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DOI
10.1145/3209281.3209321

Publication date
2018

Document Version
Final published version

Published in
Proceedings of the 19th Annual International Conference on Digital Government Research

The governance of blockchain systems from an institutional perspective, a matter of trust or control?

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ABSTRACT

Blockchain Technology is considered as a general-purpose technology with far reaching effects. As can be seen from the discussions on blockchain applications, both practitioners and researchers struggle to get to the core of blockchain technology consequences. Especially practitioners in the governmental sector explore adequate responses to this new technology. Therefore, our aim is to provide a conceptualization of the consequences of blockchain systems from an institutional perspective, and to use this conceptualization to provide insights into the governance *of* blockchain systems.

We use a Grounded Theory approach to conceptualize the institutional consequences of blockchain technology. This approach leads to our core category: power transfer in environments with highly institutionalized values.

This core category supports the synthetization of the governance issues related to blockchain systems. We conclude that the controlling powers that were formerly vested in highly institutionalized organizations (such as governments and regulators) and institutions (such as legal frameworks and agreements), are no longer automatically part of the governing ecosystem in blockchain systems but are engrained into the technical system itself. Thus, Blockchain technology enables the technological institutionalization of values in environments that are highly dependent on these values. We believe that this is at the core of why existing institutions are being pressured by blockchain technology, and as such increase the difficulty for governments to effectively govern blockchain systems.

Using this notion, public and private parties within the blockchain ecosystems can develop regulatory arrangements and strategies that strike a balance between fostering the innovative power and possibilities that blockchain applications offer and to mitigate possible negative effects of blockchain technology.

CCS CONCEPTS

• **Applied computing → IT governance**; **Computing in government**; **E-government**; *Economics*;

KEYWORDS

Blockchain Technology, Institutions, Trust, Control, Governance

ACM Reference Format:
David Meijer and Jolien Ubacht. 2018. The governance of blockchain systems from an institutional perspective, a matter of trust or control?. In *dg.o '18: dg.o 2018: Proceedings of the 19th Annual International Conference on Digital Government Research, May 30-June 1, 2018, Delft, Netherlands,* Anneke Zuiderwijk and Charles C. Hinnant (Eds.). ACM, New York, NY, USA, Article 4, 9 pages. https://doi.org/10.1145/3209281.3209321

1 INTRODUCTION

Blockchain Technology, the database technology most well-known for the BitCoin implementation [27], has attracted the interest of actors throughout sectors, organizations and society. Blockchain Technology is currently seen as one of the most important trends to watch by Harvard Business Review [28] and one of the 10 strategy trends in technology for 2017 by Gartner [31]. However, scientific literature on Blockchain Technology is still scarce. In a literature review of academic blockchain publications, Yli-Huumo, Ko, Choi, Park and Smolander [84] conclude that most literature is still focused on BitCoin implementations and the technical challenges of implementing blockchain technology. They call for research on "the possibilities of using Blockchain in other [than BitCoin and Cryptocurrency] environments" (p.21).

Thus, scientific analyses of blockchain technology from an economic, non-technical perspective is limited. In one of the few papers on this topic, Davidson, De Filippi and Potts [22] argue that one can take two perspectives on the economic effects of blockchain technology. First, a Neo-Classical Economics (NCE) perspective, in which blockchain can be seen as "a new general purpose technology [that] puts them in the same class of technological trajectories [68] as for instance electricity, transistors, computers, the internet, mobile phones, and so on [64]" (p.2). However, they argue that blockchain technology is more than that, and should be seen from a New Institutional Economics perspective, as blockchain technology can not only lower production costs (NCE), such as increasing efficiencies and decreasing risks, but also lower transaction costs (NIE). Davidson, De Filippi and Potts [22] argue that blockchain technology is "better understood as a revolutionary new institutional technology for economic coordination" (p.2) and thus, that blockchain is "an institutional technology of governance that competes with other economic institutions of capitalism, namely firms, markets, networks, and even governments"(p.1). MacDonald, Allen and Potts [52] use a similar argument to argue that "blockchains compete with banks as organizations, enabling banking transactions to shift out of centralized hierarchical organizations and back

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dg.o '18, May 30-June 1, 2018, Delft, Netherlands

ACM ISBN 978-1-4503-6526-0/18/05...$15.00
https://doi.org/10.1145/3209281.3209321

into decentralized markets" (p.1). In this paper, we follow this argumentation, and analyze the rise of blockchain systems from a NIE perspective, an approach that is often not taken in practice as most publications by corporates on blockchain technology take a perspective that focuses on efficiency gains in the sense of NCE [e.g. 9, 10]. In both academic and corporate publications analyses of the institutional consequences of blockchains remain scarce so far.

Furthermore, with the high number of actors involved in these discussions, such as governments, corporates, new entrants and software developers, and the high technological complexities of blockchain technology, blockchain has become a complex multi-actor socio-technical system [66]. This leads to high uncertainties from which an unstructured discussion on the institutional consequences of blockchain technology has emerged. Both practitioners and researchers struggle to get to the core of the institutional consequences of blockchain technology and the current empirical discussions seem to suggest that current existing institutional structures are under pressure by the emergence of this technology that transcends national borders. Due to this struggle, the institutional consequences of blockchain systems are often misunderstood, misinterpreted or even ignored by public and private organizations. Therefore, the aim of this research paper is twofold:

(1) to provide a theoretical conceptualization of blockchain technology consequences from an institutional perspective,
(2) to use this conceptualization to provide insights into the changing institutional arrangements and governance of blockchain systems

Our conceptualization of the institutional consequences of blockchain technology is based on blockchain implementations across all sectors (including governments). As such it provides insights for both the governance *of* blockchain systems as well as governance *by* blockchain systems, i.e. governments using blockchain applications in the domain of e-government applications [61]. However, the remainder of this paper is focused on governments and their response and role in the governance *of* blockchains systems.
In this research, blockchain technology is defined as: *Blockchain technology is a distributed, shared, encrypted, chronological, irreversible and incorruptible database and computing system (public/private) with a consensus mechanism (permissioned/ permissionless), that adds value by enabling direct interactions between users.* [1]

In practice, blockchain is best understood by understanding "Trusted Third Parties". Trusted Third Parties are parties, like a notary during the transaction of a house, that enable transactions between two counterparties, by ensuring that the transaction goes as expected. The notary makes sure that the seller receives money and the buyer receives the house, at the same time. Blockchain Technology does exactly the same thing, but it decentralizes the notaries' responsibility over all users of the network (referred to as nodes in the network). All users validate whether transactions can be approved or not, thereby creating a network of users that keeps a decentralized ledger of transactions (for example house ownership) up to date. This validation is fully automated by means of software. This running example of house ownership is used throughout this paper.

In the following section 2 we present the Grounded Theory approach that we applied in our research project. In section 3 we present our initial core category of disintermediation of trust in environments with highly institutionalized values which we compare with the academic literature on trust in section 4. The deliverable of this theoretical comparison is our final core category that we label power transfer in environments with highly institutionalized values. In section 5 we reflect on the consequences of this power transfer for the governance of blockchain systems. We conclude with a reflection on our research design and offer future research questions in section 6.

2 RESEARCH APPROACH

We used a Grounded Theory (GT) approch to conceptualize the institutional consequences of blockchain systems [43]. Grounded Theory is a highly explorative research method, which is aimed at developing a theory based on empirical, qualitative and quantitative data. Creswell [20] defines Grounded Theory as "a qualitative strategy of inquiry in which the researcher derives a general, abstract theory of process, action, or interaction grounded in the views of participants in a study" (p. 14). This allows us to use empirical data as an input for a conceptual framework that captures the consequences of implementing blockchain technology. Our data consisted of 56[2] sources that emerged in a process of theoretical sampling [43], ranging from corporate reports on blockchain technology, technical white papers, start-up websites and critical journalism. We only considered non-scientific literature, to stay as close to the empirical discussion as possible. Empirical data was collected using Google, with search terms "Blockchain, Distributed Ledger Technology, Report, Use case, Effects, Issues, Functions". The selected documents were published between 2015 and 2017, we analyzed them between January 2017 and April 2017. We only selected articles that followed our definition of blockchain technology, selected in-depth overviews over summarizing articles, and omitted highly technical white papers that provided no insights into the expected effects of blockchain technology. We coded the empirical data [72] using the computer-aided qualitative data analysis software ATLAS.TI [40]. We then used a Straussian Grounded Theory approach [18], which consists of an Open, Axial and Selective coding phase, to discern and conceptualize the consequences of blockchain technology. In these phases we used sensitizing concepts [11] to provide structure to the analysis. These were: Actors, Issues, Functions and Effects.
Our analysis resulted in a so-called Core Category, which is a single category that explains the current discussion on the consequences of blockchain implementation. This core category is presented in Section 3. This empirical core category is then related in section 4 to existing research in other fields, to further develop our conceptualization of the institutional consequences blockchain implementation. This core category is then used in Section 5 to provide insights into the implications for governance of these systems.

[1]Definition based on [29, 30, 44, 49, 56, 60, 62, 79, 82]

[2]**Appendix A** provides an overview of all sources

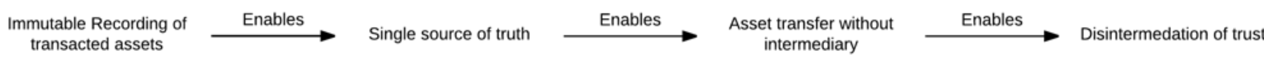

Figure 1: Overview of blockchain functions and effects

3 GROUNDED THEORY RESULTS

This section discusses the results of our Grounded Theory approach: the emergence of our empirical Core Category.

Based on the analysis of the empirical data in the open, axial and selective coding phases, we derived that the main function of blockchain technology is the *immutable recording of transacted assets*. We argue that this enables counterparties without a basis for trust to create a *Single Source of Truth*. This often-used phrase in blockchain systems is used to describe that a *single data-source* is created, which all participants in the network can agree on that the current state of this database is the *one and only correct state*. This in turn enables these counterparties to *transact assets without an intermediary* in a decentralized network. Thus, blockchain technology enables the removal of a trusted intermediary in these networks. Empirically, the consequence of blockchain technology is therefore captured by the notion: *The Disintermediation of Trust*. This relationship is visualized in Figure 1.

Our empirical data showed that blockchain technology is primarily used in the following environments: Finance, Health, Government, Insurance, Internet of Things, Music, Organizational, and Advisory. These environments are highly reliant on values, such as trust, customs and culture, which are institutionalized through a legal or institutional framework, or history. Due to these specific values, these environments were not disrupted by recent ICT-innovations, such as the Internet and Platforms (as defined by Hagiu and Wright [45]). This leads to the observation that blockchain technology is perceived as most useful in *Environments with highly institutionalized values*.

Consequently, we formulated the Core Category, that captures the consequences of Blockchain Technology from an institutional perspective as *"disintermediation of trust in environments with highly institutionalized values"*. In the next section we compare this initial Core Category based on the analysis of empirical data, to academic literature on trust to further refine it towards a final Core Category.

4 LITERATURE COMPARISON OF OUR CORE CATEGORY

In this section, we relate our Core Category of the blockchain discussion (disintermediation of trust in environments with highly institutionalized values) to existing literature in other fields. We focus on Trust Research, as our Empirical Core Category shows that shifting trust arrangements are the most important perceived consequences of blockchain technology. As this paper focusses on governmental responses to blockchain technology (governance *of* blockchain), not on governments as users of blockchain technology (governance *by* blockchain), it is highly important that governments understand the system they are governing. Therefore, we have chosen to focus our comparison on Institutional Trust Research, and not on Trust in Technology and Technology acceptance (as described by, amongst others, Pavlou and Belanger, Carter [4, 63])

4.1 Conceptualization of Trust

A multitude of conceptualizations of institutional trust exist[70]. In this research we use the conceptualization of institutional trust by Nooteboom [58], as it provides a high-level overview of Trust, including both personal and organizational trust, mitigation measures, and is based in Transaction Cost Economics/Institutional Economics, which allows us to further analyze trust from an institutional perspective.

Nooteboom [57], (further elaborated by Klein Woolthuis et al. [50]) provides a high-level overview of trust, which is visualized in Figure 2. Nooteboom conceptualizes trust in two types: *Competence trust* and *Intentional Trust*. The former being the trust that one (trustor) has in the abilities of a counterparty (trustee). This includes for example technical, organizational, cognitive abilities. The latter involves the trust one has in the intentions of a counterparty, especially how he might deal with opportunism.

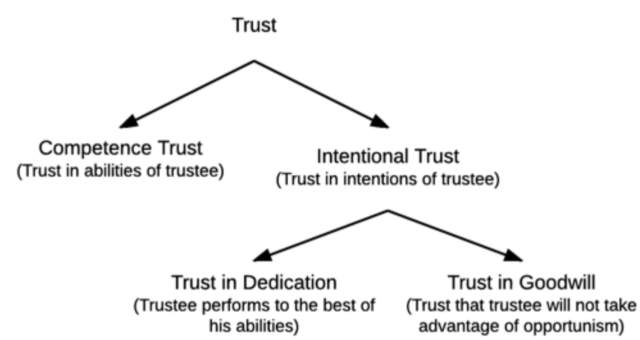

Figure 2: Conceptualization of Trust by Nooteboom (2002)

This Intentional Trust is then divided into two concepts: Passive Intentional Trust and Active Intentional Trust. Passive Intentional Trust entails a dedication to perform to the best of your abilities, and is therefore also called Trust in Dedication. Active Intentional trust is concerned with "interest seeking with guile" [81], the belief that a counterparty will not take advantage by lying, stealing or cheating, and is therefore called Trust in Goodwill.

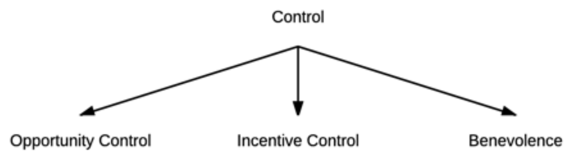

Figure 3: Conceptualization of Control by Nooteboom (2002)

Nooteboom [57] also conceptualizes mitigation measures, or measures to control a counterparty. Three main categories are conceptualized as (and visualized in Figure 3): Opportunity control, Incentive control and Benevolence.Opportunity Control entails controlling the opportunism that the counterparty, or trustee, has. The trustor restricts the possible actions that the trustee can make, thereby limiting opportunism. Incentive control entails incentivizing the trustee to refrain from opportunistic behavior due to dependency on the trustor, for example "hostages", relational consequences or material consequences. Benevolence limits the inclination towards opportunistic behavior by using norms, values or relations.

Finally, Nooteboom [58] suggests to use the term reliance as an overarching term that includes on the one hand control and on the other hand trust, reliance beyond control.

We use this conceptualization of Trust as Reliance, Trust and Control, to develop our core category on blockchain technology consequences. In other words: is our empirical data referring to trust as conceptualized by Nooteboom, or to something else?

4.2 BLOCKCHAIN TECHNOLOGY; TRUST OR CONTROL?

This section looks back at our empirical data to further develop our core category, using Nootebooms conceptualization of Reliance, Trust and Control. First, it uses examples of notions of trust in our Empirical data to analyze trust arrangements in blockchain systems. Then, we further develop those arrangements.

Analyzing our empirical data

Our analysis of the empirical data finds the following: more than 50% of articles in our dataset uses the term Trust in the text. This is still comparatively low, if we look at the importance of trust in our conceptualization of blockchain technology. However, when we take technical white papers, highly specialist implementations and critical journalistic pieces out of the equation this number becomes much higher (70%). This is also much higher than either control (10%), or reliance (5%). This was expected, as our current core category refers to trust instead of control or reliance. Trust is thus often used, but do these actors use trust as conceptualized by Nooteboom? We argue that they actually mean Control. This is exemplified by the following quotes that represent a larger trend in our empirical data:

Credit Suisse writes "Disintermediates trusted third party solving prisoners dilemma. To transact, you must trust that the:

(1) Value transfer commitment between parties will be met
(2) Other party has ownership over the value they agreed to transfer
(3) The value transferred is legitimate"[73]

IBM writes: "In business, trust is incredibly hard to engineer and impossible to guarantee. Until now, we have relied on instruments and institutions to be surrogates for our trust. With blockchains, trust can be embodied in the transaction itself. A far greater assurance of trust is now possible." [48]

Both quotes claim that blockchain enables "trust", but they provide examples of how blockchains increase the possibility of Control, instead of Trust. This trend is seen throughout our empirical data. This leads us to two important provisional conclusions:

(1) Blockchain technology is empirically often related to trust, but should rather be related to Control
(2) The empirical data suggests that if complete control is possible in blockchains, then no trust is needed.

The second conclusion relates to research into whether trust and control are substitutes or complements. Klein Woolthuis, Hillebrand and Nooteboom [50] conclude that trust and control can be substitutes (as well as complements), but that complete control is not possible. Futhermore, Nooteboom [59] concludes that "Complete, that is, unconditional or blind trust, is ill advised, and where trust ends one needs control. Vice versa, complete control is impossible, and trust is needed where control ends". Thus, current trust research implies that complete control of a counterparty is (so far) impossible. In blockchain systems this is no different.

Blockchain Technology enables us to create complete control in the outcome of a transaction, since a contract is always executed exactly as written. In the case of the transaction of a house, once a buyer and seller agree on the terms of sale of a house, blockchain technology enables them to transact without a trusted intermediary. They are 100% sure that the transaction goes as described and expected. However, it does not provide control over the intentions of the counterparty in this transaction. If both parties accept an incomplete contract, which favors one of the parties, blockchain systems will carry it out as described. In case of the transaction of a house, blockchain technology does not check whether the price the buyer is paying is fair, or whether the house is actually in the condition it was advertised. It does not provide control over the intentions of either party.

Thus, blockchain increases the amount of control that two counterparties have over each-other in a single transaction, but provide no complete control. Figure 4 visualizes this increase. Control between counterparties is highly increased within the blockchain systems, which might lead to a decreasing need for trust in this transaction.

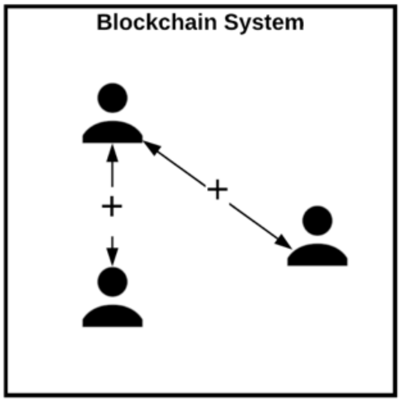

Figure 4: Increasing control between counterparties

We conclude that in the empirical discussion on the consequences of blockchain technology, a shift in Trust-arrangements is perceived as the most important consequence, , but that the discussions rather discuss shifting control-arrangements. Futhermore, we argued that complete control is not possible in all blockchain transactions or systems and thus, trust is still a factor in some blockchain environments. We therefore refine our Core Category to: disintermediation of control in environments with highly institutionalized values.

Whereas blockchain technology increases the control between counterparties in a transaction, from a systems-perspective, this is not necessarily the case. We elaborate on this difference in the following section.

4.3 CONTROL FROM A SYSTEMS PERSPECTIVE

This section discusses blockchain from a systems-perspective to analyze the control-arrangements within blockchain systems further. Blockchain environments are not only technologically highly decentralized so is their decision-making structure. Blockchain systems are governed by all end-users (referred to as nodes in the system). New rules, or adaptations to existing rules are only implemented if more than 50% of the end-users agree. In case of the transaction of a house, this means that the rules by which transactions of houses are validated should be accepted by at least 50% of the users. For example: if we want to add the necessity of identifying buyers/sellers via passports, 50% of all users should actively accept this change. Thereby creating a decentralized decision making structure.

We compare our refined Core Category to Decentralized Decision Making literature to further develop these insights. We use Bonabeau [29], an expert on collective intelligence in complex systems, to identify the main issues of decision-making in decentralized systems. Bonabeau concludes that "common to all forms of collective intelligence, is a loss of control" (p.48). In blockchain technology environments, control from a systems-perspective thus decreases. Figure 5 visualizes this decrease.

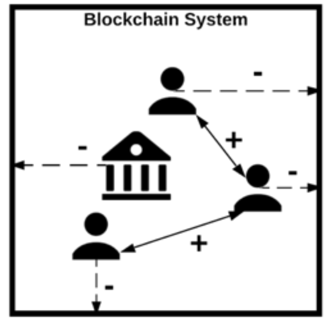

Figure 5: Decreasing control from a systems-perspective

Two main reasons can be discerned as to why blockchain systems provide less Control from a systems perspective.

First, we look at the decision-making structure in blockchain ecosystems, which is concerned with decisions that define the rules by which the blockchain system validates transactions. These can be seen as the internal governing structures of the blockchain system. These rules are ultimately not decided by developers, or a centralized entity, but by the users that are responsible for maintaining the Blockchain. These users, called validators or miners, use computing power to validate transactions. Only if more than half of these users agree with a rule change, they all update the rules for validation, and this new rule is implemented. Since all validators are, by design, anonymous this is an incredibly decentralized decision-making process. We therefore conclude that a single user has little to no effect on the governing rules of the blockchain system that s/he is part of, which decreases the control a single person has from a system perspective.

Second, the previous argument also holds for existing Trusted Third Parties. Their ability to control the rules of the blockchain system are highly limited. Of course, this is one of the main reasons why blockchain technology exists in the first place, but it also entails that Blockchain systems highly decrease the amount of control that one has from a systems perspective. In case of the transaction of a house, both single users as existing third parties see their power decreasing due to the large decentralized decision making processes they face.

Thus, we conclude that blockchain technology decreases control from a systems-perspective. Even though this is intentional and by design, it is an important and underappreciated effect of blockchain technology, as exemplified by the fact that we did not find any reference to this phenomenon in the empirical data of our study.

4.4 Final Core Category development

Based on the comparison and discussion of our initial core category with theoretical concepts from the domain of trust, we conclude that blockchain technology is a technology that increases control over counterparties in a transaction, but decreases control from a systems-perspective. This entails that end-users in the system experience an increase in their power through the decentralized decision making mechanisms, whereas power is decreased from a systems-perspective. As both an increase and a decrease in power is achieved, power is transferred. Therefore, we reformulated our initial core category into a final core category as follows: *power transfer in environments with highly institutionalized values.*

Blockhain technology enables the transfer of power from intermediaries and institutions towards end-users and technological mechanisms in environments that currently highly rely on institutionalized values such as governments, finance and health, etc. With this core category, we reach the first aim of our research, to provide a conceptualization of blockchain technology consequences from an institutional perspective. In the following section, we describe the effects of this conceptualization to provide insights into the institutional arrangements and governance of blockchain systems.

5 SHIFTING INSTITUTIONAL ARRANGEMENTS AND GOVERNANCE

As concluded in section 4.4, blockchain technology decreases control from a systems-perspective. The argument in that section was purely based on actors within the blockchain system, and therefore focused on the internal governing institutions that are grounded in the technical characteristics/design of a blockchain system. To provide more insights into the governance and institutional arrangements of blockchain systems, we now look into the external governing structures around the blockchain systems. Thus, we focus on control on the system from the outside. In contrast to the internal institutional governance of blockchains, the external institutional governance consists of legal- or institutional frameworks that govern these systems. Examples include laws, regulations and governments. These are important because blockchain based applications raise uncertainties for adoption by business, governments and citizens alike. And thus, uncertainties for the governance of blockchain systems and applications from a regulatory perspective.

First, we conclude that the arguments presented in section 4.3 hold for governance actors (such as regulators, lawmakers, banks) outside of the blockchain systems as well. Moreover, regulators are by definition not part of a blockchain system, and therefore have no power to change the rules that are set inside the blockchain system. Therefore, external control of a blockchain system decreases (visualized by Figure 6). In the case of the transactions of a house, the users define the rules by which houses are transacted instead of the existing regulatory arrangements. Since regulators are not users in this system they have no power to change or set regulations. The rules of the game have been institutionalized into the technological system, and could develop in complete contrast to what existing institutions prescribe.

Governments or other institutions facing difficulty to govern or regulate a technological innovation is not new. However, the specific shift in institutional arrangement caused by blockchain technology is special because blockchain systems are able to encapsulate institutional arrangements into their technical design, instead of into their governing ecosystem. This feature is at the core of why existing institutions are challenged by blockchain technology

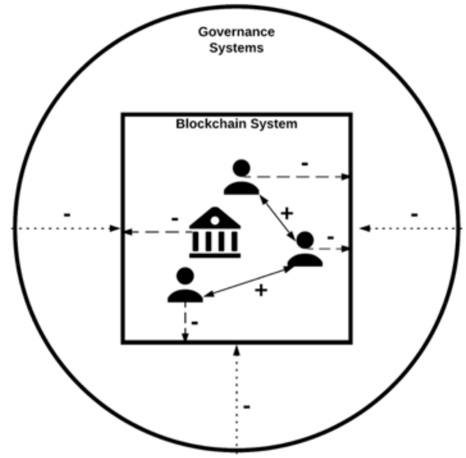

Figure 6: Control of blockchain systems from external governance systems

as its features increase the difficulty for governments to effectively govern blockchain systems. Blockchain technology is unique in the way in which governing institutions are engrained into the technological design of the system. It moves the institutional frameworks needed to govern the system from the existing outside-layer of governance institutions into the system itself. Blockchains thus, by design, circumvent the governance provided by these (historical) institutional frameworks, regulators and legal frameworks. These institutions still exist, but are engrained into the technological system. This creates a competing institutional framework to the existing institutional framework and governing ecosystem. For the first time, the technical system of blockchain technology enables us to engrain values and institutions such as trust and control into technology that were deemed to be irreplaceable by technology.

Furthermore, this ability enables blockchain technology to transform environments that were based on these institutional frameworks. These are exactly the environments which are referenced in the core category as "environments with highly institutionalized values".

Blockchain is thus a technology that engrains values and institutions in technology systems and pressures existing institutional frameworks, in sectors highly reliant on these institutional frameworks. It thereby lowers the control of existing institutional frameworks over these systems, challenging the existing institutions. Governments need to be aware of this notion to be able to more effectively find a balance between the governance of the blockchain systems and their innovative power.
To illustrate this, we explore the implications for three stakeholders in these systems: governments, existing private parties, and the blockchain ecosystem:

(1) **Governments**
Governments should realize that existing governing institutions can be challenged as they can be engrained into technological systems. Governments should therefore consider

new modes of governance that address this challenge and include these technologically engrained controlling institutions into their governing frameworks. It is paramount that governments strike a balance in these governing frameworks between fostering the innovative power and possibilities and possible negative effects (public values, black box society, etc.) of (applications based on) blockchain technology.

(2) **Existing Private Parties (incumbents)**
Private parties, in this case incumbents, should also realize that their existing governing structures are being challenged, and, as a consequence, their own roles in these structures are under pressure. Private parties that are highly reliant on existing institutional frameworks or values are at risk of being disintermediated as their institutional role is potentially replaced by technology.

(3) **Blockchain ecosystem**
Blockchain ecosystems should realize that, even though "old" institutions are being replaced by blockchain technology, there are still institutional frameworks in the "real world" that they will eventually become a part of. The integration of the technological internal institutional frameworks of blockchain systems, and existing institutional frameworks will be most successful when the blockchain ecosystem becomes a part of a discussion on how to combine both worlds most effectively.

In this section, we conclude that blockchain technology lowers control on systems from outside actors or institutional frameworks, by engraining existing institutional structures into the technological design of the system. Thus, blockchain technology enables the technologicl institutionalization of values in environments that are highly dependent on said values. We believe that this is at the core of why existing institutions are being pressured by blockchain technology, which increases the difficulty for governments to effectively govern the decentralized blockchain systems that transcend national borders.

6 CONCLUSION

In this paper we provided an overview of the current blockchain discussion by using a Grounded Theory approach that led to the emergence of our empirical Core Category: *disintermediation of trust in environments with highly institutionalized values.*

This empirical Core Category was based on the empirical data that represents the discussion of blockchain technology as a new general purpose technology. It represents that blockchain technology is predominantly related to trust. However, following the theoretical comparison of this empirical Core Category with the conceptualization of Reliance, Trust and Control by Nooteboom, we show that blockchain technology should be more related to control, instead of trust. Nevertheless, as complete control is not possible in some blockchain transactions or systems, trust is still a factor in blockchain environments.

At first sight, this seems merely a semantic difference. However, this difference could further structure the blockchain discussions, and provide both practitioners as researchers with an important caveat to blockchain implementation: complete control, making trust unnecessary, in blockchains might not always be possible, even though blockchains do significantly improve the possibilities for control. Actors should therefore consider blockchain technology from a control-perspective instead of a trust-perspective to fully understand this technology and its consequences.
Furthermore, we concluded that blockchain Technology is a technology that increases control over counterparties in a transaction, but decreases control from a systems-perspective. A transfer of power in the system takes place in blockchain environments. We therefore conceptualized our final Core Category as: power transfer in environments with highly institutionalized values.

This conceptualization of blockchain technology helps to create understanding of the possibilities of the technology and enables actors to discuss the essence of blockchain consequences, thereby structuring this discussion and helping actors with the decision whether to implement blockchain technology and its consequences in highly institutionalized environments such as the financial sector, governments, and the notary.

Furthermore, we conclude that blockchain technology lowers control on blockchain systems for external actors or institutional frameworks, by engraining existing institutional structures into the technological design of the system. Thus, blockchain technology enables the technological institutionalization of values in environments that are highly dependent on said values.

Future research is needed to help governing bodies find a balance, using the notion previously presented, between fostering the innovative power and to mitigate possible negative effects of blockchain technology. This requires studies into blockchain applications in different institutional contexts to explore how the accommodation within existing (legal) framework is taking place and from which more generic lessons can be drawn. Another future research approach is to explore the consequences of blockchain ecosystems by its very character of a distributed ledger that transcends national boundaries and the interactions with national regulatory frameworks. From the perspective of public and private organizations the uncertainties for blockchain adoption (rooted in either institutional frameworks, the evolving technology or its embedding in processes) need to be explored in-depth in order to formulate design criteria for blockchain based applications that fit into the highly institutionalized environments.

Furthermore, this research only considered public, permissionless blockchains [61]. Our conclusisions are still valid under other (less open) blockchain systems, such as private or permissioned blockchains. However, since validators in those networks are picked and regulated the loss of control from a systems-perspective is also reduced. Future research is needed to develop the notions provided in this paper for these types of blockchain systems.

Finally, future research is needed to develop these notions with more recent empirical data. Due to time-limitations of the research project we were unable to analyze more recent empirical data and literature. Since our analysis in the beginning of 2017 more data has become available, especially with a more critical note. Also, more scientific literature on Blockchain Technology from a non-technical perspective was added. This research still provides a much needed *theoretical and fundamental* analysis of blockchain systems, which are currently severely lacking.

A APPENDIX A: EMPIRICAL DATA

Table 1: Overview of Empirical data

Author or Organization	Reference
Algemeen Dagblad	[1]
Ascribe	[2]
Backfeed	[3]
Bitnation	[6]
Berkeley	[5]
Bitshares	[7]
Tapscott & Tapscott	[74]
BlockchainHealth	[8]
Blockverify	[9]
Bloomberg	[10]
CIO	[13, 14]
Cognizant	[15]
Colony	[16, 17]
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Credit Suisse	[73]
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