentially in relation to: 1) blockchain technology, 2) Ghana's land governance context, 3) prospects for further research.

3. Theoretical angle: Neoinstitutionalism

North (1990) defines institutions as the formal and informal rules that shape social interactions.

In other words, they are akin to the rules of a game. In terms of Neoinstitutional theory, institutions are defined as accepted social models informing human behavior. Institutional theory, compared to Structuration theory or Actor-Network Theory, is less sensitive to action, and emphasizes more the social models that explain and constrain patterns of individual and collective action. Neoinstitutionalism, especially Powell and DiMaggio (1991) introduced the concept of organizational field to draw a boundary around organizations engaged in the same kind of activities (e.g. projects for registering land in our case). Within a field, it is common to observe the phenomena of isomorphism, even when rational choice models would predict differentiation processes based on outcome maximization efforts. Although institutions are often mentioned in research on land registries, actual use of institutional theory is quite rare in a field that is more sensitive to envisioned developments than to persistence, for an example of such work see de Vries, Bennett, and Zevenbergen (2015).

From the cognate domain of SDI, Silva (2007) discusses how institutionalization of technology does not occur by decree. For a case of a land administration system in a Central American country, he highlights and discusses the institutional constraints for roll-out of a spatial information system. His qualitative study describes in detail the diverging approaches of the locals and information system promoters regarding the rationality of institutions, the link between the information system and work tasks, and historical resistance to change in the institutions that regulate land ownership. Prominently from this account, one sees how interorganizational cooperation is not created by an information system, rather it is a condition for the roll-out of the system.

To explain and manage blockchains for land registration in diverse settings like Ghana and other African countries, Neoinstitutional theory has two strengths. First, it can account for a variety of

groups, across which technology use spans. Second, Neoinstitutionalism has a peculiar explanatory capacity for phenomena that happen within an organizational field even when no direct interaction between people in that field takes place. For example, different countries opt for similar modes of land registration under the pressures of imitation rather than independent analyses. Indeed, isomorphism is already detectable to the extent that the idea of using blockchain in land registration was embraced by international organizations, tested in Georgia, and now tried out elsewhere across the same organizational field.

3.1 Blockchain

It is important to highlight some fundamental characteristics of blockchains to figure out how they may relate to land administration in a variety of institutional settings. Peters and Panayi (2015) classify blockchain systems along (1) whether the access to transactions is public (for everyone to see) or private (for selected parties only) and (2) whether validation of transactions is permissionless (any participating party can validate transactions) or permissioned (selected parties validate transactions), as summarized in the following table. The parties are called "nodes" in a blockchain system.

Table 3.1. Classification of Blockchain Types

	Access to Transaction Validation		
Access to Transactions		*Permissioned*	*Permissionless*
	Public	All nodes can read/submit transactions; authorized nodes validate transactions.	All nodes can read, submit, and validate transactions.
	Private	Only authorized nodes can read, submit, and validate transactions.	N/A

Adapted from Peters and Panayi (2015).

Consider Bitcoin, the best known and widely spread blockchain system to date. Bitcoin has been initiated at the same time as the beginning of the 2008 financial crisis as a system sidelining the centralization of power and avoiding external influence, such as corrupted and untrustworthy intermediaries. This is constitutive of its design: relating to the above table, Bitcoin's transactions are publicly accessible, and every party can partake in transaction validation by providing their computational power. From a user's perspective, money transfers via Bitcoin can be faster and cheaper, especially when international payments are considered.

What differentiates blockchain systems from previous systems for land registration is the provision of uniqueness of data (native authentication) without relying on any guarantor who mediate transactions. Technically, the blockchain can reliably keep record of transactions without having to rely on cadasters and/or notary services. Of course, those transactions may not have legal standing, but at the very least they can mathematically prove each transaction that occurred. So, blockchain systems rely on decentralization (no unique guarantor), immutability (records cannot be tampered nor deleted), auditability (mathematically provable), and pseudonymity (via key-pair identification) (Maurer and DuPont 2015). It is important to stress that blockchains themselves do not guarantee land data quality, which depends on who enters them, but only data immutability. Nonetheless, the persistence of data may act as a deterrent from entering false data because fraudulent entries can be traced back and not deleted.

From an institutional perspective, land management through a blockchain system is peculiar for many reasons. For one, the intermediary's function is thereby substituted by distributed consensus maintenance (mining), introducing rivalry in digital settings (Miscione et al. 2018)

(Ziolkowski, Miscione, and Schwabe 2018): Validating parties thereby compete for a reward in finding the next block by solving a complex mathematical puzzle, which is labelled as the consensus algorithm. In short, Bitcoin's immutability rests on computational power: as long as 51% of the hashing capacity[3] remains honest (complies with the code), the system continues to work as expected. The quantity of computational power devoted to the consensus algorithm and its related rewarding scheme, hence, correlates with system security.

For two, considering Bitcoin again, the rules for the system to work were formulated and enacted early on by its initiator (Nakamoto 2008). While changes to the system are possible, with varying impact levels (soft- vs. hard forks), every change requires consensus among the majority of nodes and parties. More than with free and opensource software (FOSS), every change of a software's functionality may leave those who favored the previous version behind (no backward compatibility). Something similar happened to Bitcoin and also to other blockchain systems. The history of disagreement (ending up in forks) within the Bitcoin community is well-documented (De Filippi and Loveluck 2016). Forks have endangered a system which capitalizes hundreds of billions USD at its peak (Campbell-Verduyn 2017), and show to researchers and practitioners the consequences of the collision of incompatible social models and values hard-coded into IT.

3.2 Specificities in Ghana: Institutional plurality and the plurality of documentation

As in many African countries, land governance in Ghana is characterized by fluid boundaries between formal and informal institutions (Benjaminsen and Lund 2002), (Hydén 2006), (de

[3] Sum of computational power of all validating nodes at a given time. Solving the mathematical puzzle relies on searching for the right 'hash'. This process is hereby referred to as 'hashing'.

Herdt 2015), (de Sardan 2015) and a plurality of norms and laws that govern land access, uses and transfers. The Land Administration Project of the World Bank (2003-2008) consolidated various organizations under the Lands Commission (LC) and created the Customary Land Secretariats (CLS) with the aim "to help customary authorities to improve and develop customary land administration" (Arko-Adjei 2011), p. 81). The LC holds the mandate to register land rights and maintain land tenure records as per statutory law. The customary sector includes the chieftaincy institution, namely the "stool" chieftaincy in the south and the "skin" chieftaincy in the north, the latter being accompanied in customary offices by earth priests in some northern regions (Lund 2008). Many of the statutory laws concerning land rights and associated administrative agencies originated in the time of Ghana's independence. The overall move towards formalization of land administration across various types of land sectors (Oberdorf 2017) plays a role in defining the institutional landscape around land rights documentation; and various types of institutions and associations may vie for recognition as public authorities. In so far, we can speak of a kind of isomorphism that follows the insignia of the state, an isomorphism where formal norms (de Sardan 2015) carry across different organizations and associations of actors and practices. At the same time, the "plurality of institutions produces … ambiguous practical meanings of law and property" (Lund 2008), p. 6). Procedures and practices of land rights registration are not uniform across the country, but involve different actors and different proofs of evidence in the chain of validation that lead to an eventual registration, mostly of leasehold titles, with the Lands Commission (Abubakari, Richter, and Zevenbergen 2018). In sum, despite isomorphic trends towards formalization and uniformization of registration processes, the institutional plurality and local politics over land produce a plurality also in methods to establish what counts as evidence for land claims with (contesting) oral knowledge

and witness accounts playing an important role in land claim making processes (Berry 2001). In conclusion, even if the original values of blockchain and Ghana land registrations are unrelated, they might still converge in as far as the lack of a unique intermediary authority can be circumvented by an inalterable record of transactions which can allow unrelated parties to trade.

3.3 Theoretical highlights and possible research questions

Institutional theory in any of its variations considers especially the legitimate social models, thus the socially accepted courses of action that people have in front of them when dealing with the many aspects of land management and use. As it is strikingly clear from the previous two sections, blockchain mode of organizing and land registration in Ghana show little to no overlapping. However, two considerations may avoid discouragement: firstly, the origins of technology do not exhaustively predict where it ends up. The internet was invented to reduce the consequences of a Soviet nuclear attack on the US (Abbate 2000) and ended being used to share pictures of cats and vacations. Secondly, even if the institutional logics remained different, there is no reason to exclude a priori that different logics could coexist side by side. For example, even if nuclear power came from military purposes, and is still managed in a highly hierarchical way, it serves civilian purposes no less.

So, we should not get carried away by an overemphasis on decentralized vs. centralized registrations and different courses of actions that Institutionalism highlights. The assessment of blockchain for land management should not be based on the fit between blockchain consensus and “statutory institutions” or “customary institutions.” Rather, what is likely to happen is that different systems (paper based, oral, blockchain-signed…) will be interplaying with each other. Institutional theory invites to transcend the idiosyncrasies of individuals and consider social

models to manage these interplays. With these points in mind, institutional theory can prompt further action and research on blockchain and land registries by focusing on these central concepts: immutability, auditability, incentive scheme, legal system vs. 'code is law'.

Immutability over long periods of time is obviously central for any reliable land registry. Uncertain longevity of records undermines their validity from their inception. Immutability is also the core of blockchain technology, which relies on it to diminish the influence of third parties. Thus, to the extend third parties are a threat to records (corrupted officials, speculation…), blockchain and land registries can converge in practice. Still, the actual longevity of decentralized authenticated tokens[4] over decades has to be proved. Also, their legal standing in courts awaits for confirmation.

Accordingly, research questions could be: Which land management practices would embrace or avoid blockchain-based registries; and for what reasons? Then, which existing authorities would gain or lose from the progressive introduction of those records? Finally, would the institutional landscape in Ghana see an increase or decrease of competing land registration practices?

Partly descending from immutability, auditability (allowing reading rights to non-validating parties, e. g. not-mining users) holds some promise of streamlining land management because it makes easier to check who did what and when.

Moving to the more technical aspects of blockchain, an innovation that proved viable at scale is its incentive scheme that keeps actors compliant with a consensus algorithm set up a priori. Ideally, this makes it conceivable to move away from current cost recovery strategies (fees, general taxation, etc.) and hard-code the incentives into the blockchain ledger itself. How to do

[4] A digital, intangible, unique representation of *something* such as a cryptocurrency. Native to a blockchain system.

that, would be a design research question with specific answers in specific contexts.

Lastly, institutionalism considers the legal system as one of the regulatory forces that shape organizations. Famously, Lessig (1999) stated that ‘code is law’. Therefore, code, especially if paired with suitable incentive systems, can help to enforce law or, alternatively, to consolidate the legal system in Ghana or elsewhere. More on this line of thinking is at the end of the next section.

Empirically, Institutionalism invites to collect data where different social models encounter. An obvious starting point for such inquiry is the existing registration procedures. Another one is in statutory and/or customary courts, where disputes are to be settled. Also, the definition of the consensus algorithm should not be overlooked when studying land registration, because its regulatory function is likely to be far reaching, due to the immutability it enforces.

Institutional approaches have been criticized for treating people as ‘cultural dopes’ (i.e. defined by their circumstances). So, beside the prospects presented so far, it is useful to consider other theoretical angles that help where Institutionalism runs the risk of downplaying human agency.

4. Theoretical angle: Structuration Theory

Orlikowski (2000) is usually associated with the translation of Structuration theory into information system research (see also Orlikowski and Barley (2001). This stance, which moves the traditional dichotomy between structures and agencies to an analytical (rather than empirical) level, can help in understanding if and how a land management system reproduces existing structures by facilitating established courses of action, or, reversely, if and how new patterns of action become possible. Conceptualizing technology in use as a process of enactment opens up a

better understanding of how practices change technology through its adoption.

Puri (2006), relying on Orlikowski and Gash (1994), concept of technological frames as sense-making devices, puts stakeholders' frames at the center of attention. Puri argues that an overemphasis on technological and economic resources tends to overlook organizational and institutional dimensions. With the intention of accounting for the relation between structures and agencies, the case of the Indian National SDI is depicted through the variety of stakeholders' perspectives, with a specific emphasis on the implementation side. The account provides a rich picture of how SDI is socially constructed, also in cases of failure. For example, he reports an excerpt of the design/reality gap from an interview with a public officer and SDI expected user:

> *We have no idea what NSDI is all about! No one has consulted us. Probably, like in the past, they [scientific institutions concerned] would design something inappropriate to our needs, and then we would be asked to use it effectively. This has been going on. I am not sure how large volumes would be accessible online given the rather poor status of data communication infrastructure outside metros. (Puri 2006)*

Structuration theory is a relevant lens to look at blockchain and land registries, because it allows to see how social structures are reproduced, and how they may harmonize or clash when they enter in interplay with new land registries. Symmetrically, this theoretical stance is sensitive to how agencies may change social structures.

4.1 Blockchain

Bitcoin served as a glaring example of the risks blockchain systems would face without functioning governance modes, at least when the need arises. For instance, never-ending

conflicts about block size made evident that technical consensus about transactions does not suffice to regulate the whole network. Organizational consensus is necessary to avoid forks when disputes cannot be reconciled. A first attempt to formalize organizational consensus 'on-chain' has been carried out by TheDAO (DuPont 2017). A DAO (decentralized autonomous organization) aims to predefine its operation in code, thus, code becomes the equivalent of law, allegedly. TheDAO, while generating a great deal of enthusiasm and mobilizing hundreds of millions USD in funding, became a victim of its own code-is-law dogma when an alleged hacker stole part of its funds through a bug in TheDAO software (Siegel 2016). The TheDAO community found itself in a dilemma: preserving the dogma of immutability, hence losing the funds in question, or creating a precedent by reversing the transaction, thus breaking the dogma of immutability. After heated debates, the TheDAO community, also influenced by the leading figure Vitalik Buterin, opted for the latter, forking the underlying Ethereum blockchain while leaving the dissidents continue running the original chain, which is currently called Ethereum Classic.

From an agent-structure perspective, 'code is law' entails agent's adherence to whatever outcome is predefined by the code, which keeps the interplay between the agent and structure constricted; the agent's influence on the structure, hence, is supposed to end after the design and development phase. As it became apparent to Bitcoin and even more with TheDAO, this line of thinking (which assumes the possibility of complete/self-contained contracts) cannot handle unforeseen circumstances. Thus, there must be a means for rules to change the rules, as one cannot anticipate the unknown. 'Code is law', hence, can turn into 'Code is Constitution', i.e. rules to change the rules. And, in fact, this is what happened in more recent developments: in the time that followed, on-chain governance gained in importance with large, and heavily-funded

projects such as Tezos (Crunchbase 2019), Aragon (Cuende 2017), D-finity (Crunchbase 2019). These aim to preserve the benefits of immutability while allowing for changes to the system upon consensus; and by that, facilitating the interplay between agents and structures in front of unknown circumstances.

4.2 Specificities in Ghana: structures of opportunity and strategic documentation

At a simplified level, the diverse geography of land documentation and recordation in Ghana derives from the dynamic tension between two forces: the force towards an ideal Weberian type state structure to govern Ghana, on one hand, and the forces of decentralization and fragmentation driven by the "politico-legal institutions that compete for political authority [and which] operate to legitimize their undertakings partly through territorial strategies" (Lund 2013), p. 16). This dynamic gives rise not only to legal stipulations for the registration of land rights to be implemented variously across the country (Abubakari, Richter, and Zevenbergen 2018), but also provides what Lund (2008), p. 4) calls "structures of opportunity for the negotiation of rights and distribution of resources." For example, in decision making over land uses and transfers individuals and groups of agents may act as what Moore (2000) refers to as semiautonomous fields drawing on different rationales to legitimize claims to land. The choices and decisions to document land claims as a land right (of whichever nature this may be) is contingent upon the anticipated effects of documentation on social and economic positions of individuals and groups. Berry's work (2001) in the southern Asante region of Ghana, for instance, illustrates that claims to land are made and legitimized through processes of re-narration and revisions of constructed histories of people-land relations. Thus, while land itself may form the immutable entity that provides family or clan lineages' identities through time, the

documentation of land may be used to break with, reshuffle or comply with customary social structures depending on circumstance, need and aims. The overall outcome then of a given process of negotiation and contestation may be likened to the consensus building in Blockchain systems in so far as there is no central node with final verification and legitimation power. However, in Ghana this production of records does not run according to programmable, mathematical rules, but entails political contestations and differs according to problem context. Neither is law law, nor is code law. What is strategically and politically deployed is the "mutability of records."

4.3 Theoretical highlights and possible research questions

Also in this case, a common theoretical angle does not hide the wide differences of structuration processes in relation to blockchain on the one hand, and Ghanaian land registries on the other. Nonetheless, some common central concepts can again help us in action and research: the shift from 'code is law' to 'code is constitution' is a salient one. Since algorithms – it does not matter how sophisticated – do not always achieve to put on track the unpredictable future, consensus building has to move one level down: rather than rules (i.e. structures) to regulate people (i.e. agents), the consensus needs to be about how to change rules when the need arises. The clear analogy here is to constitutional laws that regulate how laws can be changed. This can be seen as the product of tensions between structures and agencies. Indeed, since agencies and structures cannot be always reconciled, the need to have a higher level of appeal may arise.

In relation to land registries in Ghana, this theoretical angle highlights the misalignment and frictions between rules and actors. When operationalizing Structuration theory into a concrete research design, it can be useful to keep in mind that rules/actors does not necessarily correspond

to algorithms/people. Rules can be humans and actors can be software agents, especially in the context of on-chain governance, which intends to enable DAOs.[5]

Another recommendation for further action and research about blockchain and governance is to consider that, contrary to previous IT architectures, blockchain are relatively inflexible because of their promise to guarantee immutability. Therefore, consortia designing and developing blockchain based land registries have to agree quite precisely on details of how their registry is going to work early on in the process. Later changes risk to undermine the credibility of the whole record, or at least to generate inconsistencies (Ziolkowski, Miscione, and Schwabe 2018).

Finally, an interesting terrain for practitioners and researchers is to figure out if and how it is possible to design incentive schemes that make this distributed ledger scalable and self-sustainable. Indeed, making the unknowns known would certainly help in figuring out how to balance what goes into the code and what remains matter of people's discretion.

Possible research questions are: if the overall scene is one of validation of evidence as instrument in politics, how would blockchains play out in this context? Whose agency would they support in Ghana? What new structures would they create or which structures would they legitimize?

Despite its strengths, Structuration Theory tends to be weak in accounting for difference and radical transformations, as both of them are not necessarily produced by incremental change. The last section on Actor-Network Theory may help in that direction.

[5] In principle, land governance actors in Ghana could be receptive to Blockchain conceived of as another form of database to legitimize something existing (e.g. statutory or a chieftaincy's), but they would be reluctant regarding the immutability trait of blockchain. Quite likely, they would seek to build in what happened in TheDAO's case: rules to change the rules. Then, the question is: what form would such constitution take in an instance of implementation in Ghana? Would it embed practical norms implicitly? Who be the author of such blockchain constitution?

5. Theoretical angle: Emphasis on actors and objects

Related to the direct and indirect influence of actor-network theory (ANT), actors, artefacts and objects have been coming to the foreground in a number of disciplines. The concept of boundary object was first introduced by Star and Griesemer (1989) to explain the case of the foundation of a museum, which was possible, because different stakeholders did not need to negotiate a common understanding about the museum, nor common goals. Rather, it was enough for each of them to act according to their own social world; the boundary object was, at the same time, the product of those actions and the mediator across them. The basic idea of boundary objects has been developed and specified in several directions: for instance, intermediary objects (Boujut and Blanco 2003) and boundary negotiating artefacts (Lee 2007) emphasize different stages of evolution of a boundary object during product development. Bechky (2003) relates boundary objects with the boundary between professional belonging and status.

Harvey and Chrisman (1998) introduced the concept of boundary object in the geographic community by arguing how geographic information systems (GIS) act as boundary objects through mediating between different groups who do not share common understandings. Through a microscale study on GIS and wetlands, they show how it worked despite 'wetland' having different meanings for different actors: "The agreement is only paper-thin. The boundary object serves to solve jurisdictional and administrative battles while it conceals continued geographic ambiguity" Harvey and Chrisman (1998). Harvey (2006) discusses the necessarily elastic relation between the cadaster and land tenure in Poland. Local practices, also inherited over generations, have to find working accommodations to relate to Polish state and European Union regulations. Hence, this information infrastructure is tense between diverging civil and political

interests. So, it acts as a historically grounded boundary object.

This kind of objects are a suitable sense-making device to approach land registries and blockchain when the points of convergence between stakeholders are a determinant aspect to account for. For instance, when a land registry spans across areas regulated by different property regimes, conceptualizing a registry as a boundary object highlights how commonalities and differences converge on a possible solution.

5.1 Blockchain

Many of the public and permissionless blockchains (Bitcoin included) have publicly available source code, free for everyone to fork and to set up one's own blockchain. This is similar to FOSS projects such as Linux or Firefox, whose mode of governance has been labeled 'bazaar' by Raymond (1999) and Demil and Lecocq (2006): this mode of governance is characterized by openness and fairness, and an open license contract of the object in question. Further, there are fairly limited ways to exercise control over actors (to use a particular version of software), and an actors' motivation to contribute with new code is rather low unless reputation is pivotal. According to Miscione et al. (2018), blockchains differ from FOSS in many ways: blockchains bring rivalry among actors, e.g. a token always belongs to one entity at a time; their value is rooted in their uniqueness. Having conflicting versions of token ownership would undermine the ledger's integrity and by that affect the token's value. Forks are undesirable, because users of a blockchain have a mutually dependent interest in the integrity of data, which, in contrast to the 'bazaar', leads to a stronger common interest. What's more, if a majority of actors running a particular blockchain instantiation changes its consensus mechanisms, this change can be enforced on other users, which is not a feature of FOSS.

Comparing FOSS and blockchain systems with an emphasis on artefacts offers two perspectives. FOSS can certainly be seen as a boundary object, where communities of actors with widely diverging interests contribute a variety of solutions; however, there is common ground with every release, patch, or update of a software. The elasticity of FOSS is well exemplified in one's low switching costs from one version to another, so an arbitrary version (even a self-programmed version) of software can be instantiated upon one's liking. Does the same apply for blockchain systems? Even if a blockchain system can be seen as the result of a sense-making process across different actors or groups, likely with diverging interests, the elasticity of a blockchain system is far more constrained: blockchain systems are defined by the consensus protocol, which determines everyone's mode of participation.

5.2 Specificities in Ghana: land rights documents and fees as boundary objects

Within the context of land governance, land itself forms an important boundary object, across which different communities and institutions associate and disassociate (not seldom violently). While land creates boundaries through various modes of exclusion, it also forms the object around which "webs of interests" develop and sustain (see e.g. (Meinzen-Dick and Mwangi 2009) through a variety of uses with corresponding bundles of land rights (Davy 2018). Within this context, technologies to support or change processes of land documentation and recordation also function as boundary objects. The socio-technological assemblages include not only the survey equipment of certified land surveyors or the GPS enabled mobile phones of "fit-for-purpose mappers" (Lengoiboni, Richter, and Zevenbergen 2019), but also the digital data, the land rights documents that are being printed and issued to landholders as well as the associated fees for various signatures and stamps on a series of documents that come to verify a land claim

or transaction. The associations of actors that emerge through time may stabilize into larger actors that endow the process with legitimacy and at the same time bind together people, who previously held different meanings regarding land, property and documents themselves. For example, in the process of leasehold registration, we see that the technologies and templates for formal recording of the Lands Commission (LC) form boundary objects that negotiate with LC external processes and actors. In this meeting meanings and norms of the bureaucratic arena become adjusted in response to social norms and administration external actors, which in turn also change. What emerges is a space of "practical norms" that can be quite literally visited and observed at the encounters between registrants, intermediaries, and officials in front of the Customer Service Access Units of the LC (Abubakari, Richter, and Zevenbergen 2018). Fees paid for a variety of intermediary documents, services and signatures constitute an important, if not constitutive, element in the creation of such networks across differing institutional contexts. Meridia, a for-profit organization that recently entered the market of land rights documentation in Ghana, actually flipped the logic in so far as it created different "documentation packages" according to the actors that need to be involved given the institutional scene that they encountered (Salifu 2018). The latter in turn shape the content and format of a given type of documentation package, and the fees associated with various signatories create the glue in the emergence of action nets.

The examples above indicate that Ghana's context of institutional plurality is likely to give space to a new system; and it is imaginable that blockchain proponents alongside their technology may come to act as boundary objects in the emergence of new actor networks with their own normative frameworks and new shared meanings of land, property and related recording technology. However, in so far as such endeavors would succeed amidst the contestations over

legitimacy, the question as to whose claims are valid for entering on the blockchain's own sphere of "code as law" and, as recent controversies over block sizes have shown, "lawlessness of code," remains open. As such, it is as much a question of data governance as it is of land governance.

5.3 Theoretical highlights and possible research questions

Land rights documents in Ghana, generally speaking, played at least two important roles that evidence their value as boundary objects. First, for the purpose of enrolment of communities, initiatives to map land rights are able to attract interest especially in communities, where demand for (some kind of) land rights documents exists, e.g. as part of specific development projects, such as service provision, see for instance Lengoiboni, Richter, and Zevenbergen (2019). Second, the production of documents and decisions on their form and content enroll further actors, for example customary authorities, who sign in return for negotiated fees, and statutory actors to sanction the content of the documents. This kind of multi-party relation is well-exemplified by Meridia's initiative. In this case partially overlapping actor networks emerge in conjunction with the development of a whole set of so called "documentation packages" for different purposes and regions (Salifu 2018).

Actors entering the land governance scene of Ghana, often recognize the central role that the maintenance of digital land rights data plays in becoming "inevitable partners" (Oberdorf 2017). In this sense, analogue or digital documents, play a similar function as both boundary objects, but also as devices in the processes of interessment, enrolment and mobilization (Callon 1986). In a study on blockchain implementation in Ghana by BitLand and Benben, Oberdorf (2017) observed that "although not the core of the functioning of the Blockchain, the process of

digitization repeatedly returned in the interviews with the companies and public actors" (p. 44) indicating both the hopes that blockchain can make documents in their digital form indisputable as well as searchable, and indicating the greatest perceived risks: the moment of entry of a document into the database and who should be the "single party" to add the initial data (Oberdorf 2017). So, data quality and immutability are properties that offer affordance for blockchains acting as boundary objects across traditional and statutory regulations. Moving to more empirical entry points and question, what an emphasis of artefacts suggest to ask is, if and how blockchain is actually used in Ghana, for what functions exactly and at what scale; and what actors and associated normative frameworks become enrolled in the process? How is it different from what we see elsewhere, and why, for instance what specific forms and uses of blockchain may function as boundary objects and what changes in meaning would we see then at the cross-roads of different normative frameworks in land governance? If stabilizing into actor networks, how would these new patterns of action interplay over legitimacy with others; and to what outcome?

Table 5.1. Overview on applied theoretical lenses, blockchain technology, specificities in Ghana, and theoretical highlights

Theoretical angle	**Blockchain**	**Specificities in Ghana**	**Theoretical highlights and possible research questions**
Institutionalism: commonly accepted social models shape courses of action and legitimize them Neoinstitutionalism: the institutional field (comprising actors engaged in the same kind of activity) tends towards isomorphism	Originally, the distributed consensus that is at the foundation of blockchain as an architecture was intended to avoid existing social models and organizations. Algorithmically certified consensus, sealed by miners, substitutes other norms and modes of regulation. BC ensures honesty in the narrow sense of compliance with the incentive scheme.	Plurality of institutions entail differentiated processes and procedures for recording and non-recording of land rights and transfers. Isomorphism is evident especially in processes of formalization of land governance institutions.	Highlight: theory invites to transcend the idiosyncrasies of individuals and consider social models to explain and manage the interplays of different systems (paper, oral, BC-signed, etc.) Questions:: - where do/would different institutions encounter the registration court cases later on, in the definition of the consensus algorithm? Which existing authorities would gain or lose from the progressive introduction of those records; and would the institutional landscape see an

			increase or decrease of competing land registration practices? Design research question: How to do move from current cost recovery strategies (fees, general taxation, etc.) and hard-code the incentives into the blockchain ledger itself ? Theoretical pre-caution: avoid treating people as 'cultural dopes' (i.e. defined by their circumstances).

Structuration: agents and structures are in constant interplay and tend to align over time.	Most BCers, and the sector as a whole, have realized that a too inflexible system does not work well when adjustments are needed due to unforeseeable circumstances (e.g. BTC size, DAO...) On-chain governance (rules to change the rules / "Code is constitution") may fit better the constant interplay between agents and structures	Administrative structures provide opportunities for strategic documentation practices and over time the emergence of "practical norms" at the interface of social and bureaucratic norms.	Highlight: theory highlights the misalignment and frictions between rules and actors. Questions: Are consortia adopting or at least considering on-chain governance? If so, how concretely and for what? Whose agency would BC based registries support in Ghana; and what new structures would they create or which structures would they legitimize? What is kept out of agents' reach (in fixed structures)? Design research questions: If and how it is possible to design incentive schemes that make a

			distributed ledger scalable and self-sustainable. How to agree quite precisely on details of the registry's functioning early on in the process to avoid later changes to undermine the credibility of the whole record? Theoretical pre-caution: keep in mind that rules/actors does not necessarily correspond to algorithms/people.

ANT/objects/sociomateriality: emphasis on how human and non-human actors perform together. The distinction is not explanatory, better to focus on what those 'actants' do and cannot be done otherwise	BC generated its own form of sociality that is not captured by Bazaar, etc.	Land right documents (on paper and digital data) and related technologies function as boundary objects across initiatives to document land rights and associating actors from different institutional settings creating ANTs tied into a "fee economy" that surrounds documents.	Highlight: approach shifts emphasis on artefacts and how they negotiate the boundaries between different norms, meanings, and methods. Questions (also for design research): If and how blockchain is actually used in Ghana, for what functions exactly and at what scale; and what actors and associated normative frameworks become enrolled in the process? How is it different from what we see elsewhere, and why, for instance what specific forms and uses of blockchain may function as boundary objects and what changes in meaning would we see then at the cross-roads of different normative frameworks in land governance? If stabilizing into actor

			networks, how would new patterns of action interplay with others; and to what outcome, e.g. legitimacy gains/losses? Theoretical precaution: avoid overemphasizing the possibilities of 'becoming' and downplaying the constraints people and organizations live by?

6. Conclusions

Henssen (2010) outlines a set of generic legal principles underlying reliable land registration systems, namely the booking or register principle, the consent principle, the principle of publicity, and the principle of speciality. These principles also inform recent discussions and research on the potentials of blockchain based land registries (e.g. Vos (2016); Griggs et al. (2017). Since only the principle of publicity interplays directly with blockchain, one may hurriedly conclude that land registration and blockchains are unrelated. Any of the three theorical stances discussed above helps in avoiding such a shortcut. Technology and its encounter with practices cannot be deduced from principles without well-documented risks of gross reductionism. So, empirical work cannot be supplanted by logical reasoning, but fostered by a suitable theoretical angle. The same applies to predictions of how the three main cadastral processes – e.g. adjudication of land rights, land transfer and subdivision/consolidation (Zevenbergen 2002) – would be affected by blockchain. For example, to be considered as legally binding, transactions must take place in an unambiguously identifiable manner. Pseudonymity of blockchains may rule this out. We claim that unintended consequences are important, for example traceability of pseudonyms may have side effects, thus are worth proper consideration. Still, it is important to bear in mind that blockchain does not validate data quality (from traders, surveyors, notaries, etc.) but only its immutability. Data quality is beyond blockchain, which has no native connection to real world assets. Rather, it crystalizes the ‘garbage in, garbage out’... Its only effect can be deterrence: people may think twice before entering wrong data, because they are traceable as never before.

Looking at the dictionary, ‘deed’ has two quite distinct meanings: “something that is done, performed, or accomplished; an act” and, in the vocabulary of law it is "a writing or document

executed under seal and delivered to effect a conveyance, especially of real estate." These two meanings of 'deed' get exceptionally closer in the context of blockchain for land registries in Ghana, where statuary regulation is minoritarian and both customary regulation and blockchain derive their authority of authenticating from continued performance (or tribal ties and mining, respectively) rather than legal principles.

Some have tried to outline the state of the art in relation to land property and blockchain (for example Graglia and Mellon (2018) and Vos (2016). The challenges in front of practice and research are remarkable, and impossible to list here. So, we limit ourselves to the key issues:

- Relevance of transparency and immutability in low trust settings
- Longevity of records
- Cross-jurisdictional issues
- Disjunction between quality of data entry and immutability
- Role of state authorities in data quality and legal standing
- Prospects for multi-chain records to leverage different properties of different chains
- Effects of increased visibility of records on bureaucratic functioning (role or auditors and civil society.

While it is certainly possible that some of the expectations from blockchain for land management are tall tales (Bennett, Pickering, and Sargent 2019), we think that the three theoretical angles discussed above offer a toolkit to approach challenges of research and practice of land registries and blockchain. None of them is exhaustive, none of them can provide an ultimate guide to action and research in this domain. However, those quite distinctive theoretical views promise to account for the challenges and prospects of designing and implementing blockchain-based land registries in Ghana and beyond, especially where no one single regulatory regime is dominant.

Even though early stages of this application domain prevented us from relying on sound empirical materials, existing studies (Pelizza and Kuhlmann 2017, Ziolkowski, Miscione, and Schwabe 2018, Ziolkowski et al. 2018) and our initial explorations made apparent that, while blockchains strove to substitute human discretion with algorithmic authentication, humans and blockchains are more likely to re-adjust the division of labor. The outcomes of those adjustments may have far reaching consequences in terms of 'smart' land management, to the extend the rigidities of 'code is law' allow for automations that would be impossible otherwise. On the side of 'responsible' land management, technology by itself has little ethical agency. Nonetheless, the functioning of blockchains and distributed and transparent mode of authentication hold the promise of a greater accountability even thou, it has to be stressed, the lack of authorities in charge may turn up sour when problems arise.

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